Chapter I
A Qualitative Meta–Analysis of Computer Games as Learning Tools

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ABSTRACT

Drawing on grounded theory approach and a qualitative meta-analysis, this chapter intends to systematically review and synthesize the theories, methods, and findings of both qualitative and quantitative inquiries on computer-based instructional games. A major purpose of this literature review and meta-analysis is to inform policy and practice based on existing studies. Four major recurring themes concerning the effectiveness of computer-based instructional games have emerged from a comparative analysis with 89 instructional gaming studies and are discussed with the support of exemplar research. The chapter will assist practitioners and policymakers in understanding the “best practices” and key factors of a computer game-based learning program.

INTRODUCTION

Recently computer games have been anticipated as a potential learning tool with great motivational appeal and represent an interesting development in the field of education. The literature surrounding computer games and education is vast. For more than two decades, educationalists (e.g., Betz, 1996; Gee, 2003; Gredler, 1996; Kafai, 1995; Malone, 1981; Prensky, 2001; Rieber, 1996; Squire, 2003) have been investigating the potential that exists for the application of computer games to learning.

Given the broad nature of computer games, a substantial question exists as to what basic insights the literature provides on the design and application of computer-based games for learning.

As a recent search shows, there are currently more than 600 research/report articles within the category of computer games in the literature. These articles fall into generalized categories with a great deal of variance within the categories. These categories include theoretical speculation (e.g., Garris, Ahlers, & Driskell, 2002; Gee, 2003), experimental or descriptive clinical study (e.g.,
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Ke, 2007; Barab, Sadler, Heiselt, Hickey, & Zui-ker, 2007; Squire, 2003), and review of existing research (e.g., Dempsey, Rasmussen, & Lucassen, 1996; Randel, Morris, Wetzel, & Whitehill, 1992). Even within the same general category, games studies vary in theoretical framework, research purpose, methodology of data collection and analysis, and game genre adopted. Further, the findings of these games studies are conflicting (Dempsey et al., 1996; Emes, 1997; Randel et al., 1992).

Given this multi-vocal data pool, a systematic review with rigorous qualitative meta-analysis is warranted to generate a clearer profile of computer games. The review should indicate what meta conjectures or recurring themes we can form from the huge quantity of often disassociated studies on the learning effectiveness of computer games. It should also illustrate what are the best models or best practices of designing and applying computer games for education.

This proposed chapter is an attempt to systematically review and synthesize the literature on the subject of computer-based instructional games. Specifically, the chapter addresses the following questions: (1) What is the cumulative qualitative and quantitative evidence for using computer games for learning, and (2) What are the factors, if any, that weigh in an effective application of instructional gaming?

**BACKGROUND**

**Definition of Terms**

**Computer Game**

Scholars (Dempsey et al., 1996; Malone, 1981) defined a game as “usually a contest of physical or mental skills and strengths, requiring the participant(s) to follow a specific set of rules in order to attain a goal” (Hogle, 1996, p. 5). More specifically, Prensky (2001) defined a game as organized play including six key structural elements: rules, goals and objectives, outcomes and feedback, conflict/competition/challenge/opposition, interaction, and representation or story.

There is a wide category of games under Prensky’s game conceptualization. For the purpose of this research, a computer game is:

- Operated on a variety of personal computer platforms
- Developed for formal learning or adapted for informal learning
- Comprising rules, goals and objectives, outcomes and feedback, conflict/competition/challenge/opposition, interaction, and representation or story (Prensky, 2001)

In addition, a game is defined as being separate from a simulation in that a game involves competition. According to Dempsey et al. (1996), a competitive format does not necessarily require two or more participants. If a simulation enables a learner to compete against him or herself by comparing scores over successive attempts at the simulation, or has a game structure imposed on the system, it is regarded as a game mode. If the focus of a simulation involves the completion of an event only, the simulation will not be considered a game.

Multiple categories of computer games have been identified in this review, including but not limited to adventure games, simulation games, board games, puzzle games, business simulation games, action games, and strategy games.

**Learning**

In this study, learning is conceptualized as a multidimensional construct comprising all three components: “skill, metaskill, and will,” or in other terms, cognitive learning achievement, metacognition, and motivation (Mayer, 1998, p. 51). Gagne (1985) defined cognitive learning achievements as comprising declarative, proce-
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dural, and strategic knowledge. Metacognition in this study refers to knowledge or awareness of cognitive processes and the ability to use self-regulatory mechanisms to control these processes (Eggen & Kauchak, 1997). This study adopts an expectancy-value model of motivation. Specifically, the model proposes that there are three motivational components: (a) an expectancy (or perceived competence) component, which includes students’ beliefs about their ability to accomplish certain tasks; (b) a value component, which includes students’ goals and beliefs about the importance and interest of the task; and (c) an affective component, which includes students’ emotional reactions to the task (Pintrich & De Groot, 1990, p. 33).

Computer Games for Learning

Theoretical Perspectives on Computer Games for Learning

Several theoretical perspectives, such as Piaget’s Theory of Intellectual Development, Situated Learning, and Information Processing Theory, may underlie the surging interest in deploying computer games for learning. Piaget (1951) considered play and imitation as two crucial functions in a child’s intellectual development process: play as an assimilation strategy and imitation as an accommodation strategy. Extensive research on play with children and adults in anthropology, psychology, and education indicates that play is an important mediator for learning and socialization throughout life (Csikszentmihalyi, 1990; Provost, 1990). Given the natural role that play and simulation serve to intellectual development, computer games as a vehicle for both play and simulation are not just a diversion to children, but an integral part of their learning and social lives.

Researchers have stressed the importance of anchoring or “situating” learning in authentic situations (Brown, Collins, & Duguid, 1989; Choi & Hannafin, 1995; Cognition and Technology Group at Vanderbilt, 1990). One benefit is making learners become engaged by the material, thus invoking a state of “mindfulness” in which learners employ effortful and metacognitively guided processes (Salomon, Perkins, & Globeroson, 1991). Learning in a mindful way results in knowledge that is considered meaningful and useful, as compared to the inert knowledge that results from decontextualized learning strategies (such as traditional classroom worksheets). With simulated visualization, authentic problem solving, and instant feedback, computer games afford a realistic framework for experimentation and situated understanding, hence can act as rich primers for active learning (Laurel, 1991; Gee, 2003).

Information processing theory (Miller, 1956), along with aspects of dual coding theory (Clark & Paivio, 1991) and cognitive load theory (Sweller, 1988), also sheds light on computer games’ potential to facilitate learning. Information processing theory states that novel information must be processed in working memory in order to construct schemata in long-term memory. Multi-sensory information representation in a computer game will facilitate schema construction by offering a learner a “ready-made” explicit representation of the complicated concept, providing just the type of external support that would be required for the construction of a internal mental model. This external support, as stated by Gredler (1996, p. 597), “reduces the cognitive load and allows students to use their precious working memory for higher-order tasks.” Furthermore, the multi-sensory representation in computer games also helps the schema indexed in memory in multiple formats, thus making the schema accessible in more than one way.

Findings of Previous Gaming Reviews/Meta-Analysis

A discussion of previous gaming reviews offers an overview of the literature. It also highlights
the limitations of previous reviews and illuminates how this current review will expand the previous research using a grounded meta-analysis method.

According to Garris et al. (2002), the following are tangible reasons for using computer games for learning purposes:

- Computer games can invoke an intensity of engagement in learners.
- There are empirical studies in the literature showing that computer-based instructional games have a wide spectrum of utility for learning (Dempsey et al., 1996; Randel et al., 1992). The learning outcomes measured include attitudes, cognitive strategies, problem solving, rules, and corporate concepts. Computer games have been applied in diverse environments from school education to training in military, healthcare, and management.

Six recent literature reviews (Dempsey et al., 1996; Emes, 1997; Hays, 2005; Randel et al., 1992; Vogel et al., 2006b; Wolfe, 1996b) were identified as being undertaken in areas associated with the use of computer games for learning purpose. The following section summarizes the results of these review articles. Other review reports (e.g., Van-Sickle, 1986; Hogel, 1996; Leemkuil, de Jong, & Ootes, 2000) have not been summarized but used to locate original computer game articles.

Recently, Vogel et al. (2006b) conducted a quantitative meta-analysis with 32 studies on computer games and interactive simulation. They reported strong, positive effect sizes of interactive simulations and games vs. traditional teaching methods for both cognitive gains and attitude. Their analysis also indicated that the effects of games and interactive simulations sustained across people (in terms of gender and age) and situations (in terms of learner control, level of realism, and individual/group usage). However, Vogel et al. (2006b) noted that the effect size analysis of computer games, different from that of interactive simulations, yielded a low reliability and hence should be considered with caution.

Randel et al.’s (1992) review on video games, examining 68 early studies up to 1991, compared the effect of games and simulations with that of traditional classroom instruction on student performance. It produced the following results: of the 68 studies, 38 (56% of the studies) found no difference, 22 (32%) found differences favoring simulations/games in student performance, 7% favored simulations/games but their controls were questionable, and 5% found differences favoring conventional instruction. The authors concluded that the beneficial effects of games were most likely to be found when specific content was targeted and objectives precisely defined. In many studies students reported more interest in game activities than in conventional classroom instruction. Business games were not included in Randel et al.’s review.

