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# Perceptions of Engineering Learning Software in Classrooms with Diverse Student Populations Using an Expanded Technology Acceptance Model


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For the past 10 years, Dr. Idalis Villanueva has worked on several engineering education projects where she derives from her experiences in engineering to improve outcomes for minoritized groups in engineering using mixed-and multi-modal methods approaches. She currently is an Associate Professor in the Engineering Education Department at the University of Florida. In 2019, she received the Presidential Early Career Award for Scientists and Engineers (PECASE) award for her NSF CAREER project on hidden curriculum in engineering. Dr. Idalis Villanueva has a B.S. degree is in Chemical Engineering from the University of Puerto Rico at Mayagüez and a M.S. and Ph.D. degree in Chemical and Biological Engineering from the University of Colorado-Boulder. Soon after, she completed her postdoctoral fellowship from the National Institutes of Health in Analytical Cell Biology in Bethesda, Maryland and worked as a lecturer for 2 years before transitioning to a tenure-track in engineering education. Her experiences as a first-generation engineer, Latinx, woman of color, introvert, and mother has shaped the lens and research-informed practical approaches that she uses in her research.

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## Abstract

The perceptions and experiences of first year and sophomore engineering students when playing an online serious engineering game are examined in this mixed method study. The engineering game of interest was designed to improve engineering intuition and knowledge of engineering mechanics in a statics course. Use of serious educational engineering games has increased in engineering education to help students increase technical competencies in engineering disciplines. However, few have investigated how these engineering games are experienced by the students; how games influence students' perceptions of learning, or how these factors may lead to inequitable perspectives among diverse populations of students. A mixed method sequential analysis informed by the Technology Acceptance Model was performed to ascertain the experiences of one hundred and thirty-two students. Women of colour indicated that going to the next challenge level in the game made them feel as though they had increased their engineering knowledge to a higher degree than their male counterparts, this group also indicated higher levels of frustration than their male and white women counterparts. Additional studies are need to more definitive conclusions.

**Keywords:** Engineering games, serious games, intersectionality, learning software, engineering mechanics

## 1. Introduction

The incorporation of *serious games* and online learning software technology into U.S. classrooms has steadily increased over the last two decades (Yuan, Folmer, & Harris, 2011) due to the heightened use of recreational digital games, the internet, virtual reality environments, and advances in gaming technology (Kron, Gjerde, Sen, & Fetters, 2010). Educational video games have been extensively studied as tools for enhancing the engagement and performance of undergraduate students (UGs) in disciplines such as spatial learning (Checa & Bustillo, 2020; Martin-Gutierrez, Saorin, Martin-Dorta, & Contero, 2009), physics (Adams, Pilegard, & Mayer, 2016; Kavanagh, O'Hara, Palmer, Lowe, & Raftery, 2017), computer science (Alonso et al., 2010; Sevin & DeCamp, 2016), chemical engineering (Dry et al., 2016; Ribeiro et al., 2015), computer and electrical engineering (Dyer, 2015; Pantoja, 2017), mechanical engineering (M.E.) (Coller & Ieee, 2010, 2011; Coller & Scott, 2009), computer-aided design (Kosmadoudi et al., 2013; Tumkor, 2018), and aerospace engineering (Okutsu, DeLaurentis, Brophy, & Lambert, 2013). Many studies have explored engineering games' efficacy in enhancing overall student performance, game design, and development. However, few engineering education studies have examined how incorporating the game into a class influences student motivation to learn engineering topics and accept gaming technology as a learning tool. Moreover, less than a handful of these engineering studies have explored online educational games' *appeal* and *efficacy* in an undergraduate classroom as a function of gender, race, or ethnicity. This study examines the appeal and perceived usefulness of an online engineering education game in a first- and second-year undergraduate engineering statics course at a U.S. Northeastern institution of higher education. The study is informed by the Technology Acceptance Model (Davis, 1989, 1993) and emphasizes analyses at the intersection of students' race and gender.

According to Crenshaw (Crenshaw, 1989, 1993), race and gender can intersect to impact women's experiences in society. Kimberly Crenshaw began to use the term *intersectionality* to describe the social injustice that African American women experience in society at the intersection of their racial and gender identities and has been tied to mental and emotional health disparities among individuals (Mens-Verhulst & Radtke, 2008). Scholars are beginning to connect how one's *intersectionality* influences because and how students remain to the engineering field (Bruning, Bystydzienski, & Eisenhart, 2015; Godwin, Klotz, Hazari, & Potvin, 2016).

