



Effects of digital games on critical thinking: Empirical Evidence-Based Study

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Abstract

The rapidly growing phenomenon of video games, have raised concerns about the negative impact such games are reputed to have on youth. On the other hand recently interest in digital games indicated that it would be useful to update. Present systematic literature review of empirical evidence about the negative and positive impacts and outcomes of games. Since a large number of papers was identified in the period from 2005 to 2020, the current review focused on 90 papers that provided higher quality evidence about the outcomes of games. multidimensional analysis of games and their outcomes provided a useful framework for organizing the varied research in this area.

Results indicate there are relationship Between video game genre and content, player time spent and personality with negative or positive prosocial outcomes also results show relationship Between video game genre and content, quality of game design mechanic or principles with children and adolescent critical thinking. Future research on digital games would benefit from a present empirical evidence based of experimental work, examining in detail which game features are most effective in enhancing children and adolescent critical thinking.

Keywords: digital games, Computer games, serious games, learning, Empirical Evidence-Based, critical thinking

I. INTRODUCTION

Video games are very popular in various circles especially young people. As a hobby, video games also offer to entertainment. Games can contain learning orientation, skills and cooperation[1] Video games can also affect the behavior of special players and the environment in general. It becomes interesting when it turns into a study that leads to the formation of character and skills in the scope of adventures that can be framed in relation to skills, or can function as an extension of characterization practice [2]

Promoting learners' 21st-century skills like critical thinking and problem solving, can equip them with the skills required to face the challenges and demands of the 21st-century and grow learners into more active and informed citizens[1] Critical thinking is a form of higher-order thinking that involves a systematic approach toward challenges based on a deep understanding of the topic at hand, collecting all the relevant information, drawing conclusions, and proposing solutions as a result of evaluating and analyzing the issues being addressed Proficiency in critical thinking is associated with reflective thinking and skillful judging, success in undergraduate education and is considered a key skill for citizens [3]

Although there is an overwhelming consensus among researchers and educators with respect to the significance of critical thinking, a lot of students at the college level demonstrate poor critical thinking, which indicates that they are graduating high school with worryingly low levels of critical thinking [4] particularly in the domain of science learning A key reason for students' poor utilization of critical thinking is often attributed to the traditional method of schooling, which places great emphasis on test scores and lacks exposure to complex problem-solving tasks [5] Fortunately, evidence suggests that critical thinking is not an innate ability but a set of skills that can be taught and . Additionally, findings from previous research studies show that using computer technology in learning can foster students' critical thinking [6].

Among various technology-enhanced learning methods, Digital Game-Based Learning (DGBL) has been recognized as an effective method to provide learners with an enjoyable, interactive and challenging environment [7]. DGBL is a student-centered learning activity based on the incorporation of video games in learning content to achieve educational goals. Researchers and practitioners in the education sector have pointed out that this instructional approach could foster students' problem-solving abilities and fosters their critical thinking skills and prosocial behaviors. [8].



Previous research indicates the importance of student discourse in the construction of knowledge and the fostering of critical thinking skills, especially in the field of problem-based learning (PBL). Further, a growing body of research on game-based learning (GBL) draws parallels between playing certain types of games and the solving of ill-structured problems, citing similar conditions for learning (student centered, small student groups, teachers as facilitators, problems as vehicles for development), and similar learning outcomes (communication, problem-solving, critical thinking, collaboration) as PBL. However, there is a gap in understanding how GBL affects critical thinking as embodied by student discourse when implemented in traditional classroom environments [9].

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Regarding the various and sometimes contradictory reports in relation to the effects of computer games on critical thinking and educational achievement and also regarding the importance of these two variables, it seems that it is necessary to do more researches specially regarding with types of games. Therefore, the purpose of the current study was to investigate the effects of using computer games on the disposition to critical thinking, problem solving and social behaviors [11].

There are different opinions about the potential benefits of gaming on students' academic achievements, motivation, and skills in science courses due to the lack of empirical evidence and mixed results[12].

II. THEORETICAL BACKGROUND

Thinking is one of the three important aspects of cognition (perception, learning, thinking). Thinking is a mental act and arises when a person faces a problem and wants to solve it. At this point in the mind, an attempt to solve the problem begins, which is called thinking. thinking is a mixture of knowledge, attitude and skills, to determine and distinguish, select appropriate information, problem solving, identify assumptions, appropriate hypothesis, path selection solutions, test results and judgment; In other words, the rational and systematic process of conceptualizing, applying, analyzing, synthesizing, and evaluating the dynamic and skillful information gathered, which is used to guide ideas and practices[13].