Wolfe (1997), conversely, reviewed only studies regarding computer-based business games used in strategic management coursework. These studies all used comparative design with at least one treatment and one control group. He found evidence for the effectiveness of business games. In every study cited in the article, game application produced significant knowledge-level increases and was superior to conventional case-based teaching in producing knowledge gains.

Dempsey et al. (1996) examined 99 studies for common threads in the instructional game literature. They found the preponderance of games intending to promote higher-level intellectual skills and attitudes learning as opposed to verbal knowledge outcomes. They also found that games served many functions such as tutoring, amusing, helping to explore new skills, promoting self-esteem, practicing existing skills, drilling existing skills, automatizing, and seeking to change an attitude. Practicing existing skills (n = 22) was the highest frequency, and learning new skills (n = 21) was a close second. From
the studies reviewed, they delineated a list of assertions for using and designing instructional games, such as using intrinsically motivating games, employing instructional support features (e.g., debriefing, flexible scoring, progression of complexity), and selecting game genres based on learning objectives.

Another review on instructional games (Emes, 1997) examined games’ use with children and found no clear causal relationship between academic performance and the use of computer games. Although Emes’ (1997) finding was based on three studies, his conclusion was confirmed by Hays (2005), who examined 105 instructional gaming articles. Hays’ review (2005) reported:

*There is no evidence to indicate that games are the preferred instructional method in all situations*” and “although some games can provide effective learning for a variety of learning for several different tasks (e.g., math, attitudes, electronics, and economics), this does not tell us whether to use a game for our specific instructional task. (p. 6)

These past analyses/reviews highlighted six major themes:

- The literature base is sparse. Although many articles discussed the use of instructional computer games, most of the literature was based on the authors’ opinions on the potential of instructional games or propositions on how games would be developed to be instructionally sound. Far fewer articles documented the empirical data on the effectiveness of instructional games (Hays, 2005; Dempsey, et al. 1996).
- Empirical studies’ findings conflict (Dempsey et al., 1996; Randel et al., 1992; Vogel et al., 2006b). It appears that few firm conclusions can be drawn from the studies and there is no evidence that games can provide effective learning in all situations.
- The empirical research on instructional games is fragmented. Prior studies focused on different clusters of factors when evaluating the effects of an instructional game - administrative variables (game environment), learner variables (e.g., gender or academic ability), procedural variables (game-based activity, such as game-facilitated cooperative learning), and game variables (e.g., game genre and media) (Dempsey et al., 1996; Williams, 1980).
- Much of the work on the evaluation of games has been anecdotal, descriptive, or judgmental (Dempsey et al., 1996).
- Longitudinal studies are needed (Emes, 1997).
- A breakdown of the available studies by subject matter reveals that some knowledge domains are particularly suited to gaming, such as math, physics, and language arts (Randel et al., 1992; Hays, 2005).

On the other hand, the prior reviews of instructional computer games had the following limitations:

- Some existing reviews excluded qualitative studies. For example, Vogel et al. (2006b), Randel et al. (1992), Wolfe (1997), and VanSickle (1986) examined all quantitative studies in their reviews.
- Most of the existing reviews (e.g., Dempsey et al., 1996; Hays, 2005; Hogel, 1996; Leemkuil et al., 2000) were narrative literature reviews that did not reveal the decision rules used to synthesize findings from various studies, hence a lack of analytic rigor and objectivity (Hossler & Scalese-Love, 1989).
- Some existing reviews included low-quality studies or non-empirical reports that plagued the analysis result (Slavin, 1986).
MAIN FOCUS OF THE CHAPTER

Method

Drawing on grounded theory approach, the author conducted a qualitative meta-analysis to synthesize the theories, methods, and findings of both qualitative and quantitative inquiries of computer-based instructional games. Qualitative meta-analysis basically followed the same, replicable procedure of a quantitative meta-analysis, but was more interpretative than aggregative. Instead of a statistical data analysis, the researcher analyzed textual reports, creating new interpretations in the analysis process.

This study has utilized qualitative rather than quantitative meta-analysis, not because numbers are non-existent. The qualitative variant has been used specifically because it is an approach towards formulating a complete depiction of the subject and because a quantitative meta-analysis will exclude qualitative evaluation that is a major grouping in the literature. As Michelsen, Zaff, and Hair (2002) have stated, “…not every intervention strategy lends itself to an experimental evaluation.” This statement is especially true in the case of instructional games research. In the current review, descriptive and case studies comprised almost 50% of the literature. In agreement with this discovery, Dempsey et al. (1996) have argued that although experimental studies have an important place in the instructional games literature, “there is a budding movement” to look at incidental learning using process-oriented inquiry. Because the instructional games literature itself comprises both qualitative and quantitative data, the integration of both qualitative and quantitative information is essential for a thorough synthesis of the literature for a complete state-of-the-art understanding of the domain.

Although some researchers regarded qualitative review methods as appropriate for interpreting qualitative data only, others (e.g., Noblitt & Hare, 1988; Light & Pillemer, 1982) proposed the possibility of qualitatively synthesizing both qualitative and quantitative information. Specifically, Hossler and Scalese-Love (1989) developed the grounded meta-analysis using Glaser and Strauss’s grounded theory approach. Following their example, the study adopted qualitative meta-analysis and a thematic synthesis approach associated with grounded theory.

Trustworthiness of findings was achieved by using multiple coders for peer examination (Creswell, 1994). The actual procedure of research synthesis abided by the proposition of Hossler and Scalese-Love (1989) and is presented in the following sections.

Data Collection

A set of criteria was specified to select appropriate research for this study (Slavin, 1986). Preliminary criteria included:

- Content relevance - research focused on the design or application of computer-based games for learning purpose.
- Year of publication was 1985-2007
- English-language publications

The data search was systematic and exhaustive within the data pool consisting of computerized bibliographic databases (i.e., ERIC, PsycInfo, Educational Research Complete, Dissertation Abstracts, ACM), major education and technology journals, conference proceedings, and the reference lists of several reviews. A total of 256 studies were reviewed in the course of this analysis.

Data Coding and Analysis

When conducting the literature search, the author paid special attention to the studies that established components to be used in creating frameworks for analysis. An initial open-ended coding matrix was developed to delineate each study’s stated purpose, method, intervention, learner, sample
Results

A total of 256 documents on the design, use, and evaluation of computer-based games were reviewed. Of these, 167 could not be included in the analysis:

- 20 articles focused on the effects of games on non-learning-oriented outcomes, such as the effect of an action game on children’s aggression and violent behaviors, and the effect of computer video game on body movements of children with ADHD.
- 13 articles were computer-based instruction studies where gaming was only a contextual element but not the research focus.
- 45 were either development articles that described the design and development of a specific instructional game, or discussion articles that described opinions on an instructional game without empirical or systematically presented evidence (Dempsey et al., 1996).
- 45 articles presented only theoretical proposition or conceptual analysis on instructional game design principles or potential game-based learning processes.
- 18 articles were research reviews - synthesis of articles concerning games in general.
- 6 articles presented only propositions on future game application and research.
- 20 articles documented studies that were labeled as low quality.

Eighty-nine research articles that provided empirical data on the application and effectiveness of computer-based instructional games were included in the current analysis. Qualitative outlines of empirical studies coded were synthesized and are presented in Table 1. The table also revealed the coding rules used to synthesize findings from various studies and illuminated the potential factors that might weigh in an effective application of instructional gaming.

