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Effects of Gamification on Speed and Accuracy on an Interdependent Paper Sorting Task

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EFFECTS OF GAMIFICATION ON SPEED AND ACCURACY ON AN
INTERDEPENDENT PAPER SORTING TASK

by

DAVIS TINKLE

A thesis submitted in partial fulfillment of the requirements
for the Honors in the Major program in psychology
in the College of Sciences
and in the Burnett Honors College
at the University of Central Florida
Orlando, Florida

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Thesis Chair: Dr. Eduardo Salas

Abstract

This study examined the effects of gamification, i.e. (what makes games challenging, engaging and fun), and its effects on speed and accuracy on an interdependent paper sorting task. Undergraduate students (N=42) at the University of Central Florida participated by working interdependently in groups to sort numbered pieces of paper into piles before and after either playing video games or doing back-to-back drawing(basic team building exercises). It was hypothesized that participants who played video games would sort pieces of paper into the piles faster and more accurate than those who did back-to-back team exercises. Results showed that playing video games was not better than doing basic team exercises, but that the two tasks were relatively equal. Although groups were formed and dissolved quickly, there was improvement between the pre and posttests. While the experiment did not yield significant results, it is possible that using different video games or different interdependent tasks could foster increases in speed and accuracy compared to back-to-back drawing.

Keywords: Gamification, video games, accuracy, speed, communication, cooperation,

Portal 2

Table of Contents

Introduction	1
Gamification.....	2
Gender	4
Speed and Accuracy.....	4
Methods.....	7
Participants.....	7
Materials.....	7
Measures	8
Procedure	8
Results.....	11
Discussion	12
Appendix: IRB Approval Letter	14
References	16

Introduction

The use of video games for more than just entertainment has always been suggested by gamers. Research conducted by the Entertainment Software Association (2009) found that 70 percent of companies use interactive software to train their employees. Research has also found that 71 percent of American workers are either not engaged or actively disengaged in their work (Gallup, 2011). In recent years, many companies and businesses have begun to implement the process of gamification, which uses elements of games to promote learning and engagement (Kapp, 2012).

Furthermore, the shift towards teams in the workplace creates a need for an engaging process that includes all employees. As younger adults begin entering the work force and older adults begin to leave it, there needs to be a method to engage and help train both generations (Meister, 2012). Methods of training are available in many different media, but game-based training is a format that has been used frequently (Fletcher & Tobias, 2006). A game is an interactive and competitive activity shaped by a set of rules with a clearly defined goal (Hays, 2005) which is different from a simulation, which is designed to represent a real phenomenon (Crawford, 1984). The primary difference that sets games apart from simulations is that accuracy is a necessity for simulations while clarity is fundamental for games (Crawford, 1984).

The use of video games in business training is already being implemented. Marriott Hotels have developed a hotel-themed online game in which players have to juggle all the responsibilities of a hotel kitchen manager (ESA, 2009). Players can even apply for positions in the hotel from inside of the game. Gaming has also been used for training astronauts and other

professions. The Department of Defense (DOD) in partnership with the Defense Acquisition University (DAU) now uses games in its curriculum for projects too expensive, dangerous, or too large-scale to execute on a regular basis (Mientka, 2014). It is also argued that games are useful for providing the psychological experiences of conflict while excluding their physical realizations (Mientka, 2014). In a training context, teams are able to learn skills they may need to utilize within environments that would either be not effective or dangerous to learn within. In some jobs, there may not be any physical danger but emotional danger from not performing well. Games are able to emulate the actions necessary to perform the tasks while avoiding the consequences of the task in real-life.

With technology growing rapidly, video games can play an integral part in the training process. Gartner predicts that by 2014 more than 70 percent of global organizations will have at least one “gamified” application (Forbes, 2012). Sixty percent of five-hundred employers sampled indicated that they would leverage online games as well as other types of competitions between business locations or employee groups (Towers Watson, 2012). Online games can be integrated into core components of businesses in order to engage employees by entertaining and challenging them.

