Forty simple computer games and what they could mean to educators

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The purpose of this study was to evaluate computer games or components of the games that would lend themselves for use in an educational setting. Participants included 20 men and 20 women who volunteered to participate. All participants played four randomly assigned computer-based shareware or freeware games from among eight categories. Participants offered numerous suggestions for instructional applications of the noneducational games. Results suggested diverse patterns of preference and use between genders. Participants indicated many key features regarded as essential for an effective gaming environment as well as those that distracted them from play. Trial and error was observed to be the dominant strategy used across all game categories. In addition, participants suggested numerous educational applications for common categories of computer games.

KEYWORDS: *adult learning; adventure games; arcade games; board games; card games; computer games; computer-mediated games; control; educational games; freeware; gender; instructional applications; learning strategies; learning styles; motivation; puzzles; research; shareware; simulations; strategies; word games*.

How can educators find innovative ways to use computer games for learning? After playing shareware entertainment games, adult players generated numerous ideas for instructional applications of computer games. Educational researchers and theorists ascribe to games a wide range of benefits that include improved practical reasoning skills (Wood & Stewart, 1987), higher levels of continuing motivation (Malouf, 1988), and reduced training time and instructor load (Allen, Chatelier, Clark, & Sorenson, 1982). Diverse training applications, such as attention reduction or automaticity training (Jacobs, Dempsey, & Salisbury, 1990) and complex problem solving (Hayes, 1981), are hypothesized to be prime candidates for gaming strategies.

The use of games as instructional tools is well established. Games were used in China as early as 3000 B.C. Since the early 1960s, a rapid growth in the use of gaming and simulation in all areas of teaching has occurred. Children in elementary schools play word games. Military personnel use games and simulations in training. Medical students use games to practice skills needed when assessing patient conditions. Business leaders use management games and simulations to create experiential environments for learning managerial skills. For example, Faria (1987) reported that 4,600 of

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the larger U.S. firms he surveyed used business or experiential games in training or development.

The actual research in the use of gaming for educational or instructional purposes is sparse. An extensive review of instructional gaming articles (Dempsey, Lucassen, Gilley, & Rasmussen, 1993-1994; Dempsey, Lucassen, & Rasmussen, 1996) revealed little substantive research concerning ways that computer games could be used for educational purposes. The limited amount of study in this area has led some researchers (e.g., Bredemeier & Greenblat, 1981) to question many claims made on behalf of educational games because of insufficient empirical support. Even so, games, particularly computer games, are considered by many to be powerful tools to increase learning. Recognizing that educational computer gaming is a growth area and one worthy of exploration by applied researchers seems almost self-evident. Despite findings that, for example, arcade-style gaming is a social and not an achievement-oriented activity (McClure & Mears, 1986), gaming activity is increasing greatly because of more sophisticated and lower priced hardware and software for personal computers.

Educational researchers who are asked how to incorporate games into learning environments will continue to be perplexed about how to arrange studies that respond to this summons. Much of what occurs in a gaming environment may not be easily measured or at least easily reduced to a few variables. The validity of the assessment of an instructional game is quite different from that with other learning environments and, according to Ruben and Lederman (1982), is dependent on rules, interactions, roles, goals, and criteria. Therefore, although experimental studies have an important place in the instructional gaming literature, there is a movement to recognize the limitations of objective-oriented research for assessment and to look at the effects of incidental learning as well as intentional learning (Barnett, 1984; Remus, 1981). For example, as participants in a qualitative study, 21 secondary school students played a recreational computer game (Pillay, Brownlee, & Wilss, 1999). The findings of the study suggested that the students conducted complex cognitive processes, such as reasoning inductively and deductively, making inferences, reasoning metacognitively, and solving problems.

Purpose

The purpose of this article is to discuss instructional applications of computer games, particularly as they apply to adults. We will first offer a definition of games and propose selection criteria for adapting existing computer games for education or training. Next, we will describe our 2-year study of adults playing relatively unsophisticated computer games. Based on our analysis of the 160 observations in this study, we will discuss aspects of computer gaming, particularly as they apply to gender and motivational influences, learning styles, game features, strategies used by adults to play, and applications of computer games to education.[1]

What is a game?