Discussion

Four major recurring themes concerning the effectiveness and key influence factors of computer-based instructional gaming have emerged from a comparative analysis with 89 computer...
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<tr>
<th>Study</th>
<th>Purpose</th>
<th>Method</th>
<th>Sample Size</th>
<th>Timeframe</th>
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<tbody>
<tr>
<td>Abbey (1993)</td>
<td>Evaluate the effectiveness of game and explore game-based learning activity/ pedagogy</td>
<td>Quantitative (experimental)</td>
<td>86</td>
<td>1 lab session</td>
<td>Simulation game (as stand-alone or complementary pedagogical instrument)</td>
<td>College students</td>
<td>Non-content-related problem solving</td>
<td>General learning</td>
<td>Cognitive strategy near and far transfer</td>
<td>Gaming promoted far transfer significantly more than the conventional instruction, but not near transfer; there was no difference between the two gaming groups; and conventional instruction group solved significantly more levels.</td>
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<tr>
<td>Alkan &amp; Cagiltay (2007)</td>
<td>Explore game-based cognitive process</td>
<td>Mixed-method</td>
<td>15</td>
<td>1 lab session</td>
<td>Puzzle game</td>
<td>College students</td>
<td>Non-content-related problem solving</td>
<td>Informal learning</td>
<td>Cognitive strategy</td>
<td>Trial-and-error strategies were mostly used.</td>
</tr>
<tr>
<td>Anderson (2005)</td>
<td>Explore game-based learning activity</td>
<td>Quantitative (correlational - causal)</td>
<td>172</td>
<td>4 weeks</td>
<td>Business simulation game</td>
<td>College students</td>
<td>Business management</td>
<td>Higher education course work</td>
<td>Student affect toward game-based learning</td>
<td>Team dynamics (e.g., cohesiveness and heterogeneity) influenced students’ game playing performance and their affect toward game.</td>
</tr>
<tr>
<td>Bahr &amp; Raith (1989)</td>
<td>Explore game-based learning activity</td>
<td>Quantitative (experimental)</td>
<td>46</td>
<td>4 weeks (with 10 minutes per day and 3 days per week)</td>
<td>Other drill- and-practice game</td>
<td>Mildly handicapped junior high students</td>
<td>Math</td>
<td>School education course work</td>
<td>Test-based cognitive learning achievement</td>
<td>Students gained math learning achievement during gaming, but there was no significant effect of goal conditions (cooperative, competitive, and individualistic condition).</td>
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<tr>
<td>Barker, Brinkman, &amp; Durandoff (1995)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (quasi-experimental with qualitative interviewing)</td>
<td>26</td>
<td>1 lab session</td>
<td>Role playing/ simulation game</td>
<td>Pair of a child (mean age: 14) and a biological parent (mean age: 44) who had not been divorced for more than 3 years</td>
<td>Divorce adjustment</td>
<td>Informal learning</td>
<td>Rule learning and self-reported behavior change</td>
<td>There was no significant improvement in knowledge, but subjects reported positive behavior change for divorce adjustment.</td>
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<td>Bartholomew et al. (2000)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>171</td>
<td>40-minute gaming session</td>
<td>Adventure game</td>
<td>Children with asthma, ages 7-17</td>
<td>Asthma self-management skills</td>
<td>Health education</td>
<td>Descriptive knowledge and behavior change</td>
<td>Gaming increased knowledge for older children and for those who scored higher at pre-test, and gaming intervention was associated with less hospitalization. Effective reaction was favorable.</td>
</tr>
<tr>
<td>Ben-Zvi (2007)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>90</td>
<td>1 semester</td>
<td>Business simulation game</td>
<td>Graduate students</td>
<td>Business functions</td>
<td>Higher education course work</td>
<td>Student affect toward game-based learning</td>
<td></td>
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<tr>
<td>Study</td>
<td>Purpose</td>
<td>Method</td>
<td>Sample Size</td>
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<td>Learning Outcome</td>
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<tr>
<td>Cahill (1994)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>3,829</td>
<td>n/a</td>
<td>Simulation game</td>
<td>5-8th graders</td>
<td>AIDS education</td>
<td>Informal health education</td>
<td>Game-based learning process/ experience</td>
<td>Learning experience was enhanced, and positive attitudes toward subject were developed.</td>
</tr>
<tr>
<td>Cameron &amp; Dwyer (2005)</td>
<td>Evaluate the effectiveness of game and the influence of learner’s cognitive style, and explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>422</td>
<td>45-minute gaming session</td>
<td>Other (drill-and-practice game)</td>
<td>College students</td>
<td>Knowledge about heart</td>
<td>Higher education course work</td>
<td>Descriptive and conceptual knowledge</td>
<td>Simple gaming was not more effective than the conventional instruction in promoting achievement; gaming with questions and elaborative feedback was significantly more effective than the simple gaming and conventional instruction; there was no significant intervention between learners’ cognitive style (TD/FI) and gaming.</td>
</tr>
<tr>
<td>Cauzinille-Marmeche &amp; Mathieu (1989)</td>
<td>Explore game-based cognitive process</td>
<td>Qualitative (cognitive task analysis)</td>
<td>120</td>
<td>1 lab session</td>
<td>Puzzle game</td>
<td>Children ages 7-15</td>
<td>Non-content-related problem solving</td>
<td>General learning</td>
<td>Cognitive strategy</td>
<td>A deductive model was used predominantly by 11- through 15-year-olds, a rule-based model was used predominantly by the youngest subjects, a development trend was observed from rule-based model to deductive model. Affective reaction was favorable.</td>
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<tr>
<td>Chang, Yang, Chan, &amp; Yu (2003)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (case study)</td>
<td>78</td>
<td>1 lab session</td>
<td>Board games</td>
<td>College students</td>
<td>Multiple subject topics</td>
<td>Higher education course work</td>
<td>Student affect toward game-based learning</td>
<td>Game promoted student motivation (esp. low achievement students) to learning.</td>
</tr>
<tr>
<td>Chen, Shen, Ou, &amp; Liu (1998)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>n/a (6 classes)</td>
<td>One 2-hour lab session</td>
<td>Multi-user game</td>
<td>College students</td>
<td>Web navigation skills</td>
<td>Online learning</td>
<td>Motivation</td>
<td>Straight forward drill was more effective than the game format for learning-disabled students.</td>
</tr>
<tr>
<td>Christensen &amp; Gerber (1990)</td>
<td>Evaluate the effectiveness of game and the influence of learner characteristics</td>
<td>Quantitative (experimental)</td>
<td>60</td>
<td>n/a</td>
<td>Arcade drill-and-practice game</td>
<td>Elementary-level students (learning-disabled and non-disabled)</td>
<td>Math</td>
<td>School education course work</td>
<td>Factual/ descriptive knowledge</td>
<td>Game (with pedagogical agent) promoted more learning (marginally significant) than game only. Students learned little from game without any external guidance.</td>
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<tr>
<td>DeJean, Upritis, Koch, &amp; Young (1999)</td>
<td>Explore the interaction between learner characteristics and instructional game</td>
<td>Qualitative (case study)</td>
<td>104</td>
<td>6 months</td>
<td>Massive multiplayer online game</td>
<td>Students ages 12-13</td>
<td>Math</td>
<td>School education course work</td>
<td>Game-based learning experience</td>
<td>Most girls lacked awareness of math content embedded in the game.</td>
</tr>
<tr>
<td>Study</td>
<td>Purpose</td>
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<tr>
<td>Dempsey, Haynes, Loosens, &amp; Casey (2002)</td>
<td>Explore instructional game design</td>
<td>Qualitative</td>
<td>40</td>
<td>1 lab session</td>
<td>A variety of game genres for educational purposes</td>
<td>Adults ages 18-52</td>
<td>Multiple subject topics</td>
<td>General learning</td>
<td>Affect toward game-based learning</td>
<td>All game genres had potential for educational use and different learning outcomes.</td>
</tr>
<tr>
<td>Forsyth (1986)</td>
<td>Explore instructional game design and the influence of learner characteristics (gender)</td>
<td>Quantitative (experimental)</td>
<td>120</td>
<td>40-minute gaming session</td>
<td>Adventure game</td>
<td>4th and 5th graders</td>
<td>Place location learning</td>
<td>School education course work</td>
<td>Cognitive recall and retention, and affect toward game-based learning</td>
<td>Game-with-map groups outperformed the no-map group in instant recall test; labels-with-game groups outperformed the other groups; all groups showed high level of retention of knowledge after 2 weeks, there was no influence of gender on learning or attitude.</td>
</tr>
<tr>
<td>Foss &amp; Elkaas (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>1,200</td>
<td>n/a</td>
<td>Simulation game</td>
<td>College students</td>
<td>Engineering</td>
<td>Higher education course work</td>
<td>Affect toward game-based learning</td>
<td>Affective feedback to game use was favorable.</td>
</tr>
<tr>
<td>Goldsworthy, Barab, &amp; Goldsworthy (2000)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>59</td>
<td>Twice (30-50 minutes each session)</td>
<td>a week for 4 weeks</td>
<td>Simulation game</td>
<td>Adolescents ages 10-16 with ADHD</td>
<td>Non-content-related social problem solving</td>
<td>Informal learning</td>
<td>Social problem solving, social behavioral rating, and level of engagement</td>
</tr>
<tr>
<td>Gopher, Weil, &amp; Buekenk (1994)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>58</td>
<td>10 1-hour sessions</td>
<td>Flight simulation game</td>
<td>Cadets ages 18-20</td>
<td>Flight training</td>
<td>Flight training for cadets</td>
<td>Problem solving and motor skills in actual flight performance</td>
<td>Game group was significantly better in flight performance than the control group.</td>
</tr>
<tr>
<td>Gabbe &amp; Dosmann (1988)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>70</td>
<td>n/a</td>
<td>Adventure game</td>
<td>6th graders</td>
<td>Reading</td>
<td>School education course work</td>
<td>Cognitive text-processing and metacognitive skill</td>
<td>There was evidence for game's effect on text-processing and metacognitive skill development.</td>
</tr>
</tbody>
</table>

