CONSIDERING COMPUTER GAMES AS A LEARNING TOOL

EMİRHAN COSKUN[1]

ABSTRACT

This paper describes several aspects of the growing research field interested in video games in education. The idea of reviewing computer games is derived from developing a framework of using games as cognitive tools and integrating into the classroom. In this paper three different fields related with the cognitive impact playing of video games are reviewed: abilities and skills, attitudes and motivation, knowledge and content learning. However, most studies use video games as new experimental materials and tasks to contribute to their specific field, and not as a scientific object of interest. Research on video games need a methodological framework in which results and effects can be compared, interpreted and generalized. Video games can have multiple effects on players and these effects can be used as educational potentials. An empirically-based classification of games, depending on their potential effects for an educational purpose, is strongly needed. Likewise, a unified research paradigm and methodologies to carry on reliable research on video games have to be developed.

Key words: Computer Games, Education, Learning Tool

1. INTRODUCTION

This paper reviews proposed benefits of using games as cognitive tools, and discusses the complexities of assessing those benefits. Use of educational games to supplement traditional classroom lectures is implicated by some researchers to increase interest, motivation, and retention, as well as to improve higher order thinking and reasoning skills. Assessment of the effectiveness of games as cognitive tools is a complex issue, and several variables, such as learner differences, assessment methods, and implicit knowledge, must be considered. This paper is divided into three main sections. The first section defines terminology, the second

[1] Res. Assist., Istanbul Technical University, Architectural Design Computing PhD Programme , ISTANBUL

section describes game selection criteria and different kinds of computer games and their benefits. The last section discusses several factors which must be considered when attempting to measure computer games as a learning tool in education.

2. WHAT IS A GAME ? COMPUTER GAMES - A MATURING MEDIUM

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. Basically a computer game, in addition to the definition given above, is an electronic game that involves interaction with a user interface to generate visual feedback on a video device.
Computer and video games are a maturing medium and as a result of that it has caught the attention of many disciplines. In the last decades, video games have been increasingly appealing not only as an entertainment for children and adults, but also as an object of interest in academic research. A large body of studies investigated the potential of information technology as tools for learning, and particularly of games specifically designed for educational purposes. Recently, a growing interest has appeared for the potential of mainstream games in education (in or out of the classroom). The basic claim of this line of research is that videogames may have beneficial educational impacts (Prensky, 2005). Although computer and video games are most often thought of entertainment, it is important to understand that they can be powerful learning tools. Considering computer games as a tool for learning will create many opportunities. I believe that computer and video games can have multiple effects on players and that these effects can be used as educational potentials but in order to achieve that an empirically-based classification of games, depending on their potential effects for an educational purpose, is strongly needed. Also in my opinion it wouldn't be so wrong to claim that computer and video games is in need of a conceptual and methodological framework in which results and effects could be compared, interpreted and generalized. In order to achieve that framework we need a clear understanding on the cognitive and affective impacts of video games to make it clear which game has been shown to act on each specific dimension. Then the results should be empirically assessed through large-scales statistical studies and small-scale experiments. The large-scales studies will consist in investigating the level of abilities of regular players of the selected games on the specific dimensions and the small-scale experiments will evaluate the evolution of a given ability, skill or knowledge of participants that are asked to play the game regularly.

3. CRITERIA FOR COMPUTER GAMES

3.1. Game Selection

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 aspect 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 (Rieber, Smith, & Noah, 1998). Educational games, especially those that are computer-based, are often designed in a drill and practice format, to the extent that some instructors grimly refer to them as "the old drill and kill." This format may be overused, but development of cognitive skills often requires long hours of practice with consistent feedback and it can be difficult to provide those conditions within a traditional classroom setting. Well designed computer games can be useful for consistent practice. However, games, like any other activity, require an interesting context to prevent students from losing interest and motivation (Wood & Stewart, 1987).

As a result of that, psychology and cognitive sciences have investigated the effect of video games on the players. The first thing to do is to decide what criteria were most likely to make a game a good candidate for study. According to Dempsey there are five criteria for choosing games that are more fitting to intentional instructional purposes : (1) The game must be relatively simple to play. This criterion arises from 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. It is defined that 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. (3) The game must have some identifiable potential for educational use, if adapted. It is necessary to have 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 can be designed so that it can be played by a single player if needed. Most games could be played by either one or more than one player. One of the important factors is the integration of another player in game.

