(Board 51/Work in Progress) Cognitive and Emotional Effects of the Video Game Freedom Bridge.

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WIP: Cognitive and Emotional Effects of the Video Game, Freedom Bridge

Abstract

This work-in-progress study investigates the effect of playing an emotionally engaging video game on feelings and long-term knowledge retention compared to traditional reading of information. Teaching and learning have evolved with technology, and today online software or mobile learning platforms and learning management systems have become more common for students. Despite this, integrating technology into education is challenging because of traditional curriculum, structure, and academic demands. Additionally, educational video games are gaining popularity and provide interactive ways to learn and keep students motivated. Educational games allow students to interact with the material in new ways, increase their motivation, foster independence in their education, and have the potential to promote a student-centered learning experience. This study aims to investigate how playing emotionally engaging video games affects long-term knowledge retention and emotional responses when compared to traditional learning methods or the passive reading of information.

Background

Digital games provide rich media content and engaging action, accessible individually or in groups collaborating or competing against each other, making them promising for use as a stimulus in research settings [1]. Playing digital games involves intricate behaviors that may require different cognitive and emotional processes depending on the game's design. Consequently, games offer a great medium to explore various psychological concepts, such as memory retention, social aptitude, and decision-making skills [1], [2]. Digital games are a natural choice for a stimulus, not only when studying gaming and the gaming experience, but also for other research questions calling for an engaging, yet challenging activity [3]. Psychologists have mostly focused on the negative effects of gaming, such as violence, addiction, and depression. However, it is important to consider both the drawbacks and benefits of playing these games for a more balanced perspective [4]. Engaging in video games can provide players with immediate feedback, motivation, clear goals, opportunities for skill development, distributed learning, transfer of knowledge, and other effective teaching methods. When game-based learning is integrated into education, students are naturally stimulated and can enhance their skills and knowledge in academic subjects through distributed practice [5].

According to the 2023 survey by the Entertainment Software Association (ESA), 76% of children below 18 and 62% of adults in the United States play video games. Fifty-three percent are males, 46% are females, and the average age of a video game player is 32 years [6]. The potential of video games is enormous when it comes to studying human growth and development, serving as training simulators for various professions and skills, providing education at all levels - primary, secondary, and collegiate institutions, and offering many other possibilities [7]. Video gameplay affects and enhances several cognitive skills [5], through increased hand-eye coordination from kinesthetic skills, video game-playing surgeons perform significantly better in laparoscopic surgical skills than non-video game-playing surgeons [5].

With advancing technology, video games are increasingly used in educational settings. They serve as effective educational tools to provide students with a hands-on approach to learning about a specific field [7], video games can also be used in preventing neurological disorders, impairments, and negative behaviors, as well as treating physical problems that may result from accidents and illnesses [7]. Depending on the specific condition or circumstance, video games can be customized and tailored to help individuals uniquely. Furthermore, video game simulators can be incredibly valuable tools for educating and training professionals, especially those in industries like medicine and the military. By using these simulators, individuals can benefit from a variety of training methods, including the development of operational skills, the acquisition of medical knowledge, kinesthetic training, or a combination of these approaches. For instance, da Vinci surgeons can use video game simulators to hone their skills and improve their performance in the operating room [7, 8].

The video game industry has undergone significant changes in the past 40 years from the development of business and war games on high-speed computers like the IBM 650 computer [9], [10], [11], to using high-definition graphics computers today. Video games have been associated with negative effects, such as aggression, academic decline, addiction, motion sickness, seizures, and mood swings [10], [11]. Action video games (AVGs) belong to a genre of video games that require fast reactions, constant vigilance of the visual field, and the ability to track multiple targets at once [12]. AVG has become a popular intervention to improve cognitive functions in healthy adults, due to its ability to involve multiple cognitive domains [13].

Video gaming is gaining popularity as a training tool because it offers a playful alternative to traditional methods and has a significant impact on brain structure and function in a short time [14], [15].