Table 1. continued
<table>
<thead>
<tr>
<th>Study</th>
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<th>Learning Outcome</th>
<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greenfield, Camaioni, Ercolani, &amp; Weiss (1994)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (correlational-causal)</td>
<td>200</td>
<td>n/a</td>
<td>Entertaining action game</td>
<td>College students</td>
<td>Scientific-technical discovery</td>
<td>Informal education</td>
<td>Cognitive strategy</td>
<td>Knowledge of the game was developed as a result of inductive discovery process and subjects' gaming performance correlated with their test performance with scientific-technical discovery. Game was more effective (than lectures) in promoting post-test performance. Game enhanced learning. There was no effect of gender on game-based math learning achievement, but females gave more evidence of using metacognitive, cognitive, and cooperative strategies. Females showed higher motivation through relevance, while males were more motivated by challenge in terms of self-esteem. Game facilitated the improvement in multiple cognitive outcomes, from basic recall to higher-level thinking (classification and inference), as well as in usage of scientific language. Transfer was not significant. Subjects demonstrated substantial skill development and maintenance. Gender and challenge level in game influenced students' flow experiences and game-playing behavior. Girls had more tendency playing mind games, boys enjoyed the game playing and forming group more than girls; ludology had more effect than the narratology of games on flow of boys, while girls were the opposite.</td>
</tr>
<tr>
<td>Gremmen &amp; Potters (1997)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>47</td>
<td>1 semester</td>
<td>Economic simulation game</td>
<td>College students</td>
<td>Economic education</td>
<td>Higher education course work</td>
<td>Conceptual knowledge</td>
<td></td>
</tr>
<tr>
<td>Halhtunen &amp; Sormunen (2000)</td>
<td>Evaluate the effectiveness of game</td>
<td>Qualitative (case study)</td>
<td>n/a (1 class)</td>
<td>1 tutoring session</td>
<td>Simulation/ modelling game</td>
<td>College students</td>
<td>Information search strategy</td>
<td>General learning</td>
<td>Rule learning</td>
<td></td>
</tr>
<tr>
<td>Haynes (2000)</td>
<td>Explore the interaction between learner characteristics and game, and instructional game design</td>
<td>Mixed-method (quasi-experimental and qualitative interviewing)</td>
<td>5 classes</td>
<td>1 lab session</td>
<td>n/a (educational game)</td>
<td>9th graders</td>
<td>Math</td>
<td>School education course work</td>
<td>Test-based cognitive learning achievement, attitude (value) toward subject</td>
<td></td>
</tr>
<tr>
<td>Henderson, Klemes, &amp; Eshet (2000)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method</td>
<td>20</td>
<td>45-minute session daily for 6 weeks</td>
<td>Microworld simulation game</td>
<td>2nd graders</td>
<td>Science education</td>
<td>School education course work</td>
<td>Descriptive knowledge, conceptual knowledge, problem solving, and transfer</td>
<td></td>
</tr>
<tr>
<td>Horn, Jones, &amp; Hamlett (1991)</td>
<td>Evaluate the effectiveness of game</td>
<td>Qualitative (case study)</td>
<td>3</td>
<td>n/a</td>
<td>Action game</td>
<td>Non-vocal students (ages 5-8) with severe physical handicaps</td>
<td>Basic motor skills</td>
<td>Special education</td>
<td>Scanning and selection motor skills</td>
<td></td>
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<tr>
<td>Inal &amp; Cagiltay (2007)</td>
<td>Evaluate the interaction between gender and game</td>
<td>Mixed-method (case study)</td>
<td>33</td>
<td>1 hour per week for 6 weeks</td>
<td>A variety of game genres</td>
<td>Children ages 7-10</td>
<td>Social skill development</td>
<td>General learning</td>
<td>Game-based experience</td>
<td></td>
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<tr>
<td>Inkpen, Booth, Klawe, &amp; Upitis (1995)</td>
<td>Explore game-based learning activity and the influence of learner characteristics</td>
<td>Mixed-method (experimental and qualitative observation)</td>
<td>435</td>
<td>40-minute gaming session</td>
<td>Puzzle game</td>
<td>School children ages 6-12</td>
<td>Non-content-related problem solving</td>
<td>Informal learning</td>
<td>Cognitive problem-solving tasks and motivation</td>
<td>Playing configuration (playing together or not) had a significant effect on motivation; grouping children around one computer did not negatively affect performance and in the case of female/female groupings, it had a positive effect.</td>
</tr>
<tr>
<td>Johnson (1993)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>446</td>
<td>6-minute gaming session</td>
<td>Puzzle game</td>
<td>General public: from preadolescent to senior citizen</td>
<td>Health education</td>
<td>Informal learning</td>
<td>Descriptive knowledge gain and motivation</td>
<td>Game promoted statistically significant gain in knowledge and self-efficacy.</td>
</tr>
<tr>
<td>Ju &amp; Wagner (1997)</td>
<td>Evaluate the effectiveness of game and explore instructional game design</td>
<td>Quantitative (descriptive)</td>
<td>12</td>
<td>1-hour gaming session</td>
<td>Adventure games</td>
<td>College students (from senior to PhD level), most were female</td>
<td>General cognitive outcomes</td>
<td>Training</td>
<td>Cognitive problem solving, conceptual knowledge, and affect toward game</td>
<td>Games endorsed least information retention and most conceptual knowledge. Ludology, role-playing, appropriate complexity level made a game appealing.</td>
</tr>
<tr>
<td>Kafai &amp; Ching (1996)</td>
<td>Evaluate the effectiveness of game (as construction kit)</td>
<td>Qualitative (case study)</td>
<td>4</td>
<td>1 hour a day for 3 days</td>
<td>Game design</td>
<td>5th graders</td>
<td>Math</td>
<td>After-school learning</td>
<td>Conceptual knowledge</td>
<td>There was evidence of improved learning.</td>
</tr>
<tr>
<td>Kambouri, Thomas, &amp; Mellau (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Qualitative (case study)</td>
<td>n/a (3 UK learning centers)</td>
<td>n/a</td>
<td>Adventure game</td>
<td>Young adults</td>
<td>Literacy learning</td>
<td>Formal adult education</td>
<td>Literacy gains</td>
<td>The game was engaging and learners made significant literacy gains beyond expectation.</td>
</tr>
<tr>
<td>Kashibuchi &amp; Sakamoto (2001)</td>
<td>Evaluate the effectiveness of game and the influence of learner characteristics</td>
<td>Quantitative (experimental)</td>
<td>279</td>
<td>50-minute gaming session</td>
<td>Simulation and board games</td>
<td>2nd- and 3rd-year high school students in Japan, ages 16-18</td>
<td>Sex education</td>
<td>School education course work</td>
<td>Conceptual knowledge and motivation</td>
<td>Gaming with a reversal role-playing facilitated conceptual knowledge most, and there were no effects of experimental situations on attitudes/motivation.</td>
</tr>
<tr>
<td>Ke &amp; Grabowski (2007)</td>
<td>Explore game-based learning activity and the influence of learner characteristics</td>
<td>Quantitative (quasi-experimental)</td>
<td>125</td>
<td>Twice a week (40 minutes each session) for 4 weeks</td>
<td>Puzzle games</td>
<td>5th graders</td>
<td>Math</td>
<td>School education course work</td>
<td>Cognitive learning achievement and attitude toward subject</td>
<td>All gaming groups outperformed control group in cognitive learning achievement. Cooperative gaming group outperformed all other groups (competitive and control) in attitudes scale. SES-disadvantaged students benefited from cooperative gaming most. There was no effect of gender.</td>
</tr>
<tr>
<td>Kiili (2005)</td>
<td>Explore instructional game design</td>
<td>Mixed-method (case study)</td>
<td>18</td>
<td>n/a</td>
<td>Role-playing/simulation game</td>
<td>College students</td>
<td>General motivation</td>
<td>Informal learning</td>
<td>Motivation (flow)</td>
<td>Content creation was the main activity causing flow; bad usability and low gameness were cited as obstacles.</td>
</tr>
<tr>
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<tr>
<td>Kiili (2007)</td>
<td>Explore instructional game design</td>
<td>Qualitative</td>
<td>12</td>
<td>5-hour gaming session</td>
<td>Business simulation game</td>
<td>College students ages 20-30, all male</td>
<td>Business functions</td>
<td>Higher education course work</td>
<td>Game-based learning experience</td>
<td>Authenticity, group dynamic, and learning by doing were found to be most effective elements for effective instructional game application.</td>
</tr>
<tr>
<td>Ko (2002)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>87</td>
<td>1 lab session</td>
<td>Board game</td>
<td>Children ages 6-10</td>
<td>Basic cognitive skill development</td>
<td>General learning</td>
<td>Cognitive skill development (decision making, choice behavior, and use of logical reasoning); affect toward game-based learning</td>
<td>Children’s developed cognitive skills over the practice of games; children reported high satisfaction and joy; there was no difference between computer game and traditional game on learning.</td>
</tr>
<tr>
<td>Leger (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (case study)</td>
<td>7 weeks</td>
<td>Business simulation game</td>
<td>College students</td>
<td>Business functions</td>
<td>Higher education course work</td>
<td>Conceptual knowledge, technical skills, and affect toward game-based learning</td>
<td>Affective feedback on using game was favorable.</td>
<td></td>
</tr>
<tr>
<td>Leutner (1993)</td>
<td>Explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>182</td>
<td>n/a (1 lab session)</td>
<td>Simulation game</td>
<td>7th and 8th graders and college students</td>
<td>Economic education</td>
<td>School and higher education</td>
<td>Conceptual knowledge</td>
<td>Learners without instructional support in game learned to play game rather than domain-specific concepts; the opposite occurred with the learners given advice. Instructional support is essential for instructional games.</td>
</tr>
<tr>
<td>Lim, Nonis, &amp; Hedberg (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (case study)</td>
<td>8</td>
<td>Longitudinal</td>
<td>Massive multi-user game</td>
<td>4th graders</td>
<td>Science education</td>
<td>School education course work</td>
<td>Engagement level and conceptual knowledge</td>
<td>There was a significant knowledge gain but the level of engagement of students was low.</td>
</tr>
<tr>
<td>Malouf (1987)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>25</td>
<td>20-minute gaming session</td>
<td>Puzzle game</td>
<td>6-8th graders identified as learning disabled</td>
<td>Vocabulary skill</td>
<td>School education course work</td>
<td>Motivation and descriptive knowledge</td>
<td>Game produced significantly higher continuing motivation and quicker question response, but there was no difference in descriptive knowledge learning in comparison to computer program (with no game feature).</td>
</tr>
<tr>
<td>Mandich (1987)</td>
<td>Explore instructional game design, evaluate game effectiveness and the influence of learner characteristics</td>
<td>Quantitative (correlational-causal)</td>
<td>48</td>
<td>n/a</td>
<td>Strategy game</td>
<td>7th and 8th graders</td>
<td>Non-content-related strategic planning skill</td>
<td>School education</td>
<td>Cognitive problem solving</td>
<td>Students with successful game performance performed better on problem-solving transfer tasks than unsuccessful students; low-ability students appeared to perform better at gaming with instructional support.</td>
</tr>
</tbody>
</table>
Table 1. continued