Gamification

The process of using video game elements in non-gaming systems to improve user experience and engagement is known as gamification (Deterding et al. 2011). Taking the competitive and interactive components of games and implementing them in an interface that has rules and clearly defined goals can engage employees and promote more efficient ways of work (Hays, 2005). The major purpose of gamification is to make work fun because researchers at

Elon University concluded that playing beats working. If games challenge workers, then playing can be embedded in work in addition to learning and will make things run more smoothly (Webb & Cantu, 2013). When workers combine games with work they will be actively engaged and entertained. The Hay Group found that actively engaged office workers were 43 percent more productive and companies that have engaged workers have 6 percent higher net profit margins (Webb & Cantu, 2013). The use of game-based training promotes engaging work and work that challenges employees in a dynamic environment. Game-based training has become a common method of delivering training to teams or individuals (Fletcher & Tobias, 2006), showing that games have an increasingly important role in the workplace.

Gamification can lead to motivation for workers to train for new parts of a job or to alter current aspects of their job. Keller (1987) developed the ARCS model, which gamification can follow in its application in the workplace. The ARCS model consists of attention, relevance, confidence, and satisfaction. According to the model, attention must be gained. This can be accomplished by promoting curiosity or uncertainty about the new method, which video games would apply to in the context of the workplace. Relevance is necessary in order to keep the attention and to increase motivation of the worker. Confidence is the next step in the ARCS model, where if workers are confident in their effort they will continue to grow and learn. This is assisted further through the process of feedback, so workers know how they are doing and what they can improve upon. The final step in the model is satisfaction, where workers must find the process satisfying and useful. Video games are applicable to this model since they will gather the attention of the worker since it is a new method of doing old tasks. It is relevant since aspects of training or team work are relevant in tasks in the games.

The aspects of the ARCS model contribute to tasks being performed quicker by motivation. Motivation is correlated with confidence and satisfaction in the ARCS model, allowing for increased speeds in learning and training (Keller, 1987). Keller also proposes that satisfaction can be achieved from a sense of achievement, which can be found through increased speeds in task completion.

Gender

The relevance of gender differences in video games has been very controversial. Females who play video games are negatively stereotyped and are exposed to gender bias which can lead to worsened performance (Chan, 2009). The presence of females has even led to lower levels of performance while playing video games (Brown et al., 1997). Research conducted by Martin and Good (2014) found that all-female teams had a higher rate of cohesion and satisfaction where all-male teams employed more risky strategies in an online farming simulating game. Takeda and Homberg (2014) suggested that gender balanced groups exhibited enchanted group work and better group contributions. Differences in gender composition may play an impact on performance, allowing for a more balanced gender team to perform higher than gender imbalanced teams.

Speed and Accuracy

With new workers entering the workplace and organizations expanding, there is a need to increase the speed in which tasks are completed. The Harvard Business Review (2012) polled more than a thousand leaders, and found that over eighty one percent of them were expected to move faster and complete more than what they accomplishing. With the great demand for speed, a way to increase the rate in which tasks are completed is necessary. In addition to speed,

accuracy has also been an objective measure of human performance (Glickman et al., 2005). Groups today need to increase the speed in which tasks are completed in addition to maintaining the level of accuracy necessary for the assignment. Since the inception of video games, gamers were thought to have increased cognitive abilities in attention allocation and spatial orientation (Granic et al., 2014). Puzzle video game players were found to be more accurate than action video game players in a task that emphasized both speed and accuracy, while action video game players had a quicker speed but lower accuracy (Nelson & Starchan, 2009). By playing action and puzzle video games it may be possible to increase both the speed and accuracy of tasks. Participants who were active video game players completed more categories on a card sorting task than those who did not play video games (Buelow, 2015). The positive effects that video games have on cognitive functions make them a viable method to increase the efficiency of work by increasing the speed and accuracy that workers exhibit on tasks.