Critical thinking is an integral part of many common activities. It has long been considered an important ability, and not just in the field of education. For example, the ability to analyze given information and propose new solutions that did not exist before has been a core part of thinking skills in many workplaces. [14] referred to critical thinking as "[...] seeing both sides of an issue, being open to new evidence that confirms your ideas, reasoning dispassionately, deducing and inferring conclusions from available facts and solving problems". To develop critical thinking, many kinds of skills are needed.

Recently, critical thinking was listed as a 21st century skill [15] The notion of 21st century skills stems from the emphasis on information in today's society. The value is not just in having information, but also in being able to use it. The problems with which individuals are confronted today are ill defined and require critical thinking in drawing on knowledge from a variety of fields.

The concept of critical thinking can be traced to Socrates, but John Dewey is closely associated with critical thinking in modern times. Although definitions today vary, there is a generally accepted core set of cognitive skills involved in critical thinking, including analysis, interpretation, evaluation, explanation and self-regulation In addition to cognitive skills, dispositions are crucial to critical thinking. A disposition towards critical thinking is the 'likelihood that one will approach problem framing or problem solving by using reasoning consistent with internal motivation to engage problems and make decisions by using thinking' [16]

Critical thinking skills are crucial for every day survival and are crucial to the successful decision making that is involved in an entrepreneurial business venture [17] Many people possess the skills necessary for critical thinking but fail to utilize them due to the unstructured or 'lazy' nature of their decision-making processes. It has been argued that entrepreneurs are specifically adept at what could be thought of as connecting-the-dots, and therefore it should be the pedagogical goal of any business program to seek ways to enhance the soft skills such as critical thinking through deliberate practice. The act of encouraging students to think entrepreneurially includes a certain amount of critical thinking, which is enhanced quite remarkably through problem-solving based exercises [18] It is through these exercises that the students are exposed to real-world problems which are faced by entrepreneurs. These include the cognition of "me" into the problem itself affecting the decision-making process that relies heavily on critical thinking skills amidst a combination of extreme time pressures and a sense of extreme uncertainty [19]



III. CRITICAL THINKING AND VIDEO GAMES

Considerable amount of researches on the effects of computer games on players' critical thinking area, report its positive effect. From Garalee's [20] point of view, serious and purposeful games can help students to improve useful skills such as critical thinking. These games from the beginning of construction have been faced with some obstacles, probabilities, reasonable trajectory, success, prize, etc. For this reason, games have become one of the most effective ways to create critical thinking. In a critical thinking research which has been conducted by [21] to investigate the effect of online group games on writing ability and critical thinking skills. The finding showed that online group games help university students to increase and improve their writing ability. The researches which have been conducted in Iran confirmed the positive effect of these types of games on critical thinking. For example, [22] organized a research on the effects of computer games on critical thinking in high school students. The results of the study confirmed the research hypothesis which was computer games have positive effect on students' critical thinking.

However, there are some researches which have not reported any significant relationship between games and students' critical thinking. For example, [23] prepared a research to consider the relationship between the amount of different digital games using and the level of critical thinking among the high school students. The results of this research revealed that there is no relationship between six groups of games (action, puzzle, strategic, educational, adventure, simulation) and the level of critical thinking.

IV. METHOD

A. Databases searched

Since initial searches had suggested that a very large number of papers would be found, the electronic databases searched in this review were a Science Direct, Applied Social Sciences Index and Abstracts (ASSIA), BioMed Central, EducationResources Information Center(ERIC),PROQUEST,Scopus,Springer, EBSCO, Ingentaconnect and Institute of Electrical and Electronics Engineers (IEEE). Limiting the number of databases selected provided a manageable number of papers with ACM, , Extended Academic ASAP, Emerald, Index to Theses and the ECGBL conferences excluded from the current review.

B. Search terms

The search terms were addressed the variety of games that might be played: ("computer games" OR "video games" OR "serious games" OR "simulation games" OR "game based learning" OR Game Geres OR MMOG OR MMORPG OR MUD OR "online games") as well as terms for the possible outcomes or impacts of playing games: AND (evaluation OR impacts OR outcomes OR effects OR learning OR education OR skills OR behavior OR critical Thinking OR problem solving, Social Behaviore, OR Prosocial Behavior OR affect).