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<tr>
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<tbody>
<tr>
<td>Martens, Gulikers, &amp; Bastiaens</td>
<td>Explore the intervention between learner characteristics and gaming</td>
<td>Quantitative (descriptive)</td>
<td>33</td>
<td>Maximum was 3 hours</td>
<td>Simulation game</td>
<td>College students (20 years old)</td>
<td>Game content learning</td>
<td>Higher education course work</td>
<td>Descriptive knowledge</td>
<td>Students with high intrinsic motivation did not do more but demonstrated more explorative study behavior; however, the learning outcomes of students with high intrinsic motivation were not better.</td>
</tr>
<tr>
<td>McMullen (1987)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>37</td>
<td>1 lab session</td>
<td>n/a</td>
<td>6th graders</td>
<td>Science education</td>
<td>School education</td>
<td>Descriptive knowledge, Cognitive learning achievement, retention, and attitude toward learning materials</td>
<td>There was no significant effect of gaming on instant or delayed learning achievement test; gaming promoted significantly more positive attitudes than conventional instruction.</td>
</tr>
<tr>
<td>Miller, Lehman, &amp; Koedinger</td>
<td>Explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>24</td>
<td>30-minute gaming session</td>
<td>Microworld simulation game</td>
<td>College students</td>
<td>Physics, electrical interaction</td>
<td>Higher education course work</td>
<td>Conceptual knowledge</td>
<td>Students in the standard-goal gaming condition learned less than did those in the two alternative conditions, the good and average conditions.</td>
</tr>
<tr>
<td>Moreno &amp; Mayer (2004)</td>
<td>Explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>164</td>
<td>1 lab session</td>
<td>Simulation game</td>
<td>College students</td>
<td>Natural science</td>
<td>Higher education course work</td>
<td>Descriptive knowledge, Conceptual knowledge, Cognitive learning, retention, and attitude toward learning materials</td>
<td>Students performed better in the narration condition than in the text condition. The media—desktop displays or head-mounted displays—did not affect performance on measures of retention, transfer, or program rating.</td>
</tr>
<tr>
<td>Moreno (2004)</td>
<td>Explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>104</td>
<td>1 lab session</td>
<td>Simulation game</td>
<td>College students (with a mean age of 18 who were novice in subject knowledge)</td>
<td>Natural science</td>
<td>Higher education course work</td>
<td>Descriptive knowledge, Problem solving, and attitude toward learning materials</td>
<td>Students learned more deeply from personalized interaction than non-personalized feedback. Head-mounted display (high immersion) did not lead to better performance or problem solving than desktop computer (low immersion).</td>
</tr>
</tbody>
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</tr>
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<tbody>
<tr>
<td>Noble, Best, Sidwell, &amp; Strang (2000)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (case study)</td>
<td>101</td>
<td>1 lab session</td>
<td>Arcade-style motorcycle action/racing game</td>
<td>Children ages 10-11</td>
<td>Drug education</td>
<td>School education</td>
<td>Expectancy and value</td>
<td>Game increased students awareness toward illegal drug and their self-efficacy</td>
</tr>
<tr>
<td>Okolo (1990)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>18</td>
<td>7-hour gaming session</td>
<td>Other (drill-and-practice game)</td>
<td>Learning-disabled high school students</td>
<td>Keyboarding motor skill</td>
<td>Special education</td>
<td>Basic motor skills, attitudes toward subject, and continuing motivation</td>
<td>There were no significant differential effects between drill-and-practice and game on skill acquisition and attitudes, but the game format had a detrimental effect on continuing motivation.</td>
</tr>
<tr>
<td>Okolo (1992)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>41</td>
<td>4 gaming sessions</td>
<td>Other (drill-and-practice game)</td>
<td>Intermediate-level students with learning disabilities</td>
<td>Math</td>
<td>Special education</td>
<td>Descriptive knowledge and continuing motivation</td>
<td>There were no significant differential effects between drill-and-practice and game on knowledge acquisition, but the game had a facilitative effect on continuing motivation of students with low initial attitudes toward math.</td>
</tr>
<tr>
<td>Ota &amp; DuPaul (2002)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental-multiple baseline design)</td>
<td>3</td>
<td>60-80 minutes in total (4 times a week)</td>
<td>n/a (educational game)</td>
<td>4-6th graders with ADHD</td>
<td>Math</td>
<td>Special education</td>
<td>Cognitive math performance and task engagement</td>
<td>Gaming led to increases in active engaged time and decreases in off-task behaviors in all subjects; all subjects also showed some improvement in math performance, but improvement was modest in comparison to conventional instruction condition.</td>
</tr>
<tr>
<td>Oyen &amp; Bebko (1996)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>120</td>
<td>1 lab session</td>
<td>Puzzle game (with endogenous or exogenous gaming element)</td>
<td>Children ages 4-7</td>
<td>Memory-enhancing strategy</td>
<td>Preschool education</td>
<td>Memory rehearsal strategy and recall performance</td>
<td>Games increased overt rehearsal strategy use, yet no greater memory recall (in comparison to traditional), and there is no effect of game type.</td>
</tr>
<tr>
<td>Padgett, Strickland, &amp; Coles (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (pre-/post-case series design)</td>
<td>5</td>
<td>1 lab session</td>
<td>Massive multi-user game</td>
<td>Children diagnosed with fetal alcohol syndrome, ages 4-7, low or average intellectual functioning</td>
<td>Fire safety skill</td>
<td>Informal learning and special education</td>
<td>Procedural knowledge gain and retention</td>
<td>Game helped all participants develop procedural knowledge gain and helped knowledge retention (in one-week follow up test).</td>
</tr>
<tr>
<td>Pannese &amp; Cusini (2007)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>n/a</td>
<td>n/a</td>
<td>Business simulation game</td>
<td>College students and company employees</td>
<td>Business functions</td>
<td>Higher education course work and work force training</td>
<td>Affect toward game-based learning</td>
<td>Affective feedback to game use was very high.</td>
</tr>
<tr>
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<tr>
<td>Paperny &amp; Starn (1989)</td>
<td>Evaluate the effectiveness of game and the influence of learner characteristics</td>
<td>Quantitative (experimental)</td>
<td>718</td>
<td>30- to 40-minute session</td>
<td>Action games</td>
<td>High school students ages 13-18</td>
<td>Health education</td>
<td>Informal learning</td>
<td>Descriptive, conceptual knowledge, and attitude (value)</td>
<td>Games produced significant knowledge gain and attitude change (as opposed to traditional instruction); students with low SES enjoyed and learned from games especially.</td>
</tr>
<tr>
<td>Perzov &amp; Kozminsky (1989)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>68</td>
<td>110 minutes total (10 minutes/day for 11 days)</td>
<td>A variety of games with or without elements requiring visual perception</td>
<td>Kindergarten children in Israel age 5</td>
<td>Non-content-related visual perception skill</td>
<td>Preschool education</td>
<td>Basic motor skill</td>
<td>No significant effect of games (with or without elements requiring visual perception) was found.</td>
</tr>
<tr>
<td>Pillay (2002)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (quasi-experimental &amp; qualitative cognitive task analysis)</td>
<td>36</td>
<td>15-minute gaming session</td>
<td>2D puzzle recreational game and 3D strategy recreational game</td>
<td>School children ages 14-16</td>
<td>Environmental education</td>
<td>School education course work</td>
<td>Time on task, cognitive task performance, and cognitive/meta-cognitive process</td>
<td>3D game promoted successful subsequent performance on 3D computer-based instructional tasks (as opposed to 2D game), suggesting the extent of recreational game influence depends on how closely the game type matches the design of the tasks in the educational software.</td>
</tr>
<tr>
<td>Pillay, Brownlee, &amp; Wilss (1999)</td>
<td>Explore game-based cognitive process</td>
<td>Qualitative (cognitive task analysis)</td>
<td>21</td>
<td>n/a</td>
<td>Puzzle and strategy entertainment games</td>
<td>High school students ages 14-18</td>
<td>General problem solving</td>
<td>General learning</td>
<td>Cognitive strategies</td>
<td>Game players demonstrated complex cognitive processes (e.g., general search heuristics, use of game tools, and a combined approach, metacognitive monitoring, maintaining temporal information for multitasking).</td>
</tr>
<tr>
<td>Piper, O’Brien, Morris, &amp; Winograd (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Qualitative (case study)</td>
<td>8</td>
<td>5 gaming episodes</td>
<td>Board game</td>
<td>Children from social cognitive therapy class</td>
<td>Social skill development</td>
<td>Informal learning</td>
<td>Social skill development</td>
<td>The game provided an engaging experience for participants to work with others.</td>
</tr>
<tr>
<td>Rai, Wong, &amp; Cole (2006)</td>
<td>Evaluate the effectiveness of game (as construction kit)</td>
<td>Qualitative</td>
<td>n/a</td>
<td>1 semester</td>
<td>Game design</td>
<td>College students</td>
<td>Computer science (programming)</td>
<td>Higher education course work</td>
<td>Affect to game-based learning</td>
<td>Game construction promoted active engagement with the content and increased enthusiasm level.</td>
</tr>
<tr>
<td>Ravenscroft &amp; Matheson (2002)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>36</td>
<td>20- to 30-minute gaming session</td>
<td>Other (dialogue games)</td>
<td>Secondary school students ages 15-16</td>
<td>Physics</td>
<td>School education course work</td>
<td>Conceptual knowledge</td>
<td>Games promoted significant improvement in conceptual knowledge gain and retention (in comparison to conventional learning).</td>
</tr>
<tr>
<td>Study</td>
<td>Purpose</td>
<td>Method</td>
<td>Sample Size</td>
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</tr>
<tr>
<td>Renaud &amp; Suissa (1989)</td>
<td>Evaluate the effectiveness of game and explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>136</td>
<td>One 3-hour gaming session</td>
<td>Simulation games (with or without attitude-triggering elements)</td>
<td>5-year-old children in school</td>
<td>Traffic safety education</td>
<td>Preschool/ general education</td>
<td>Attitude (value), behavior change, and transfer of learning</td>