Research Questions

As technology grows and the demand for educational technology increases, it is important to understand how to build technology tools that would be efficient in the most cost-effective way especially when the cost of building a game can be quite expensive. This study explores the correlation between game environments, emotions, and cognition. Through this study, we aim to understand:

I. Do deep emotional engagements lead to better learning outcomes when using games for learning?
II. Do the emotional and learning experiences change when the visuals are changed?
III. Does playing a video game impact brain functions and learning compared to using traditional methods?

Methods

To answer the research questions, we chose to use an emotional video game that is short to play and has educational learning outcomes. Our selection was the online game called *Freedom Bridge.* This game highlights the story of North and South Korea and the difficulty of accessibility between the countries despite having a connecting bridge. The original game by Magnuson [16] is a 2-minute emotionally intensive *notgame* “a form of entertainment that does not have a winner or even a real conclusion” [17]**.** It uses a tiny black square to represent the player in a two-dimensional top-down game environment. Players are encouraged to use

headphones to be fully immersed in the gameplay. At the end of the game, a message about the game is displayed in two lines, “Freedom Bridge spans the Imjin River between North and South Korea. Despite its name, it remains impassible from either side”[16].

Game Design

We created a 3-dimensional (3D) version of the *Freedom Bridge* game using blueprints in Unreal Engine 5.1, the 3D version allows us to experiment with texture and color to study the effects of changing on participants. The game environment is simple with walls featuring barbed wires on top, replacing the barbed wire in the original game. The barbed wire, textures, and assets used in the game are assets from the Unreal Megascan. Game programming in Unreal engine was done entirely using blueprints. Markers that would later be used with EEG were also embedded at the fence and on the bridge to correlate the brain activity to the different events that happen as the participant plays the game. For example, when the player crosses the fence and starts bleeding, the marker will help correlate that activity with the brain activities, which the EEG would record; this will later help us when analyzing the EEG data.

Player Experience

The gameplay involves the player character passing through the barbed wire, which slows them down considerably. The struggle to pass through the wire is almost palpable, and as the player character passes through, they begin to bleed. Although the player character's speed increases after passing through each wire, it is not as fast as it was before. The speed is further reduced with each barbed wire they cross. After the fourth fence, the player encounters a river and a bridge. By this point, the player's movement is significantly slowed. However, as they cross the bridge, they get shot. One could say that the game is built to guide the player character to its death with no way to escape or change the outcome.

To maintain the original feel of the game, we retained the river sound and the gunshot sound but rendered them in 3 dimensions. To keep the field of vision in the original game, which in 2 dimensions only allowed limited visibility for the player, we added some fog to the environment to reduce visibility thereby limiting how far the player sees into the game scene. Additionally, we retained the speed-reducing mechanism in the original game, giving the impression of limping as they approach the bridge. Finally, just like in the original game, the player character gets shot on the bridge.

When participants start the game, they will see a user interface with instructions on how to play the game. Participants are instructed to use the headphones provided as this is a vital element transferred from the original game. The 3D spatial audio used in the game is used to subtly guide the participants in the desired direction and to reduce external stimuli. The participant can navigate the scene using the WASD or the arrow keys on the keyboard, and the spacebar key enables the player character to jump. When the player makes a jump facing the wall and the distance to the wall is close enough, the player character can hang on the wall. Pressing forward (W or arrow Up) will make the character finish the wall climb. Jumping while the player is positioned on the wall itself is disabled, so the participants can feel the struggle of crossing the fence as in the original *Freedom Bridge* game. To exit the game, we replaced the “Esc” key with “Shift Esc”; this is to prevent the participant from accidentally exiting the game when they press the “Esc” key. When the game is over, information about the *Freedom Bridge* is displayed on the

screen for a few seconds, long enough for the participants to read the information. The participant then receives instructions on how to exit from the gameplay.