To assist in searching the electronic databases an automated retrieval system was used to identify articles according to the search terms specified by the researcher. In this method aqured large number of papers However many of these were irrelevant and to focus on a more manageable set of papers, this set of papers was further screened by searching all titles and abstracts of papers for the terms "game", Serious game "gaming", "MMOG" and "MMORG" behavior OR critical Thinking OR problem solving, Social Behavior, Prosocial Behavior. Papers selected on this basis were collated and duplicates removed.

C. Selection of papers for inclusion in the review

To select appropriate studies for inclusion in the review, abstracts of these papers were read and a number of further criteria were applied based on those used in the original review. Selected papers had to (1) include empirical evidence relating to the impacts and outcomes of playing games, (2) date from 2005 to 2020, (3) include an abstract and (4) include participants over the age of 6 years.

D. Quality of the studies

Papers were quality assessed according to the 4 criteria: (1) quality of research design for answering the question: high, e.g. RCT; medium, e.g. quasi-experimental controlled study or low, e.g. pre-test/post-test design; (2) appropriate methods & analysis; (3) generalizability of findings; (4) relevance of the focus of the study (including conceptual focus, context, sample and measures) for addressing the research question. Each paper was scored between 1 and 3 on these five dimensions and total scores for each paper varied between 5 and 15.

E. Papers selected using our inclusion criteria

Applying the four inclusion criteria to these papers, 250 papers were identified and, to provide a more manageable task, the current review focused on the 90 papers that were quality rated as 10 or over, since these papers provide the strongest evidence about the impact of games in critical thinking, problem solving and prosocial behavior. The largest number of high quality papers was found in ScienceDirect, ERIC, springer, Biomed Central and IEEE.



RESULTS: EMPIRICAL EVIDENCES: VIDEO GAMES EFFECTS ON CRITICAL THINKING

Until recently, a small number of research studies have been conducted to explore the relationships between video games and critical thinking skills. Two studies have explicitly tested this relationship; in both, critical thinking skills were defined as crucial skills that encourage and motivate individuals to engage in problem solving and make decisions by thinking critically to solve it. One study was a quantitative study, and conducted by Gerber and Scott [23] to investigate the difference between video game players and non-players on critical thinking dispositions. As well, they examined relationship between critical thinking dispositions and game context. Among a sample of 121 adolescents aged between 18 to 22, video game playing was positively associated with critical thinking skills. However, this association was only found in strategy video game players. Specifically, strategy video game players have higher critical thinking skills than non-strategy gamers. The other study was conducted by Yang and Chang [24] and showed that the more adolescents participated playing digital game, the more improvement were evident in students' concentration and critical thinking skills.

Results of [25] research, showed that games were effective in improving student critical thinking, the findings showed that strategic computer games were very attractive to participations.

[26] research result showed that the improvement critical thinking of the students in the experimental group was significantly better than that of the students in the control group. computer games can improve critical thinking. They findings suggest that the proposed game improved students' critical thinking; moreover, it was revealed that students in the intervention group who received their instructions via the proposed educational computer game developed with the ICMDCR framework did not significantly outperform their counterparts in the comparison group who learned with the traditional method of teaching in regards to their self-efficacy to learn science, or in their learning motivation. The experimental results confirm the findings of who recognized gaming as an activity that could foster students' capacity to think critically in the area of science.

[28] findings show that practicing problem-solving scenarios with a focus on critical thinking in a time limited setting results in a measured improvement of this skill. The findings suggest that educators could use games more as tools for problem-solving to contribute to their students' learning outcomes around developing critical thinking. More research could be devoted to developing problem-solving and critical thinking skills through game-play models. Improved critical thinking skills in individuals could make a greater contribution to society.

[29] study indicates Video games can also affect the behavior of special players and the environment in general. One type of video games that provides it, is adventure video games which are the result of combining survival methods for specific purposes that contain knowledge of the surrounding environment and skills in exploiting opportunities. The main player character is often presented in video games in the form of problem solving and thinking ability in complete the adventure or the game itself based on the character for the purpose of learning about characters that are strengthened with certain skills. Video games with the main character elements in them can reflect the discovery of new ideas, approval of ideas, completion of skills or reconfiguring ideas, so playing an adventure video game can lead to positive values that influence players' thought also motivate them to complete adventure challenges. In this study, we want to know the effect of adventure video games on the development of student's character and behavior. From the calculation of the Wilcoxon test it can be concluded that; (1) adventure video games influence the development of student character (2) Adventure video games influence the development of student behavior.