<td>All gaming interventions promoted three learning achievements more than the control condition; attitude-triggering elements (role-playing and groups) was necessary and sufficient to modify behavior.</td>
</tr>
<tr>
<td>Ricci, Salas, &amp; Cannon-Bowers (1996)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>60 (most are male)</td>
<td>45-minute gaming session</td>
<td>Puzzle game</td>
<td>Military students with a median age of 20</td>
<td>Military rules</td>
<td>Military training</td>
<td>Descriptive knowledge gain and retention, and attitude (value) toward subject</td>
<td>Gaming promoted knowledge gain and retention significantly more than text situation, but not different from test situation; participants in gaming demonstrated significantly higher attitudes than the other two situations.</td>
</tr>
<tr>
<td>Rosas et al. (2003)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (experimental and case study)</td>
<td>1,274</td>
<td>30 hours over a 3-month period</td>
<td>n/a</td>
<td>1st and 2nd graders from socio-economic disadvantaged schools in Chile</td>
<td>Reading, math, and spelling</td>
<td>School education course work</td>
<td>Cognitive learning achievement and motivation to learn</td>
<td>Game use had positive impact on motivation and classroom dynamics. There was significant difference between gaming group and internal control group in relation to the external control group, but no significant difference between gaming and internal control groups on cognitive learning achievement.</td>
</tr>
<tr>
<td>Sandford, Ulicsak, Facer, &amp; Rudd (2007)</td>
<td>Explore game-based learning activity/design</td>
<td>Survey research</td>
<td>924</td>
<td>n/a</td>
<td>n/a</td>
<td>Primary and secondary school teacher</td>
<td>n/a</td>
<td>School education course work</td>
<td>General school learning</td>
<td>Teacher played important role in effective use of instructional games in classroom.</td>
</tr>
<tr>
<td>Santos (2002)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>41</td>
<td>3 weeks</td>
<td>Business simulation game</td>
<td>College students</td>
<td>Business education</td>
<td>Higher education course work</td>
<td>Affect toward game-based learning</td>
<td>Students’ affective feedback toward game use was favorable.</td>
</tr>
<tr>
<td>Simms (1998)</td>
<td>Evaluate the effectiveness of game</td>
<td>Qualitative</td>
<td>4</td>
<td>5 weekly lessons</td>
<td>Other (educational game)</td>
<td>College piano students with motivation problem</td>
<td>Musical skills (note identification and note playing)</td>
<td>Musical education</td>
<td>Motivation</td>
<td>There was evidence of motivational effects of game.</td>
</tr>
<tr>
<td>Spivey (1985)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>29</td>
<td>20 days</td>
<td>Puzzle games</td>
<td>1st graders</td>
<td>Math</td>
<td>School education course work</td>
<td>Cognitive math learning achievement</td>
<td>No significant effects of the game (with conventional teaching) on math learning (in comparison to conventional teaching only) was found.</td>
</tr>
<tr>
<td>Squire &amp; Barab (2004)</td>
<td>Evaluate the effectiveness of game</td>
<td>Qualitative (case study)</td>
<td>18</td>
<td>6 weeks (3 times per week, 45 minutes per session)</td>
<td>Massive multi-user entertainment game</td>
<td>High school students who were academically disadvantaged</td>
<td>History, geography, and political science</td>
<td>School education course work</td>
<td>Game-based learning experience</td>
<td>Failure to understand basic facts drove students to learn; the game can be a powerful tool for engaging learners.</td>
</tr>
<tr>
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<tr>
<td>Squire, Barnett, Grant, &amp; Higginbotham (2004)</td>
<td>Evaluate the effectiveness of game</td>
<td>Mixed-method (experimental &amp; case study)</td>
<td>96</td>
<td>n/a</td>
<td>3D simulation game</td>
<td>8th graders</td>
<td>Electromagnetic</td>
<td>School education coursework</td>
<td>Conceptual knowledge</td>
<td>Learning group outperformed the conventional instruction.</td>
</tr>
<tr>
<td>Streunmen (1993)</td>
<td>Explore game-based learning activity</td>
<td>Quantitative (experimental)</td>
<td>56</td>
<td>n/a</td>
<td>Other (educational game)</td>
<td>4th graders</td>
<td>General learning</td>
<td>School education</td>
<td>Game task performance</td>
<td>Cooperative environment resulted in better game-based learning performance than the competitive environment.</td>
</tr>
<tr>
<td>Stone (1995)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>248</td>
<td>n/a</td>
<td>Business strategy game</td>
<td>College students</td>
<td>Business management</td>
<td>Higher education coursework</td>
<td>Affect toward game-based learning</td>
<td>Affective feedback toward game use was favorable.</td>
</tr>
<tr>
<td>Taylor (1987)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>194</td>
<td>1 lab session</td>
<td>Simulation game</td>
<td>College students</td>
<td>Political science</td>
<td>Higher education coursework</td>
<td>Cognitive academic achievement and attitudes toward subject</td>
<td>There was no significant effect of game with lecture in comparison to lecture only.</td>
</tr>
<tr>
<td>Thomas &amp; Cahill (1997)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>211</td>
<td>1 lab session</td>
<td>Adventure game</td>
<td>High-risk adolescents (ages 12-22)</td>
<td>Health education</td>
<td>School education</td>
<td>Self-efficacy</td>
<td>There was significant effect of the game on self-efficacy improvement.</td>
</tr>
<tr>
<td>Tuzun (2004)</td>
<td>Explore game-based motivation process</td>
<td>Qualitative (ethnography)</td>
<td>20</td>
<td>Longitudinal</td>
<td>Massive multiplayer game</td>
<td>School children</td>
<td>Science education</td>
<td>General learning</td>
<td>Motivation</td>
<td>Thirteen categories of motivational elements to play the game emerged: identity presentation, social relations, playing, learning, achievement, rewards, immersive, context, fantasy, uniqueness, creativity, curiosity, control, and ownership.</td>
</tr>
<tr>
<td>Tuzun (2007)</td>
<td>Evaluate the effectiveness of game and explore game-based learning activity design</td>
<td>Qualitative (case study)</td>
<td>77</td>
<td>1 week</td>
<td>Massive multiplayer game</td>
<td>4th and 5th graders, 9th graders, and college students</td>
<td>Science education</td>
<td>School higher education coursework</td>
<td>Game-based learning experience</td>
<td>Potential of using game in classroom setting and relative issues: school infrastructure, role of teacher, classroom culture, distraction in games.</td>
</tr>
<tr>
<td>Van Eck (2006)</td>
<td>Evaluate the effectiveness of game and explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>123</td>
<td>50-minute gaming session</td>
<td>Simulation/modeling game (with pedagogical advice or competition scheme)</td>
<td>7th and 8th graders ages 12-15 in Catholic school</td>
<td>Math</td>
<td>School education coursework</td>
<td>Attitude (value) toward subject</td>
<td>The game with no competition but contextual advisement promoted most positive attitude; and there was no significant difference between gaming and the control condition. Game did not promote learning, neither more than conventional CAI, deaf children improved learning in conventional tradition more than in gaming.</td>
</tr>
<tr>
<td>Vogel, Greenwood-Erikson, Cannon-Bowers, &amp; Bowers (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (quasi-experimental)</td>
<td>44</td>
<td>2 weeks with 10 minutes per day</td>
<td>Other (virtual reality game)</td>
<td>Children ages 7-12 (some were hearing-impaired)</td>
<td>Math and language arts</td>
<td>School education coursework</td>
<td>Descriptive and conceptual knowledge</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1. continued**
<table>
<thead>
<tr>
<th>Study</th>
<th>Purpose</th>
<th>Method</th>
<th>Sample Size</th>
<th>Timeframe</th>
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<th>Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walters &amp; Others (1997)</td>
<td>Explore the interaction between learner characteristics and game</td>
<td>Quantitative (descriptive and correlational-causal)</td>
<td>80</td>
<td>Half semester</td>
<td>Strategy simulation game</td>
<td>College students</td>
<td>Business functions</td>
<td>Higher education course work</td>
<td>Affect toward game-based learning</td>
<td>Students whose psychological profiles exhibited significant deviation from that required to function effectively in a team were less satisfied with game use.</td>
</tr>
<tr>
<td>Washbush &amp; Gosen (2001)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (correlational-causal)</td>
<td>474</td>
<td>1992-1997</td>
<td>Business enterprise simulation game</td>
<td>College students</td>
<td>Business management</td>
<td>Higher education course work</td>
<td>Cognitive learning achievement</td>
<td>Learning took place as a result of simulation participation, but there was no relationship between learning and simulation performance.</td>
</tr>
<tr>
<td>Wiebe &amp; Martin (1994)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (experimental)</td>
<td>109</td>
<td>1 lab session</td>
<td>Adventure game</td>
<td>5th and 6th graders</td>
<td>Geography education course work</td>
<td>Descriptive knowledge and attitudes toward subject</td>
<td>Game-based learning experience</td>
<td>No significant effect of computer games in comparison to non-computer games.</td>
</tr>
<tr>
<td>Wildman &amp; Reeves (1996)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (descriptive)</td>
<td>557</td>
<td>n/a</td>
<td>Simulation game</td>
<td>Nursing students</td>
<td>Nursing education</td>
<td>Higher education course work</td>
<td>Affective feedback was favourable and games encouraged teamwork.</td>
<td>There was no significant effect of gaming, but game with variable payoff resulted in increased persistence.</td>
</tr>
<tr>
<td>Whitehill &amp; McDonald (1993)</td>
<td>Evaluate the effectiveness of game and explore instructional game design</td>
<td>Quantitative (experimental)</td>
<td>1 lab session</td>
<td>Simulation game</td>
<td>Military personnel</td>
<td>Electric repairs</td>
<td>Military training</td>
<td>Problem solving and persistence</td>
<td>Game-based learning experience</td>
<td>There was significant effect of games with lecture in comparison to lecture only, and the affective feedback was favorable.</td>
</tr>
<tr>
<td>Yip &amp; Kwan (2006)</td>
<td>Evaluate the effectiveness of game</td>
<td>Quantitative (quasi-experimental)</td>
<td>100</td>
<td>9 weeks</td>
<td>Other (online educational game)</td>
<td>Engineering students</td>
<td>English vocabulary</td>
<td>Higher education</td>
<td>Descriptive knowledge and affect toward game-based learning</td>
<td>There was significant effect of games with lecture in comparison to lecture only, and the affective feedback was favorable.</td>
</tr>
</tbody>
</table>
game studies and are discussed with the support of exemplar studies.