Our experiences in playing, reviewing, and designing computer games; our prior reviews of the simulation and gaming literature; and our discussions among ourselves and those in electronic research forums (e.g., PSYGAME) have led us to our present definition of a game. A *game* is a set of activities involving one or more players. It has goals, constraints, payoffs, and consequences. A game is rule-guided and artificial in some respects. Finally, a game involves some aspect of competition, even if that competition is with oneself.

Most games are intended to be entertaining, not instructional. Often, the reason a person chooses to play a game is to experience the fun of engaging in the gaming activity. Learning is usually incidental or intentional only for the purposes of one becoming a better gamer. One challenge for educators, therefore, is to take the learning that does take place in game activities, such as exploring a route through a maze or improving a motor skill on a keyboard, and apply that incidental knowledge or ability to an intentional learning task. The implications for designing educational computer games include the means to blend motivation and self-regulated learning (Rieber, Smith, & Noah, 1998).

Educators have long advised instructional designers to look for existing gaming strategies when developing or adapting games for instructional purposes (see Driskell & Dwyer, 1984). The focus of our study was to probe for components or structures of existing computer games that would lend themselves for use in an educational or instructional setting. Concurrently, we wished to identify, primarily through observations and questionnaires, those attributes that were either motivating or distracting to adult players and to determine if these attributes tended to vary because of the gender of the player.

Game selection criteria

Our first task was to decide what criteria were most likely to make a game a good candidate for study. We selected five criteria for choosing games that are more congruous to intentional instructional purposes.

1. The game must be relatively simple to play. This criterion arises from our belief that gaming used for instructional purposes should not be overly complex. Complex rules and scoring require the learner to use limited learning time to understand the game (Jacobs & Dempsey, 1993). An exception would be a game that is intrinsically motivating and directly related to the intended learning outcome. We define an intrinsically motivating instructional game as one in which game structure itself helps to teach the instructional content.

2. The game can be adapted and reprogrammed inexpensively. To maintain a reasonable cost-benefit ratio, the value of resources that must be sacrificed to gain

benefits or effects must be comparatively less than the value of the benefits or effects themselves (see Levin, 1983).

3. The game must have some identifiable potential for educational use, if adapted. Here we liberally interpreted *potential* to be any reasonable possibility of applying the game to education or training. For example, card games require some arithmetic skills and therefore have some potential for intentional educational use and application to specific learning outcomes.

4. The game must be different from the other games in its category. This criterion was selected to study as many kinds of games as possible.

5. The game must be designed so that it can be played by a single player. This was an arbitrary decision. One person is the lowest common denominator in computer game playing, and we felt that it would be less confounding to restrict our study, at this point, to a single player. Many of the games we reviewed could be played by either one or more than one player. One of the frequent comments made by players during game play was the wish to compete with another human player.

Participants

Forty adults, 20 men and 20 women, volunteered to participate in the study. Ages of the participants ranged from 18 to 52 years. Educational achievement of individuals was rather evenly divided among high school, college, master's degree, and doctoral degree. Most were moderately to very experienced using computers. A majority of participants reported that they enjoyed playing games. Slightly fewer adults reported they enjoyed games using computer technology. Men reported they played technology games more often and in greater frequency than did women.

Only a small percentage of participants reported that they played no games at all. The number of adults playing no technology-based games, however, was double that amount. With respect to competition, slightly more than half of the participants reported that they were competitive or very competitive when they did play games. Respectively, participants were most experienced playing card games, board games, puzzles, and word games.

Materials

Forty computer games were used in this study. Games were categorized into eight divisions: simulations, puzzles, adventure games, board games, card games, arcade games, word games, and miscellaneous games. Some of the games included color graphics and others were black and white. Each category was composed of five games

serving as a sampling of the variety of games found in each area. Two men and two women played each game. Ten packets containing four games each were randomly assigned to the 40 volunteers (160 observations).