[30] research says because it is thought to develop 21st century skills such as critical thinking. To date, there has been a dearth of generalizable research investigating the relationship between gaming and critical thinking. Results of a survey of 121 adults found that gamers and non-gamers do not differ significantly on critical thinking dispositions. However, gamers who play strategy games scored higher on actively open-minded thinking than did other types of gamers. In addition, low compared with high involvement in the gaming community was associated with higher open-minded thinking. Implications for educators and for further research are discussed.

[31] in thier research show when evaluating memorization abilities, results revealed that there are no significant differences among the three groups (one individual learning group and two collaborative learning groups). Learners in individual learning groups tended to depict and understand situations in greater detail. Collaborative learning groups usually described situations in a simplified manner as a result of the knowledge externalization that took place among partners. When evaluating critical thinking, there were significant differences between individual learning groups and collaborative learning groups in our study, and also between the two types of collaborative learning group. Most individual learning groups provide simple analysis, in other words, surface thinking. Collaborative learning groups with deficient information performed relatively well (in-depth thinking) compared to the collaborative learning groups that had sufficient information, and interactive messages rather than independent messages were conveyed between the team members during their collaborative learning due to their need to get the information that was unavailable to the individual.



[33] Results demonstrated that compared to control groups, non-problematic use of videogames can lead to improved task-switching, more effective top-down attentional control and processing speed and increased sub-second time perception. Two studies highlighted the impact of gaming on cognitive skills differs depends upon game genre. The studies reviewed suggest that videogame play can have a positive impact on cognitive processes for players.

The most studied game genre in the videogame addiction literature is massively multiplayer online role-playing games (MMORPGs, e.g., World of Warcraft, Final Fantasy XIV, Guild Wars 2). Indeed, this game genre presents features facilitating the development of pathological use, such as a continual never-ending play universe (i.e., requiring players to connect for long periods daily so not to fall behind the other players), and a powerful and reinforcing reward system (i.e., requiring the player to achieve important quests several times to acquire a specific and powerful item). However, there is also much research in the gaming studies literature that has focused on the many positive impacts of videogames among typical videogame players. Regarding playing performance—either cognitive or visual. the most studied videogame genre is action videogames including first-person shooters (FPSs, e.g., Overwatch, Battlefield, Call of Duty) games. In these games, as the name implies, a first-person perspective is used providing a greater immersive experience for the videogame player. Such games can be played either online or offline. In offline games, the purpose is often to advance from one specific point to another without the game character dying, while completing various sub-missions. In FPS game scenarios, while videogame players always need to kill their opponents' game characters, the main purpose of the session can vary between capturing specific areas and catching flags. This type of game genre has been selected as one to empirically study due to the importance of player flexibility, reflexes, and attention required (e.g., having to focus on several stimuli at the same time, switching between different tasks). Given that improved cognitive skills on a task can be transposed to other tasks [1] it has been suggested that playing videogames requires important cognitive skills that could improve such skills. When it comes to problematic and/or addictive videogame playing, several studies have investigated the negative impact of videogame use on diverse cognitive processes, primarily decision-making, inhibition, and multi-second time perception [32] Research into the effect of problematic and/or addictive videogame playing on decision-making comprises three main strands: risk-taking, the ability to make a decision when an individual knows the odds of losing (e.g., Game of Dice Task [GDT]; Brand et al. 2005); delay-discounting, the ability to select a larger reward later rather than a smaller reward now and ambiguous decision-making, the ability to adapt one's decision as the situation evolve.. Experiments in these areas have demonstrated that there is an impaired decision-making process in risk-taking situations, but preserved decision-making when it comes to ambiguous situations. Furthermore, pathological videogame players show a significant difficulty in delaying rewards [34].