For this study, four versions of the game were created,

- Version I: The scene is textured. The player character's speed reduces, and the player character bleeds when they cross the fence. Participants who played this game are categorized to be in Group I.
- Version II: The player starts bleeding as they climb and cross barriers. In this version of the game, the default grey box or cubes in Unreal Engine was used, and the player bleeds and have a reduced speed when they cross the fence. Participants who played this game are categorized to be in Group II.
- Version III: The scene is textured. The player character's speed reduces, but the player does not bleed when they cross the fence. Participants who played this game are categorized to be in Group III.
- Version IV: The scene is the default grey box in Unreal Engine. The player does not bleed when they cross the fence, and the speed is also reduced. Participants who played this game are categorized to be in Group IV.

With the four versions of the game, the study hopes to test the effect of game elements, such as texture and color on the participants' performance. For example, how significant will the difference in the performance be (if any) from the participants in the group who play the game with texture and blood when compared with other groups? This study hopes that the outcomes will provide input to help inform minimum requirements for creating games for education, awareness, or campaigns.

Experiment Design

Participant recruitment is done by sending an email to Texas A&M University staff and students through the university bulk email system. Interested participants are then sent a link to schedule a time to come in person to the lab. On arrival, the researcher obtains informed consent from the participant. Participants are signed in for the study using a Google form at this time participants generate their participant ID, which consists of the participant's initials and the last four digits of their unique university identifier number. Participants are then asked to complete a pre-study survey after which they are asked to perform one of the activities depending on the group they are assigned to.

Groups are assigned in sets of three to maintain randomness among participants. When a participant arrives at the lab, they are assigned to the next task group. The first three participants play version I of the game, the next three play version II, the following three play version III, and the subsequent three play version IV. The next three participants are assigned to the control group, and they only read the end screen for the game. To maintain anonymity, the different tasks on the opening screen of the game are coded. The code "TB", "B", "TN", and "N" represents versions I, II, III, and IV respectively. The code "R" takes the participant to the end screen, while "Quit" ends the game if the participant chooses not to continue with the study.

After the activity, participants are asked to complete another survey which is similar to the pre-study survey to measure any changes in the previous responses. We adopted a combination of the State-trait Anxiety Inventory [18], Toronto Empathy Questionnaire [19], Game Experience Questionnaire [20], Self-Assessment Manikin [21], Discrete Emotions Questionnaire [22], Motivated Strategies for Learning Questionnaire [23], and the Situational Motivational Scale [24] to help us understand the shift in motivation, empathy, emotion, and experience.
One week after the activity, participants are sent a five-minute survey that asks questions about the information on the game end screen. These questions are aimed at understanding if the participant plays video games for more than an hour a week and also to check if the participants remembered the information they read at the end of the activity. The questions related to the retention of information are:

I. What is the name of the river mentioned in the text?
II. What are the two countries mentioned in the text?
III. What is the name of the bridge mentioned in the text?

The study is categorized into two separate experiments. In the second iteration of this experiment, a set of participants will wear an electroencephalogram (EEG) device during the study, while the second set will play the assigned game without EEG. EEG will help measure participant engagement, emotion, and focus following the methodology described above. The aim is to establish correlations between these variables and other factors studied in this research. While we can study some changes in emotional response with the surveys administered during the study, we will be able to measure the electrical activity in the brain using the EEG device, which will be connected to the participant's head via electrodes and an EEG cap. This electrical activity will then be analyzed to understand the parts of the brain that responded to the triggers at the markers placed in the game.

Conclusion

Currently, we have gathered data from 27 participants for this study. In the next phase of the project, we aim to increase the number of participants in the study. One way we hope to accomplish this is by providing participants with incentives to have a minimum sample size of 25 participants per group for the first experiment. We also have a target of obtaining 60 participants to wear an EEG device for the second experiment. Statistical analysis will be conducted using ANOVA to determine if there is a significant difference within the varied groups and how they differ from the control. By the end of this research, we aim to provide data-driven guidelines to educators and game design professionals for creating effective educational games.

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