Compared to video games, traditional exercises used to build teamwork skills attempt to increase synergy through goal-oriented events or games that foster communication and provide feedback (Graves, 2014). Using drawing as a method to build teamwork skills helps to explore dialogues and communication as well as increase collaboration among group members (Madsen, 2013). Back-to-back drawing allows small groups to work together by taking turns describing figures and accurately redrawing them based upon the description given by a member in the group. As group members switch roles between drawing and describing, they are able of understanding the difficulty of describing and breaking down the big picture into smaller segments, which is often an issue for large organizations (Duke, 2006).

There is currently a gap in research regarding the effects video games on performance of interdependent tasks. The purpose of this experiment is to examine the effects of playing Valve Corporation's Portal 2 on speed and accuracy on an interdependent paper sorting task compared to a traditional exercise used to build teamwork skills through employment of back-to-back drawing. The experiment also aims to examine the gender composition of the dyads and their effects on performance.

It has been suggested that playing video games affects the performance of participants on tasks that require cognitive abilities. Therefore, participants who play Portal 2 will sort faster and with a higher accuracy than those who participate in back-to-back drawing.

Methods

Participants

Forty two participants were present in the study making up 21 dyads, making 11 dyads in each condition. Participants were between the ages of eighteen to twenty five. Nineteen were males (45%) and twenty three were females (55%), making five groups of males and males (M/M) (24%), seven groups of females and females (F/F) (33%), nine groups of males and females (M/F) (43%). Participants were students from the University of Central Florida; that were recruited using the UCF Sona system. Participants received partial course credit after successfully completing the study.

Materials

Some participants played Portal 2, a first-person puzzle-platform game developed by Valve Corporation. The participants played through the tutorial of the game and then played thirty minutes of the cooperative campaign, which includes six levels. Participants were given a PowerPoint presentation explaining the controls and rules of the game as well as the goal of each level. Participants used an Xbox 360 controller that was plugged into a computer. Portal 2 was run on a laptop computer with 6GB of RAM and a 2.30GHz processor. The display of the laptop computer was 1366 x 768. The computer had Windows 7 as an operating system.

Other participants, who did not play Portal 2, did back-to-back drawing. Some participants were the orators and were given a picture to describe, while the other participants were the illustrators who were responsible for drawing a picture based off of the instructions from their partner. The pictures that participants were required to draw were compiled in a packet that started with simple pictures and moved to more complex figures that included different polygons in different directions and orientations.

The paper sorting task consisted of sorting three piles of numbers, which were individually numbered one through twenty, making sixty pieces of paper (1-20 three times).

Portal 2 was chosen as it is a popular video game that has been shown to improve problem solving, persistence, and spatial skill (Shute, 2015) and follows the ARCS model by providing attention, relevance, confidence, and satisfaction (Keller, 1987). Portal 2 allows for manipulation of the ARCS model by providing attention in the form of arousal to a game that participants may not have experienced before. Portal 2 provides relevance by providing knowledge that will help the participants through the experiment. Portal 2 also provides confidence and satisfaction through reinforcement by completing levels and personal control by exerting direct influence on the game.

Measures

Performance was measured via speed, accuracy, and number of levels and drawings completed. Speed was measured using a stopwatch on the length of time of the paper sorting task and was recorded in seconds. Accuracy was measured by how accurately participants ordered the paper into piles and was taken as a fraction out of the sixty overall numbers. Drawings completed were measured by looking at how many drawings were completed. Levels completed were measured by the last full level that was finished.

Procedure

The study is a between groups study where participants in the experimental condition play Portal 2, and participants in the control group back-to-back draw.

The experimenter was an undergraduate student completing their Honors in Major program requirements. The experimenter was trained and directed participants without the use of

a script. The experiment was not blind to the conditions of the study or the hypothesis, but did not choose the conditions participants were placed in.