(A) Analysis of Critical Thinking in Gamers and Non-Gamers

Independent group t-tests indicated no differences between gamers and non-gamers on critical thinking scores. This finding is different from other research on gaming and cognition that indicates that gaming has a positive effect on certain aspects of cognition. It is possible that critical thinking and problem solving are aspects of cognition that are not influenced by game play; however, it is also possible that the current study found no effects due to sampling error and small sample size. However, this finding is consistent with [1] who found that gamers and non-gamers did not differ on critical thinking (problem solving was not examined in Gerber and Scott's study). The current project extends these previous findings to problem solving. Furthermore, the current study expands on [1] results by examining critical thinking and problem solving by game type.

(B) The Relationships Between the Genre of Video Games and Critical Thinking

The current study found no relationships between the types of video game played with critical thinking. This means that no support was found for a relationship between types of video game played and critical thinking. This may be due to low power in the study: only 27 participants were included in the one-way ANOVA, meaning that the effect of video game genre on critical thinking would have to have been large to be detected by the test. Perhaps the effect was too small to be found with such a small sample size. The findings of the present study are not consistent with previous research on video game genres and critical thinking.

[38] found that people who play strategy video games have higher critical thinking scores than people who do not play strategy video games.

There are key differences between and the present study: namely, differences in measurement of video game type and differences in analysis. [37] asked participants which types of video games they played, and asked them to select all that applied from a predetermined list. The present study asked participants to list their favorite games, and the researcher categorized the games based on game descriptions. The present study did not utilize the same categorizations of video game type as [38] due to small sample size. In the present study, each participant had only one game type, while Gerber & Scott had multiple game types for each participant. In terms of analysis, the present study compares critical thinking and problem solving across game types (i.e., using a one-way ANOVA by game type), yet [38] use a series of t-tests to compare individuals who play and do not play a single type of game. Gerber and Scott is the only study that has examined the relationship between critical thinking and video games.

The relationship between types of video games and problem-solving was not significant. This means no support was found for a relationship between type of video game played and problem-solving behavior. Again, the low power in the current pilot study may



have affected these results. Another possible explanation for this result may stem from the measure of problem-solving used in the current study. The study's scales were self-report questionnaires that obtained participants' reflection to the questions rather than measuring these skills objectively. The measure of problem solving might be vulnerable to social desirability bias. Critical thinking and problem solving are seen as positive qualities indicating competence more often than not. Since individuals typically perceive themselves to be competent individuals with good qualities, they may rate themselves higher on these constructs than what an objective test would indicate. While subjective measures are important, as they indicate how a participant views themselves, objective measures provide greater insight into the quality itself, rather than the participant's view of that quality. I chose to use a subjective measure because objective measures of critical thinking and problem solving may have posed a challenge to recruitment, as participants may be reluctant to complete a test due to testing anxiety or test duration. Future research should utilize both objective and self-report measures to assess problem solving. This result of the relationships between types of video games and problem-solving is not consistent with previous research findings [1].

Thus, comparison of findings from the current study with other studies was difficult. For example, the research conducted by [1] was a longitudinal study that examined only one genre (strategy video games) along with problem solving skills. Their sample consisted of 1492 adolescents between 11 to 14 years old. They found that, over time, adolescents who frequently played strategic video games had higher problem-solving skills than those who were not frequent players. Similarly, [32] studied 167 school aged children to examine the effectiveness of playing digital games on improving problem-solving skills. They found that playing digital games lead to increased problem-solving skills. Due to the diversity and difference in these studies, both in the age of the participants and in the study design, it is difficult to compare across studies. However, due to the lack of research in the area of video games participation on problem solving and critical thinking in general, there are few alternatives for comparison similar to the current study. It should also be highlighted that because of the small number of video game players in the current pilot study, it was difficult to achieve statistically significant findings. With only 27 gamers included in the one-way ANOVA, effect sizes would have to have been large to be detected by the test [36]. It is possible that more significant findings would have been discovered if the sample had been larger. Future research should develop recruitment strategies aimed to increase the participation rates and subsequently enhance generalizability of the results and detect smaller effects.