**Game Research Purpose and Methodology**

The empirical studies coded can be classified into five major research purposes: (1) evaluating the effects of computer-based game on learning (65 out of 89 studies), (2) exploring effective instructional game design (17 out of 89), (3) exploring game-based learning activity or pedagogy (9 out of 89), (4) evaluating the influence of learner characteristics on game-based learning process (10 out of 89), and (5) investigating cognitive or motivational processes during game playing (4 out of 89).

**Studies on the Effects of Instructional Gaming**

Studies that evaluated the effectiveness of computer-based games for learning purposes are predominant. Among these studies, 69% used quantitative design-experimental, quasi-experimental, correlational-causal, or descriptive. For example, Gopher, Weil, and Bareket (1994) investigated the effect of a flight simulation game on cadets’ flight performance by randomly assigning 58 participants into two experimental conditions (gaming vs. conventional instruction). The experiment lasted 10 hours (one hour each session) and the results favored simulation game. Vogel, Greenwood-Ericksen, Cannon-Bowers, and Bowers (2006a) examined the difference between virtual reality games and conventional computer-assisted instruction in promoting math and language arts learning. They assigned 44 primary school students (in intact class unit) to two experimental conditions (lasting two weeks with 10 minute/day) and reported that there was no significant effect of games. Greenfield, Camaioni, Ercolani, and Weiss (1994) used one-group design in their game study and discovered that there was no significant correlation between college students’ successful game performance and their achievement in scientific-technical discovery. Johnson (1993) surveyed 446 instructional game players after a six-minute gaming session and reported that game promoted significant self-efficacy.

Among the studies examining the effects of games, about 15% employed mixed-method design and another 15% were qualitative ethnography or case study. For example, Barab et al. (2007) evaluated the effects of a massive multiplayer online game on 28 fourth graders with both quantitative pre- and post-tests and qualitative in-field observation. Conversely, Piper, O’Brien, Morris, and Winograd (2006) reported a positive effect of a cooperative tabletop computer game for social skills development only with a thick, qualitative description.

In terms of results, 34 out of the 65 game effectiveness studies reported significant positive effects of computer-based game, 17 reported mixed results (instructional games facilitated certain learning outcomes but not the others), 12 reported no difference between computer games and conventional instruction, and only one study (Christensen & Gerber, 1990) reported conventional instruction as more effective than computer games.

It should be noted that in these 65 studies, computer games were compared with conventional instructions either as a stand-alone pedagogical instrument (e.g., Abbey, 1993; Bahr & Rieth, 1989; Cameron & Dwyer, 2005; Goldsworthy, Barab, & Goldsworthy, 2000) or as a drilling tool complementing the conventional instruction (e.g., Taylor, 1987; Gremmen & Potters, 1997; Yip & Kwan, 2006). In addition, less than 50% of the game evaluation studies were longitudinal; most of them lasted no more than two hours. This finding is in agreement with the claim by Emes (1997) that more longitudinal studies were still needed for game effectiveness evaluation. Another notable pattern is that qualitative studies tend to report
positive effects of instructional games; few of them describe games’ negative aspects.

**Studies on Instructional Game Design**

Among the 17 studies on game design, 10 are quantitative, three are qualitative, and the remainder are mixed-method. The examined game design features include pedagogical agent within a game, game playing group dynamics, games’ goal condition (having specified goal or not), games’ interface format (verbal narration, text, personalized speech or not), feedback type (elaborative or not), alignment of game-play and learning task, attitudes-triggering elements (grouping and competition), reward mechanism (at fixed or variable interval), complexity and authenticity level, richness of storyline, and the sort.

Most game design studies indicate significant results. A common finding extracted from these design studies is that instructional support features are a necessary part of instructional computer games. The studies generally conclude that learners without instructional support in game will learn to play the game rather than learn domain-specific knowledge embedded in the game (Leutner, 1993; Mandinch, 1987).

**Studies on Game-Based Pedagogy**

In this category of game studies, the researchers generally explore how game-based learning activities should be organized or administered, or how a game-based external learning environment should be constructed. For instance, Anderson (2005) examined how team dynamics, such as cohesiveness and heterogeneity, influenced team playing in a business enterprise simulation game and hence individuals’ performance and attitudes toward game use. Bahr and Reith (1989), Ke and Grabowski (2006), and Strommen (1993) investigated whether the game-based learning goal structures—cooperative, competitive, and individualistic— influenced learning outcomes. Sandford, Ulicsak, Facer, and Rudd (2007) reported that teachers’ facilitation played an important role in an effective use of instructional games in the classroom. These studies assert that the investigation on computer games for learning should focus on how games can be carefully aligned with sound pedagogical strategies or learning conditions to be beneficial.

**Studies on Learner Characteristics**

Only 10 out of 89 game studies examine the variable of learner characteristics; this confirms the finding by Dempsey et al. (1996) that studies on the interaction of learner characteristics and instructional game usage are limited. Among the studies reviewed, gender is the most examined learner characteristic. Some research (e.g., DeJean, Upitis, Koch, & Young, 1999; Inal & Cagiltay, 2007) has reported gender difference in terms of game-based learning performance and game design preference, while other research (e.g., Forsyth, 1986; Haynes, 2000; Ke & Grabowski, 2007) has not. Interestingly, the studies reporting gender difference are qualitative in nature, while those failing to find gender difference are mostly experimental and comparative in nature. A potential proposition extracted may be that gender influences game-play and learning processes more than learning outcomes.