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 game categories has potential for learning or instructional use (table 1). Whether verbal information, motor skills, or intellectual skills are the object of the instruction, computer games can be designed to address specific learning outcomes. 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. 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 players in this, use trial and error as their game-playing strategy. This choice of strategy was due in part to several reasons related to what the participants themselves expressed as important concerns. Often, players 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. Likewise, a statement of goals and objectives is important to encourage engagement in a game.

Table 1. Different Games - Abilities

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 Developing strategies Pattern	Calculating risks Addition

4. COMPUTER GAMES AS A LEARNING TOOL

A tool is an instrument that a user may operate and manipulate to make a process easier or more productive. It may further be described as cognitive when the tool assists constructive thinking (Pea, 1985). Cognitive tools aid students in performing conceptual operations otherwise beyond their abilities. Learners become better, more independent thinkers when using effective cognitive tools, inasmuch as cognitive tools promote and cultivate higher order thinking skills (Salomon, 1993). Salomon (1993) lists the four attributes of a cognitive tool as: (a) an implement or device, such as a symbol system, mental strategy or computer program (b) which entails the purpose for which it is designed to serve, (c) serves functions beyond itself, and (d) is distinguished from machines by the need for skillful operation throughout its function. On the other hand when considering computer games as a learning tool it is important not to 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. Computer and video games may improve several types of cognitive learning strategies. These include: organizational strategies (paying attention, self-evaluating, and self-monitoring), affective strategies (anxiety reduction and self-encouragement), memory strategies (grouping, imagery, and structured review), and compensatory strategies (guessing meaning intelligently). These strategies are in direct relation with computer games.

Research aims at measuring the effect of playing video-games on cognitive abilities (perception, visual attention) and on development and personality (particularly on aggressive behaviors). A second body of research appeared recently within the theoretical framework of the multimedia learning community, in which video games are considered as a particular interactive multimedia instructional material. In both cases, the video game is used as a particular task or material but its specificities are not taken into consideration. The effects of playing video games on cognitive and perceptual abilities, emotional responses and knowledge acquisition emerged in the literature, but they remain very disparate and inconsistent. Studying the effects of

video games, lead to ask what dimensions of the game experience can affect cognitive abilities. According to Gentile there are four independent dimensions: amount, content, form and mechanics. The amount refers to the time spent playing video games and the habits of play. This leads to considerations about video game addiction. Content, refers to effects of the messages carried by the video games as a media. Studies about games having an effect on behaviors, skills and attitudes typically are related with this dimension. Effects can be studied as negative, like violence and change of aggressiveness, or positive like health promotion. Form, refers to a kind of knowledge of the media. For example, the constant need to scan the screen in action games could improve some visual attention skills. Realism issues are also contained in this dimension. Mechanics refers to mechanical input-output devices used (Gentile, 2005). Another important issue could be the environments that games have. In the assessment of computer games as learning tools, games' environments can encourage the learning of implicit knowledge. Implicit learning occurs when a subject is not consciously intending to learn, is not aware of what they have learned, and yet they acquire new knowledge (Kihlstrom, 1994). Implicit knowledge is not necessarily reflected in people's ability to answer written questions, since they are not always consciously aware of what they have learned.

Is it possible to mix a game with a lesson and produce a valuable educational tool or is there any innovative way to use computer games for learning? Games marketed as being educational often seem to lack obvious cognitive value, while many educational toys are neither fun nor engaging. One of the most important things is to review proposed benefits of using games as cognitive tools, and to discuss the complexities in assessing those benefits. Researchers propose many benefits from the use of educational games, but the issue is complex, and several variables must be considered in assessing their effectiveness (Randel, Morris, Wetzel & Whitehill, 1992). 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 and reduced training time and instructor load. Diverse training applications, such as attention reduction or automaticity training (Jacobs & Dempsey, 1993) and complex problem solving (Hayes, 1981), are hypothesized to be prime candidates for gaming strategies. The limited amount of study in this area has led researchers 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.