While playing Portal 2, participants were required to work interdependently by using portals to redirect lasers, transport characters, as well as other movements required to navigate the platforms and complete the level. Without cooperation, the levels are impossible to complete, thus participants have to work interdependently to solve puzzles using in game mechanics. As participants progress through the levels, additional mechanics are added increasing the difficulty of the game.

Participants who were in the back-to-back drawing condition took turns describing and illustrating pictures with each other, and upon completion of the drawing, rotated roles after each drawing. Participants drew and described pictures for thirty minutes, or until all ten drawings assigned to the participant were accurately completed. Participants never exceeded thirty minutes, but sometimes did not run the whole thirty minute duration.

In both conditions, participants completed an interdependent paper sorting task which required participants to work together to sort pieces of paper into piles in the correct order as quickly as possible, before and after the experimental conditions. Participants were given half of each pile, and had to work together to sort them in the correct order. Participants were timed and their accuracy was recorded in both before and after the experimental or control condition.

The amount of levels completed was recorded for the participants who played Portal 2, and the number of drawings completed was recorded for participants who did back-to-back drawing as well.

Participants were randomly assigned to the different conditions: an experimental group that played Portal 2; and a control group that performed back-to-back drawing. Participants entered and filled out basic demographic information consisting of age, gender, and race. Participants were then told the instructions on how to complete the paper sorting task. Once completed, participants then did the paper sorting task and the experimenter timed them and checked their accuracy upon completion. After this, in the experimental condition, participants then read a PowerPoint that taught them the basics of Portal 2 and the objectives of each level, which took around five minutes. Participants then played Portal 2 or did back to drawing as a team building exercise. Participants spent 30 minutes in both of the conditions, or until all levels or drawings were completed. In the Portal 2 condition, participants' achievement level was recorded based on how far they get in the game. In the back-to-back drawing condition, achievement level was recorded based upon how many drawings were completed. Once the time was up, the participants then worked together on the paper sorting task once again. Once the participants finished the evaluation, they were debriefed and given credit for their participation in the study.

Results

A paired-samples t-test was conducted to examine the impact of condition (playing portal two or back-to-back drawing) on speed and accuracy of completion. Results indicated that participants took approximately the same amount of time to sort the paper regardless of condition in both the first and second sorts, respectively, ($M = 96.60$, $SD = 22.37$), ($M = 79.50$, $SD = 9.82$) $t(9) = 4.97$, $p > .05$), or portal condition, first and second sort, respectively, ($M = 98.55$, $SD = 24.15$), ($M = 81.18$, $SD = 17.28$, $t(10) = 2.92$, $p > .05$). Results also indicated that groups that consisted of males and males ($M = 99.00$, $SD = 32.74$), ($M = 76.00$, $SD = 18.80$), or males and females ($M = 94.11$, $SD = 22.14$), ($M = 78.78$, $SD = 13.15$) also had a lower mean sort times before and after, respectively, playing Portal 2 or doing back-to-back drawing. Males and males and males and females both had lower scores than groups that consisted of two females, before ($M = 101.14$, $SD = 17.99$), after ($M = 85.58$, $SD = 11.28$). Results additionally indicated that participant accuracy on the paper sorting task was the same regardless of condition, sort number, or group gender ($M = 60.00$, $SD = 0$).

Discussion

In the experiment, it was hypothesized that participants who play Portal 2 will sort faster and with a higher accuracy than those who participate in back-to-back drawing. However, this was found not to be the case, as participants who back-to-back drawing completed the paper sorting task just as quickly as participants who played Portal 2. Although this goes against the hypothesis, it does indicate that even though video games did not outperform traditional activities, they did not hamper the performance of the group either. Results also indicated that when groups had males present, that the task took a shorter amount of time in all conditions, although the result was not significant.

It is possible that participants that played further in Portal 2 were able to experience more of the gain and could have acquired more skills necessary to increase their performance in the paper sorting task. Ericsson et al. (2014) propose that development of complex skills and mechanics that mediate performance rely on practice. Participants who completed more levels of Portal 2 had access to more content to help better practice and hone their skills to better apply them to the paper sorting task.