Learner psychological profile or cognitive style (Walters et al., 1997; Cameron & Dwyer, 2005) is another examined characteristic variable. Generally, prior studies have reported that individuals’ cognitive styles influence their performance in game-based team playing, yet failed to indicate the effect of cognitive styles on game-based individual learning.

In addition, learners with a lower socio-economic status and lower ability have been reported as enjoying games most (Papernv & Starn, 1989; Ke & Grabowski, 2007). Conversely, there is
evidence suggesting learners with lower ability have difficulty extracting target knowledge from games (Mandinch, 1987).

Studies on Game-Based Cognitive or Motivation Processes

In the four studies that examined game-based cognitive processes (Alkan & Cagiltay, 2007; Cauzinille-Marmeche & Mathieu, 1989; Pillay, Brownlee, & Wilss, 1999; Pillay, 2002), game-based cognition is a graduate development from random trial-and-error strategy, general deductive reasoning, rule-based learning, purposeful tools usage, to a combined approach. There is also a record of game-based metacognitive self-planning and regulation processes, yet the evidence is descriptive and anecdotal. Tuzun (2004) explored game-based motivation process and found 13 core components of game-facilitated motivation: identity presentation, social relations, playing, learning, achievement, rewards, immersive, context, fantasy, uniqueness, creativity, curiosity, control, and ownership. Although the games used in these types of studies are not necessarily instructional in nature, the results on game-based cognitive or motivational processes address the question as to whether games are a potential anchor to activate learners’ cognitive, metacognitive, and motivational processes.

Learning

As the analysis results indicate, game studies involve a variety of learning settings: informal learning, kindergarten/preschool education, elementary education, secondary education, adult education, business management, military, and healthcare. Business management education seems to be the one associated with the most prevalent positive outcomes.

Learning subject areas in game studies comprise science education, math, language arts, reading, physics, health, natural science, science, and non-content-related social skill and general problem-solving skill development. Although Randel et al. (1992) suggested that a breakdown of the available studies by subject matter reveals that some knowledge domains (i.e., math, physics, and language arts) are particularly suited to games, this pattern is not evident in the current analysis.

Cognitive learning outcomes in those reviewed studies consist of basic motor skill (e.g., Horn, Jones, & Hamlett, 1991), descriptive knowledge (e.g., Bartholomew et al., 2000), conceptual knowledge (e.g., Conati & Zhao, 2004), problem solving (e.g., Moreno, 2004), and general cognitive strategies (e.g., Cauzinille-Marmeche & Mathieu, 1989). An interesting pattern is that games seem to foster higher-order thinking (e.g., planning and reasoning) more than factual or verbal knowledge acquisition, which sustains the finding of Dempsey et al. (1996). Importantly, it should be noted that few game studies directly measured metacognitive process or outcome.

Affective learning outcomes, involving self-efficacy, value (or attitudes toward subject content learning), affective feedback toward game use, and continuing motivation (or persistence), are present in many game studies. Generally, instructional computer games seem to facilitate motivation across different learner groups and learning situations. This finding is in agreement with Vogel et al.’s (2006) quantitative meta-analysis conclusion that the effect size of games vs. traditional teaching methods is highly reliable for attitude outcomes.

Learners

In this analysis, school children and college students are predominant among the targeted learner groups. Fewer studies focus on adult learners, especially the elderly. Studies regarding games for learners with disabilities typically report significant positive effects of computer games on their learning performance (e.g., Horn et al.,
1991; Inal & Cagiltay, 2007; Ota & DuPaul, 2002; Padgett, Strickland, & Coles, 2006). This finding suggests that computer games can be a powerful instructional intervention in special education.

**Intervention: Game Genre and Features**

Games used in these studies demonstrate a high heterogeneity and can be classified as simulations, puzzles, adventures, board games, action games, strategy games, and business simulation games. These games are different in terms of game genre, media format (2D or 3D), timeframe, game-play design, and instructional support features. Since all of these game features can potentially influence the effectiveness of a game for learning purposes, it is difficult to quantify and synthesize the impact of games across different studies to create a standard effect size, especially when certain gaming studies failed to clearly describe their gaming treatments.

**FUTURE TRENDS**

This grounded meta-analysis implicates a list of propositions on the future practice and research of instructional gaming. These propositions, with the support of synthesis findings, are discussed below.

**Implications on Future Instructional Gaming Policy and Practice**

As the analysis indicates, the learning outcomes achieved through computer games depend largely on how educationalists align learning (i.e., learning subject areas and learning purposes), learner characteristics, and game-based pedagogy with the design of an instructional game. Out of the 89 coded gaming studies, 36 (40%) have investigated the influential role of learning purposes, learner characteristics, game-based pedagogy, and instructional game features; they generally assert the significant effects of these mediating factors on game-based learning outcomes. Additionally, there is a trend that instructional gaming may serve certain levels of learning objectives (e.g., higher-order thinking and affective outcomes) better than the others (e.g., factual knowledge acquisition) or serve certain learners (e.g., learners with disabilities) better than others. Therefore, educationalists should more frequently ask how (as opposed to whether) games can be incorporated into learning environments. Rather than using games in a one-shot and decontextualized manner, educationalists should take a comprehensive diagnostic approach to identify and measure multiple influential factors in a game-based learning environment, thus deciding how to use games effectively or when to use games.

The analysis results also implicate a careful design of external and internal instructional support features for gaming application, especially when the games are used for factual knowledge development or learners who have lower prior ability and have difficulty extracting target knowledge from games. External instructional support can be provided using teacher facilitation, good team dynamics, or structured cooperative learning/playing (Anderson, 2005; Bahr & Reith, 1989; Ke & Grabowski, 2006; Sandford et al., 2007). Internal instructional support features, as the prior studies suggest, are a necessary part of instructional games and should be embedded within a game through elaborative feedback, pedagogical agent, and multimodal information presentation (Cameron & Dwyer, 2005; Conati & Zhao, 2004; Forsyth, 1986; Moreno & Mayer, 2002; Moreno, 2004).

The current analysis demonstrates that instructional gaming can be used in multiple educational settings that range from informal, community learning to school education. There is no evidence to suggest that gaming is favorable for certain educational settings but not others. Therefore, educational policymakers are encouraged to con-
sider using games as a learning tool in situations both within and beyond the classroom.

**Implications on Future Gaming Research**

Consistent with the finding of previous gaming reviews, this analysis indicates that the empirical research on instructional gaming is fragmented by research variables (i.e., research purpose and methodology), administrative variables (i.e., learning setting), learner variables, procedural variables (i.e., game-based pedagogy), and game variables (e.g., game genre and media). It is proposed that instead of adopting one-shot, incoherent experiments, future gaming research should take a systematic, comprehensive approach to examine dynamics governing the relations among multiple influential variables in a game-based learning system.

In addition, it is found that the empirical research on instructional gaming tends to focus on traditional learner groups while ignoring adult learners, especially the elderly. Hence more evaluation studies should be conducted to measure the effects of games in adult education.

Finally, instructional gaming researchers should provide clear descriptions on games used and game application contexts when reporting their game evaluation results. Without knowing the specifics of every game application, the literature reviewers will have difficulty synthesizing the impact of games across different studies using explicit decision rules.

**CONCLUSION**

This chapter reports a grounded meta-analysis with 89 empirical studies on instructional gaming. Research features and findings of these empirical studies are synthesized qualitatively under standard coding rules. The four recurring themes (gaming research purpose and methodology, learning, learner, and instructional game intervention) have been extracted from the analysis to outline the four clusters of influential factors that weigh in the evaluation of instructional gaming. It is argued that the best models or best practices of designing and applying instructional gaming would form by carefully aligning and integrating the three clusters of key variables—learning, learner, and instructional game design.

**NOTE**

A single study may serve multiple research purposes.

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**KEY TERMS**

Effect Size: A name given to a family of indices that measure the magnitude of a treatment effect.

Game Genre: Computer games are categorized into genres based on their game-play. Due to a general lack of commonly agreed-upon criteria for the definition of genres, classification of games is not always consistent.

Game Play: In computer game terminology, used to describe the overall experience of playing the game. It refers to “what player does.”

Grounded Theory: A qualitative research method that uses a systematic set of procedures to develop an inductively derived theory about a phenomenon. The primary objective of grounded theory is to expand upon an explanation of a phenomenon by identifying the key elements of that phenomenon, and then categorizing the relationships of those elements to the context and process of the experiment.

Instructional Support Features: Instructional support, or “instructional overlay,” is the component that serves to optimize learning and motivation within a multimedia learning environment, such as a simulation or game.
**Simulation:** A computer simulation is a computer program that attempts to simulate an abstract model of a particular system.

**Simulation Game:** A game that contains a mixture of skill, chance, and strategy to simulate an aspect of reality, or a simulation that has a game structure imposed on the system.