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. It is 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. Participants found certain features to be distracting. 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. Bowman contrasts video gamers, who are engaged in states of flow, with students in traditional school environments. Students in traditional, teacher led classes have little control over what they learn, are passive recipients of material chosen by teachers, must conform to the pace and ability level of the group (group instruction), and are given shallow, imprecise, normative feedback on their work. Contrasting characteristics of video game playing and traditional schooling are expanded in Table 2 (1982). Bowman suggests that educators could use video games as a model for improving learning environments, by providing clear goals, challenging students, allowing for collaboration, using criterion based assessments, giving students more control over the learning process, and incorporating novelty into the environment. Bowman acknowledges that well designed learning environments use many of these design features in order to engage learners in states of flow; educational approaches such as problem-based learning environments, case based reasoning, learning through participation in communities of practice.

Table 2. Differences between video games and traditional school environment

Player controls how much she plays and when she plays.	Groups of students learn at one pace, and are given very little freedom to manage the content and pacing of their learning.
Students are actively engaged in quick and varied activity.	Students passively absorb information in routine activities, such as lecture
Players play and practice until they master the game; players can take all of the time they need to master Pac-Man.	Students must all go at the same pace, regardless of achievement. As Reigeluth (1992) describes, traditional schooling holds time constant, allowing achievement to vary, instead of holding achievement constant (ensuring that all students master material) and allowing time to vary.

Players have feeling of mastering the environment, becoming more powerful, knowledgeable and skillful in the environment.	Students learn knowledge abstracted by teachers and regurgitate this knowledge on pencil and paper tests, rarely applying it in any dynamic context.
Video game players work together, sharing tips and trading secrets.	Students perform in isolation, and cannot use one another as resources.
Performance is criterion based; each student competes against his/her ability to master the game, to reach new goals. Every student can reach a state of "mastery" over the game.	Students are graded normatively, graded against one another's performance and encouraged to compete against one another.
Games are played for the intrinsic reward of playing them, for the emotional state they produce (Herz, 1997).	Schools are structured around extrinsic rewards, such as good grades or a fear of failure (flunking).

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 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. Trial and error was by far the predominant strategy across all game types. It is the predominant strategy used in games. 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.

5. CONCLUSION

Assessment methods are complex issues while measuring the value of computer games. A long list of questions have been raised about gaming assessment. Further study intends to develop a framework in order to integrate computer games into the design studios. Educational games may offer a wide variety of benefits. Increases in interest and motivation, as well as improvement of retention and higher order thinking skills are worthwhile goals for an instructional tool. However, several factors must be considered in the design of an educational game, and in the design of its assessment. Researchers must be careful with their methods, and administer the game as well as the assessment in an appropriate manner. Instructional objectives of the game must be clear, and matched to the assessment tool. Assessments should consider individual personality types and cognitive styles, and carefully consider how the learner can demonstrate what they may have gained from the activity.

REFERENCE

Bowman, R.F. 1982. A Pac-Man theory of motivation. Tactical implications for classroom instruction. Educational Technology 22(9), 14-17.

Gentile, D. A., & Gentile, J. R. (2005). Violent video games as exemplary teachers. Paper presented at the Biennal meeting of the society for research in child development, Atlanta.

Hayes, J. R. (1981). The complete problem solver. Philadelphia: Franklin Institute Press.

Jacobs, J.W., & Dempsey, J. V. (1993). Simulation and gaming: Fidelity, feedback and motivation. In J. V., Dempsey & G. C. Sales (Eds.), Interactive instruction and feedback, Cliffs, NJ: Educational Technology.

Kihlstrom, J.F. (1994). Cognition unawares [book review of Implicit Learning and Tacit Knowledge: an Essay on the Cognitive Unconscious by A.H. Reber]. Science, 264, 1013.

Pea, R. D. (1985). Using the computer to reorganize mental functioning. Educational Psychologist, 20, 167-182.

Prensky, M. (2005). Computer games and learning: digital game-based learning. In J. Raessens & J. Goldstein (Eds.), Handbook of computer game studies. Cambridge: MIT Press.

Randel, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes: A review of recent research. Simulation & Gaming, 23(3), 261-76.

Rieber,L. P., Smith, L.,& Noah, D. (1998). The value of serious play. Educational Technology, 38(6).

Salomon, G. (1993). On the nature of pedagogic computer tools: The case of the Writing Partner, In S. P. Lajoie & S. J. Derry (Eds.). Computers as cognitive tools. (pp. 179-198). Hillsdale, NJ: LEA.

Wood, L. E., Stewart, R.W. (1987). Improvement of practical reasoning skills with computer skills. Journal of Computer-Based Instruction, 14(2), 49-53.