Instruments

A "Demographic and Gaming Experience Questionnaire" was developed to gather information about the participants' age, gender, and educational experience. It includes a scale related to the participants' predisposition toward game playing, technology-based game playing, frequency of game playing, and frequency of technology-based game playing. Kolb's (1984) Learning-Style Inventory was implemented to look for patterns in participants' experiential styles and game preferences. The CAS-Q questionnaire (Seligman, 1992) was administered in this study to measure participants' degree of optimism and compare that to observations of their game-playing behavior. Researcher observations were recorded for each gaming experience on a two-page observation protocol. Finally, two gaming scales were specifically developed for this study and were administered after each game. The first, the Motivational Gaming Scale, was a modification of Keller's (1987) Instructional Motivational Scale. The scale includes statements related to attention, relevance, confidence, and satisfaction specifically oriented toward computer gaming. A factor analysis of this scale suggested limited support of some aspects of this scale, particularly in measuring attention or interest (Dempsey & Johnson, 1998; Haynes, 1999). The second gaming scale, the Game Features Scale, was derived from a review of the gaming literature. The areas analyzed from this scale included aspects considered to be important in gaming: challenge, fantasy, and curiosity (Malone, 1981); fidelity, artificiality, and interactivity (Duchastel, 1991); complexity (Jacobs & Dempsey, 1993); and control (Westrom & Shaban, 1992).

Procedure

Participants received information from an evaluator concerning the purpose of the study. They completed a demographic and gaming experience questionnaire, as well as the Kolb and Seligman scales mentioned above. Following the surveys, the participants received verbal instructions on how to play the game selected and were asked to comment freely during the game play about feelings and strategies. The evaluator asked participants to identify game attributes and strategies that may be useful for education and training. The evaluator assumed an observer-participant role recording observations and comments during the play. Most of the observations took place in a university office that included a computer with a color monitor. Upon request, the evaluator provided a limited amount of help to initiate game play. After each game observation, the evaluator conducted a debriefing interview as a means of stimulating

discussion about the game play. The debriefing concentrated on critical incidents and strategies used by the participant. In addition to the debriefing interview, the participants completed the Motivational Gaming Scale and the Game Features Scale.

Results

Gender and motivation

The most diverse patterns between men and women occurred in simulations. Women in this study may have been less motivated to engage in the simulations because the simulations did not capture their interest or attention. For example, women stated that the screen designs were boring and not enough screen variety was included in the simulations. During the debriefing interview, 56% of women also indicated that the simulations were "too aggressive." Similarly, 44% of men indicated that the simulations were "male games." Arcade games were also designated as male games by 11% of women and 40% of men. Based on statements from the participants, male games may be viewed as games with aggression, high levels of action, and war-like characteristics.

Challenge is usually considered to be an important component for motivating people to engage in game play. Women were more likely than men to indicate that successful completion of simulations was not important. Participants did not have a high level of confidence for success in any of the game categories. Again, some differing trends were noted for men and women who played simulations. Although the particular simulations used in this study may have produced an effect, women were three times more likely than men to say that they were not confident that they could succeed during simulations. Participants of both genders felt that they were not in control of simulations. On the other hand, both men and women did not indicate that they found simulations to be too difficult. More than 40% of the men felt that the adventure, arcade, board, and simulation games were male-oriented games. A much larger percentage of women than men expressed a dislike of violent or aggressive games.

Learning styles

Participants in this study represented all four quadrants of Kolb's (1984) learning styles. A larger percentage of women were accommodators and divergers. Men comprised a larger percentage of convergers and assimilators. Many learning-style patterns observed or reported by the participants may have been due in part to gender differences. For example, accommodators, with a larger percentage of women, were less competitive and less likely to be experienced using simulations, and were generally more pessimistic on Seligman's (1992) CAS-Q Scale than were the other learning groups.

Features

Qualitative data, especially, showed many key features that participants regarded as essential for a good gaming environment. Common concerns from all qualitative sources were, first, the need for clear, concise instructions describing how to play the game. Second, the game should be challenging. Third, the player should have control over many gaming options such as speed, degree of difficulty, timing, sound effects, and feedback. Each of these concerns was listed in all eight of the gaming categories. Crookall, Martin, Coote, and Saunders (1986) asserted that learning potential is greatest when participants, rather than computers, have control over events.

Aesthetic factors, specifically color, screen design, appropriate use of sound, and feedback, were considered very important in seven of the eight gaming categories. The need for opportunities for success was isolated as an area of concern in all gaming categories except adventure, arcade, and board games. Especially in simulations, adventure, board, and card games participants felt that clear goals and objectives were needed.