(C) The Relationships Between the Time Spent Playing Video Games and Critical Thinking

Correlations between time playing different types of video games with problem solving and critical thinking skills were not significant. No significant correlation was noted between problem solving skills and critical thinking ability, suggesting that these two variables are examining different constructions. The low power in the current pilot study may have affected these results. Moreover, some participants did not record their hours of play. Therefore, with a limited number of participants and missing data, further research is needed to better understand the relationship between frequency of gaming and cognitive skills in young adults. This contradicts the finding of [38] regarding to the relationships between gamers and game contexts and critical thinking disposition. [22] found that adolescents that play more than two hours of video games each day have significantly lower critical thinking skills than adolescents who play video games for less than two hours each day. Similar to the findings of Gerber and Scott [40] found that greater time spent playing video games was related to less creativity and less flexible methods of thinking and problem solving in elementary school students. These results suggested that video game players who spend more time playing video games tend to be less flexible in thinking. Moreover, since gamers are highly familiar with the video gaming world, they become adept at solving problems using the same methods for other video games, so they do not engage in extreme creative thinking in solving different problems. However, it should be noted that these results do not suggest that video games are making adolescents less creative, but it is possible that the creative adolescents simply less attracted to play video games.

(D) The Relationships Between the Extracurricular Activities and Critical Thinking

The analyses of the relationships between types of extracurricular activities with critical thinking and problem-solving skills were not significant. Although data analysis showed no significant results, there are many significant benefits of extracurricular activities in youth development. Wilson et.al[40] indicated that participation in extracurricular activities are significantly associated with increasing interpersonal competence and school engagement in adolescents. [38] also indicated that extracurricular activities can promote three distinct elements, including intrinsic motivation, concentration, and cognitive efforts, and cumulative over time to achieve a goal. In the present study, extracurricular activities were combined based on similarity because of small sample size. Again, larger sample sizes may lead to significant findings; further research is required.

CONCLUSION



Gentile and his colleagues [41] have proposed five dimensions along which video games can have effects—the amount, content, context, structure, and mechanics. This approach explains how research findings that initially appear contradictory are actually congruent. Games and the ways people interact with them are multidimensional, and each dimension is likely to be associated with specific types of effects. The amount of time that people spend on recreational games can have effects on them, regardless of specific game features. Studies have demonstrated that amount of time playing games predicts poorer school performance. Theoretically, this effect is likely due to displacement of other academically beneficial activities. Other studies have demonstrated a relationship between amount of sedentary gaming and obesity [42] Again, it is likely that sedentary games displace other more physically active activities, and children may also snack more while gaming than they otherwise would. Amount of gaming has also been implicated in repetitive stress disorders [43] and in video game addiction. Most of the research on video game effects has focused on the content dimension, with the bulk of that research focused on violent content. It should be no surprise that people learn the content of whatever games they play. If they play educational games, they learn the educational content and can apply it to their schoolwork [44] if they play games designed to teach health content, they learn those concepts and apply them to their lives if they play violent games, they learn the violent content and may apply it to their lives.

The context of game play may produce differential effects, but this is the dimension with the least research at this time. Context can be defined within the game or outside of the game. One type of within-game context can be seen in violent games that allow for either team-based or free-for-all modes of play. Both may be equally violent, but playing in an everyone-for-oneself mode might lead to greater aggressive thoughts, lower empathy, and greater desensitization. If the in-game context requires players to cooperate to achieve goals, this might also teach teamwork and social coordination skills. Furthermore, the social context outside of the game may matter. Playing a violent game in a room with other friends (virtual or real) might increase the aggression effect because players are giving each other social support for aggression. It might actually reduce the aggression effect, however, if one's motivations are prosocial (to help your friends). To our knowledge, no studies have yet tested these hypotheses.

How the game is structured and displayed on the screen can also have effects. This screen structure provides information that is learned, similar to how we learn to perceive other visual information [44]. Perceptual skills can be improved through practice, as has been shown in several studies [33] Other studies have demonstrated an improved ability to get three-dimensional information from flat screens [45] or improved mental rotation skills [1] after playing games that require those skills. Finally, the mechanics dimension refers to what can be learned from practice with different types of game controllers. Depending on the type of controller, several different skills could be improved, including fine motor skills (e.g., by using a thumb controller), gross motor skills (e.g., by swinging the Wii remote like a golf club), or balance skills (e.g., using the Wii balance board). These effects can be used intentionally, such as in physical therapy or to improve dynamic balance control after brain surgery [46] The intersection of structure and mechanics is the continuous feedback loop that is often referred to as hand eye coordination. One benefit of noting the dimensions on which games can have effects is that it allows us to recognize that the dichotomous question of whether games are good or bad is too simplistic. Games have multiple effects at multiple levels of analysis, some of which may be beneficial and some of which may be harmful, even within the same game.

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