One untapped area in engineering education is the role that both *gender* and *race* play in forming students' perceptions of the ease of use and efficacy of online engineering educational tools in their courses and how their experiences with these tools inform their perceptions about the engineering field. Most of the online learning games used in undergraduate classes are in freshman and sophomore level courses. Hence, investigating *how* these games influence students' attitudes towards the engineering field and student perception of game efficacy in teaching engineering skills is critical. These issues affect how online engineering games motivate or demotivate diverse populations of students to persist in the engineering field.

This study focuses on ascertaining students' experiences when engaging with an online educational game that reflects content studied in an engineering mechanics statics course. Statics is one of (if not the first) engineering courses students experience across <u>all</u> engineering majors. Statics is also perceived by many undergraduate students as a "weed out" course (Budhu, 2002), that is used by many institutions to restrict enrollment of *unqualified* engineering students into specific engineering majors. Careful design and assessment of resources and tools for courses like these are important in facilitating successful completion of the course for diverse populations of engineering students. Hence, this work seeks to initiate steps towards learning how the design and method of serious game incorporation into an engineering mechanics statics course may result in diverse perspectives and motivations for engineering students.

## 2. Literature Review

The categories of the relevant literature reviewed reflect critical areas of educational gaming in middle school and undergraduate (UG) classrooms, the use of the Technology Acceptance Model (TAM) (Davis, 1989; Venkatesh & Davis, 1996) in accessing the appreciation of engineering educational games and engineering educational game studies that include engineering subgroups, such as gender, race and/or ethnicity.

### *2.1. <u>Classroom Learning Experiences using Video and Serious Online Educational Games in UG classrooms</u>*

There have been numerous studies aimed at examining the design and efficacy of video games in K-12 classroom environments (Garneli, Giannakos, & Chorianopoulos, 2017; Manero, Torrente, Serrano, Martinez-Ortiz, & Fernandez-Manjon, 2015; Paliokas, Arapidis, & Mpimpitsos, 2011; Rajan, Raju, Gill, & Asee, 2014) and computer science and programming courses (Overmars, 2004; Paliokas et al., 2011; Ye, Liu, Polack-Wahl, & Ieee, 2007; Yoon &

Kim, 2015) as advancement in computer technology and access to computer technology has increased.

The majority of video and online education game studies in undergraduate classes have taken place in computer science and electrical engineering programming classes where students *learn by doing* as they design their own games in either non-competitive (Chen & Cheng, 2007; Jong, Lai, Hsia, Lin, & Lu, 2013; Overmars, 2004; Pantoja, 2017) or competitive class environments (DeNero, Klein, & Aaai, 2010; Hingston, 2009; Karakovskiy & Togelius, 2012; Yoon & Kim, 2015). Most recently, studies of undergraduate student design of engineering games have been extended in these disciplines to include artificial intelligence (AI) (Bayliss & Ieee, 2012; Yoon & Kim, 2015). Educational video games have also been studied as tools for enhancing the engagement, motivation, STEM intuition and performance of undergraduate students (UGs) in chemical engineering (Dry et al., 2016; Ribeiro et al., 2015), electrical engineering power system design (Dyer, 2015), mechanical engineering (Coller & Ieee, 2010, 2011; Coller & Scott, 2009), computer aided design (Kosmadoudi et al., 2013; Tumkor, 2018), physics (Adams et al., 2016; Rohde et al., 2009) and aerospace engineering (Okutsu et al., 2013). Though the use of these tools has steadily increased over the last decade, many studies have produced conflicting results. For example, Jiau *et al.* (2009) examined SIMPLE as a tool for enhancing student motivation towards performing repetitive tasks that refine and enhance programming skills, and found that 32% of the participants did not enjoy using the game and that 28% of the students did not think playing the game SIMPLE improved their learning experience. Yoon *et al.* exposed undergraduate computer science and engineering students to video game design when designing code on a platform for an Angry Birds AI competition and found that the majority of the students liked the course and its content requirements, i.e., $4.58 \pm 0.67$ and $4.58 \pm 0.51$, respectively (13 students) on a Likert scale (1 strongly disagree and 5 strongly agree). On the other hand, students did not indicate that the content of the course was useful in their learning in other courses ($3.75 \pm 0.97$). These students also indicated that they did not produce a satisfactory final project in the final round of the competition ($3.75 \pm 1.36$) that was reflective of their learning experience. Jong *et al.* (2013) examined whether incorporation of an online game for cooperative learning of operating systems enhanced the motivation of students to learn the course materials. They found that students who engaged with the online game spent more time with its connected course content, pursued opportunities to make-up late/missed assignments more, and self-reported higher motivation to learn course material in comparison to the control group of students who did not engage in the online gaming experience.