An overview of player position was considered an important feature in adventure games. Participants expressed a desire for variety in arcade games. They reported that help functions, hints, and examples were necessary in adventure, miscellaneous, and word games. Some games contained an element of mystery, intrigue, and suspense. These characteristics were pleasing to some players. Many liked the idea of games with familiar scenarios or stories.

Participants found certain features to be distracting (see Table 1). Lack of control, poor or no instructions, unsuitable levels of challenge, insufficient feedback, and intrusive sound across all game types were a main source of frustration for many of the players. Many of the games used in this study were shareware games lacking in three-dimensional color graphics. This, no doubt, led to expressions of dissatisfaction with both color and graphic quality. Players often found the screen designs to be boring or unsophisticated.

Strategies

Trial and error in computer gaming is defined as the absence of a systematic strategy in playing a game. This particular strategy involves actions and reactions to circumstances, consequences, and feedback within the game framework. Knowledge of how to play the game is accumulated through observation and active participation in the gaming process, not by reading rules and instructions.

In this study, strategies in playing computer games included trial and error, reading instructions, relying on prior knowledge or experiences, and developing a personal game-playing strategy. Trial and error was by far the predominant strategy across all game types. It was the predominant strategy used in 126 of the 160 games played. It was often employed even in cases where participants reported that they knew a more efficient strategy.

TABLE 1: Summary of Distracting Features or Areas of Concern Expressed by Players During or After Game Play by Type of Game

	Adventure	*Arcade*	*Board*	*Card*	*Puzzle*	*Simulation*	*Word*	*Miscellaneous*
Control	X	X	X	X	X	X	X	X
Color	X	X	X	X	X		X	X
Instructions	X	X	X	X	X	X	X	X
Challenge	X	X	X	X	X	X	X	X
Feedback	X		X	X		X	X	X
Interactivity	X							
Graphics	X	X	X	X				X
Player position	X							
Unclear goals	X		X	X		X		
Help/hints	X						X	
Readable text	X							
Screen design	X		X	X		X	X	X
Sound		X	X	X	X		X	X
Variety		X						
Lack of success				X	X	X	X	X
Violence		X				X		

Although trial and error was clearly the most common strategy, other strategies were used in some cases. People who played puzzle games read instructions and reported using visual imagery techniques more often than those who played other games. Personal strategy development included visual imagery (with puzzles); note taking (with simulations); memorization and pattern matching (with miscellaneous games involving sound); use of help, hint, and game tools (with adventure, board, puzzles, and simulation games); and systematic use of alphabet characters (with word games). Surprisingly, the amount of experience a participant had in playing a particular game did not appear to influence the amount of time spent in game play.

Applications

Participants were asked how they thought particular computer game formats might be used in an educational/instructional setting. Their suggestions for use in each of the eight game categories are summarized in Table 2. Although many of the responses were specific for the topic of the game for which they had most recently engaged, some participants offered suggestions that were more general in nature. Participants indicated that simulation, adventure, arcade, board, puzzle, and word games could be used for teaching problem solving and decision making. Many of the computer games could be constructed in a manner to address particular topics. Depending on the desired learning outcome, one type of game might be more suitable than another.

Participants identified specific games that do not have a place in an educational setting. Most players, male and female, felt that games containing violence had no place