Despite not being statistically significant, the findings do show that playing video games can be an alternative to using back-to-back drawing as a basic team building exercise. Interestingly enough, all participants who completed back-to-back drawing were able to complete the drawings in the allotted time while participants who played Portal 2 ranged in the levels in which they completed.

Results that were found differ from research, which states that females have an advantage in processing speed tasks involving digits (Roivainen, 2010). Although females are found to have faster processing speed, the processing was only half of the paper sorting task and the

sorting of the numbers was the other necessary step for participants to complete. The gender differences can also be explained by a speed and accuracy tradeoff. The speed and accuracy tradeoff states that people lower their speeds in order to increase accuracy (Scali et al. 2000). This could explain why participants all had perfect accuracy throughout the experiment while their speeds differed greatly. Participants who played puzzle games had higher accuracy but slower speeds than those who played action video games (Nelson & Strachan 2009). It is possible that playing the puzzle games primed participants to think more about the order allowing for perfect accuracy at the cost of speed.

Limitations to the study would include not having a direct control group to see if the changes in speed and accuracy of the paper sorting task were a result of the manipulations or if it was just an improvement from learning the task. Another limitation to the study was using video games as an independent variable as they are not the preferred method of training. The amount of time participants spent in the experimental and control conditions could be a possible limitation, as participants who engaged in back-to-back drawing sometimes completed the task before the allotted thirty minutes of time was completed.

Despite failing to support the hypothesis, the study showed the practical application that video games have as team building activities. Future research has the potential to focus on what specific attributes of games foster the highest amount of cooperation and communication. Future research can also look into which attributes of video games best influence cooperation and communication as well as speed and accuracy of interdependent tasks.

Appendix: IRB Approval Letter



University of Central Florida Institutional Review Board
Office of Research & Commercialization
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Approval of Human Research

From: UCF Institutional Review Board #1
FWA00000351, IRB00001138
To: Eduardo Salas and Co-PI: Davis C. Tinkle
Date: February 19, 2015

Dear Researcher:

On 2/19/2015, the IRB approved the following human participant research until 02/18/2016 inclusive:

Type of Review: UCF Initial Review Submission Form
Project Title: The Effects of Gamification on Team Building and Team Cohesion
Investigator: Eduardo Salas
IRB Number: SBE-15-10974
Funding Agency:
Grant Title:
Research ID: N/A

The scientific merit of the research was considered during the IRB review. The Continuing Review Application must be submitted 30 days prior to the expiration date for studies that were previously expedited, and 60 days prior to the expiration date for research that was previously reviewed at a convened meeting. Do not make changes to the study (i.e., protocol, methodology, consent form, personnel, site, etc.) before obtaining IRB approval. A Modification Form **cannot** be used to extend the approval period of a study. All forms may be completed and submitted online at <https://iris.research.ucf.edu>.

If continuing review approval is not granted before the expiration date of 02/18/2016, approval of this research expires on that date. When you have completed your research, please submit a Study Closure request in IRIS so that IRB records will be accurate.

Use of the approved, stamped consent document(s) is required. The new form supersedes all previous versions, which are now invalid for further use. Only approved investigators (or other approved key study personnel) may solicit consent for research participation. Participants or their representatives must receive a copy of the consent form(s).

All data, including signed consent forms if applicable, must be retained and secured per protocol for a minimum of five years (six if HIPAA applies) past the completion of this research. Any links to the identification of participants should be maintained and secured per protocol. Additional requirements may be imposed by your funding agency, your department, or other entities. Access to data is limited to authorized individuals listed as key study personnel.

In the conduct of this research, you are responsible to follow the requirements of the [Investigator Manual](#).

On behalf of Sophia Dzegielewski, Ph.D., L.C.S.W., UCF IRB Chair, this letter is signed by:

Page 1 of 2

Signature applied by Joanne Muratori on 02/19/2015 09:21:59 AM EST

IRB Manager

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