Coller and Shernoff (2009) redesigned a traditional numerical methods course, Dynamic Systems and Control, to be centered around an engineering video game, *NIU-Tores* incorporated into an existing open-source video game called Tocs (www.torcs.org) on fifty-one 3$^{rd}$ and 4$^{th}$ – year engineering students. In this study, students were tasked with writing computer programs to race a simulated car around a track. An Experience Sampling Method (ESM) was used to measure students' activity, social partners, and affective and cognitive experiences in real-time. Coller and Shernoff (Coller & Shernoff, 2009) also concluded that students had higher levels of concentration, enjoyment and interest when playing the game. The effectiveness of the video game was evaluated according to the time spent on the course outside of class, student concept mapping, and student survey ranking of engineering course importance juxtaposed to other engineering classes (with the same course taught in the traditional method). It was concluded that students who played the online educational game spent roughly twice as much time on the course outside of class, demonstrated deeper learning (according to concept mapping assessment) and rated the redesigned course higher in terms of importance; in comparison to the course taught using the traditional format. Also, student class averages were higher in the class that incorporated game-based technology (Coller & Ieee, 2010).

On the other hand, Adams *et al.* (2016) examined whether short-term playing of the game, Portal (online educational game developed to help enhance critical thinking and learning of physics principals) could help players improve student spatial skills (required in physics), gain *intuition* for the physics of force and motion, and achieve higher learning gains on subsequent physics lessons. In particular, this study compared students who played non-physics related computer games to those who played physics related games, where the number of men and women in each group playing either Portal, Tetris (spatial control) or TextTwist (nonspatial control game) did not significantly vary. Adams *et al.* (Adams et al., 2016) found that there were no significant differences on recall of the three laws of motion between the groups. They also found that there were no significant differences on measures of physics reasoning (selected from the Force Concept Inventory) or measures of spatial cognition (mental rotation and perspective taking) between groups studied. In fact, they concluded that there were no significant differences in physics learning between groups, which indicated that although the educational game (Portal) was developed to teach students physics' instinct and intuition about motion and spatial abilities related to physics learning, Portal did not.

### *2.2. <u>Technology Acceptance Model in Engineering Educational Games</u>*

The Technology Acceptance Model, originally developed by Davis (1989), states that individuals' adoption of information technological systems is linked to and a function of two primary variables: users' *perceived usefulness* and the *perceived ease of use* of the technological system. In other words, people will use or not use an application/tool to the extent that they believe it will help them do their jobs better (Davis, 1989, 1993). However, according to the TAM, if people deem the level of effort needed to use the tool is *too hard*, they will abandon use of the technology, especially if they believe the benefits of its use do not outweigh the effort. Many researchers (Cheung & Vogel, 2013; Goh, Hii, Tan, & Rasli, 2020; Park, 2009; Saade & Bahli, 2005) have confirmed that the TAM model and iterations of this model are useful in understanding and explaining the behavioral intention to use e-learning tools. However, this study focuses on the original TAM developed by Davis(Davis, 1989). Many have sought to examine the benefit or deficit of incorporating educational gaming into undergraduate classrooms using the TAM. However, the results have been mixed. For example, Rafique *et al.* (2020) applied the TAM to examine the key factors contributing to undergraduate students (460 students) developing programming skills in e-learning in a Computer Science and Software Engineering institution. In this study, perceived usefulness and ease of use were integrated with factors such as teaching practices, intrinsic factors, and efficacy problems with learning intentions. They concluded that of these factors, effective teaching, perceived usefulness, and correct intrinsic motivations are needed to motivate students to aspire to learn. They also concluded that these techniques must be coupled with face-to-face communication in e-learning to provide immediate help during programming problems. Mi *et al.* (2018) compared an incentive and reward model game called, GamiCRS with traditional teaching methods aimed to enhance student motivation to learn code readability using TAM. The results from this study indicated that students were ambivalent in terms of ease of use (53% neither agreed nor disagreed for both statements that it was easy for them to become skillful at using GamiCRS and that their interaction with the game was clear and understandable). In addition, 59% of the students did not agree or disagree that the badge system in GameiCRS motivated them to participate more than usual. Nguyen *et al.* (Nguyen, Hite, & Dang, 2019) used the technology acceptance model to study the perceptions of 38 undergraduate students' in three case studies pertaining to the development of increasing difficult and creative web-based virtual content in comparison to other platform applications. They made three conclusions regarding web-based VR tools. First, web-based VR tools allowed for fast development with relatively little knowledge of HTML and JavaScript. Second, web-based VR tools included a responsive community to questions and third, were open-source and enabled easy sharing. However, they also found that web-based tools were not "easy to use", because it was difficult for users to control aspects of the applications that added subcodes and subroutines that were not 'standardized', and these VR tools also had unstable libraries and components.