TABLE 2: Uses of Computer Games in an Educational Setting Suggested by Players

- Adventure games
  - Survival skills
  - Inventory
  - Supply and demand
  - Probability
  - Consequences
  - Problem solving
  - Navigating
  - History
  - Purchasing
  - Budgeting
  - Higher order thinking skills
  - Learning verbs/nouns
  - Spelling/writing
- Puzzles
  - Planning strategies
  - Thinking ahead
  - Spatial orientation
  - Map reading
  - Architectural design
  - Problem solving
  - Hand-eye coordination
  - Pattern recognition
  - Matching
  - Assembly/disassembly
- Arcade games
  - Hand-eye coordination
  - Reflexive action
  - Motor skills
  - Speed simulations
  - Multiple problems/priorities
  - Timing
  - Angles, trajectories
  - Air current
  - Planning
  - Decision making
- Miscellaneous games
  - Logic
  - Pattern recognition
  - Short-term memory
  - Learning alphabet
  - Probabilities
  - Pattern matching
  - Audio/visual discrimination
- Word games
  - Vocabulary
  - Spelling
  - Problem solving
  - Remediation
  - Verbal information
  - Drill and practice
  - Reinforcement
- Board games
  - Budget
  - Logic strategy
  - Counting
  - Planning
  - Problem solving
  - Deductive reasoning
  - Critical thinking
  - Coordination
  - Navigation
- Simulations
  - Writing fiction
  - Developing framing strategies
  - Tactical and strategic planning
  - Coordinates
  - Velocity, speed, wind, angles
  - Decision making
  - Consequences
  - Economics
  - Stock projections
- Card games
  - Probabilities
  - Calculating risks
  - Developing strategies
  - Addition
  - Pattern recognition

in education. Several card games depicted a gambling scenario. Several players believed this was inappropriate, especially for children. Because the highest suggested use of card games involved instruction in probability and risk calculation, perhaps this type of game should be limited to an adult population.

Discussion

Computer games can be very complex, particularly simulation and adventure games. Arcade, card, and word games are based on a more simple structure. Each of the eight game categories has potential for educational or instructional use. Whether verbal information, motor skills, or intellectual skills are the object of the instruction, computer games can be designed to address specific learning outcomes.

Based on the data collected from this study, specific features displayed in a game are important. Players want challenging games with clear and concise instructions, help functions, and control over gaming options such as speed, difficulty, and timing. High-quality screen design, color, action, animation, and appropriate use of sound and feedback are desirable. In most of the games studied, participants indicated that these features were very important to sustain interest in the game. Because of the availability of fast-action and multifaceted computer games on the market today, games lacking the features listed above may not keep a player engaged for a sufficient amount of time for learning to occur.

The majority of participants in this study used trial and error as their game-playing strategy. We suggest this choice of strategy was due in part to several reasons related to what the participants themselves expressed as important concerns. Chief among these were lack of clear instructions, unclear goals of the game, and the participants' desire to discover the object of the game while playing the game. Often, participants would begin playing the game using trial and error and then would look for guidance by reading instructions or hint screens. As a result, computer games in an instructional setting should be constructed to allow for discovery learning, but clear and concise instructions and goals should be available for the player to access if needed. Clear and precise instructions are required to encourage game players to proceed with a game. Likewise, a statement of goals and objectives is important to encourage engagement in a game. Often, game players were frustrated when they were unsure of the game's objective.

Gaming for educational purposes should not be overly complex. Levels of complexity should be based on the learner's experience (Jacobs & Dempsey, 1993). Providing examples, *winning prototypes*, of how to play the game can facilitate engagement in a game as well as incidental learning. Similarly, game players could acquire winning prototype learning strategies that would transfer to other learning tasks. In a highly competitive economic simulation used in this study, a framing strategy could clearly organize the details of the game action and maximize the players' opportunities for success. Once learned, this strategy could transfer to intentional academic goals requiring problem organization or establishing relationships through logical inference.

Increased confidence encouraged adults to continue a game of skill. Where confidence was low, persistence was short lived. Aspects of confidence, personal control, and self-attribution were perceived as highly lacking, especially by women for certain types of games. Consequently, success, particularly positive consequences, was frequently observed as an indicator of satisfaction with the game. Clearly, learners are likely to sustain interest in games that are challenging and goal oriented. In addition,

learners desire clear and concise instructions, help functions, and control over gaming options.

What can we learn from 40 simple computer games? Participants in this study reported strong opinions regarding key features, strategies, and types of games they prefer to play. There were fairly defined gender differences regarding many of these variables. Participants were eager to report features that detract from simple computer games. Likewise, based on their experiences playing, they suggested many uses of these games in an educational setting. Their experiences and suggestions provide evidence that instructional designers, game developers, and programmers can employ to develop game-based learning opportunities. Happily, these learning opportunities exist in an environment that has already been embraced as fun.

Note

1. A 161-page technical report relating to this study is available on the Internet at http://www.coe.usouthal.edu/techReports/notes.html. To limit excessive detail, many frequencies, percentages, and other descriptive statistics available in the technical report are not directly reported in this article.

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