Wai *et al.* (Wai, Ng, Chiu, Ho, & Lo, 2018) used the TAM to explore the 150 undergraduate students' perceptions of usefulness and ease of use of mobile phone apps. The population studied consisted of undergraduates representing business, education, and engineering disciplines in Hong Kong. Wai *et al.* (2018) concluded that the students have a positive attitude towards using mobile apps in daily life and for learning, where students preferred to use these apps for communication and interaction, searching and checking for learning and reference materials, and information sharing. They also found that while there were minor differences in the types of apps used depending on subject needs according to discipline, the major driving force for these students was their perception of the usefulness of the mobile apps in comparison to ease of use. Cizmesija et al. (Čižmešija & Stapić, 2019), used the TAM and the Unified Theory of Acceptance and Use of Technology (UTAUT) to examine the use of GitHub software in a undergraduate class of 78 software engineering students. In this study, it was found that variables outside of the UTAUT model may have an important role in understanding students' intention to use social coding platforms, where the variables described in TAM and learning satisfaction were found to be statistically relevant. They also indicated that analysis of software adoption would be improved if *students were asked in interviews what variables were important to them in an academic setting* and if different university/environmental settings were studied since their setting was homogenous. A key aspect of the work herein, is that students were asked in focus group discussions what things fostered or dissuaded their use and acceptance of engineering learning games as learning tools to supplement traditional course materials like textbooks and lecture notes.

The extension of the TAM model to include the intersectionality of race and gender in undergraduate engineering is an area only studied by the authors Cook-Chennault and Villanueva (2019a, 2019b) to date, though several have been expanding this model to account for gender or race in general education of middle and high school students and undergraduate computing education (Bourgonjon, Valcke, Soetaert, de Wever, & Schellens, 2011; Bourgonjon, Valcke, Soetaert, & Schellens, 2010). The authors opted to start from the original TAM model from Davis (Davis, 1989, 1993) and not newer versions in an effort to premise future iterations of this model to consider intersectionality-informed elements. The original TAM was modified to include additional questions pertaining to user satisfaction with the game. It was found that women of colour expressed their distaste for aspects of the online educational game due to game design, thematic landscape, and limited exposure to serious games before entering college. Also, women experienced higher levels of frustration while playing the game than their male counterparts (Cook-Chennault & Villanueva, 2019a, 2019b, 2020b). In contrast, Bourgonjon *et al.*, (2010) used a modified TAM model to examine 858 Flemish secondary school students' (ages 12 – 20) preference for video game usage (results averaged across broad subject/disciplines) as educational tools *in general* and found that students' perceptions of usefulness and ease of use were directly related to students' perception of the games' opportunities for learning within the games, where responses varied according to student gender. This group also noted that differences in gender were *mediated by experience with and ease of use of the game* (Bourgonjon et al., 2010). Porter and Donthu (2006) extended the TAM model to explain differences in internet acceptance between younger/older, less/well educated, White/minority and lower/high income Americans, and concluded that although access barriers have a significant effect in the model, ease of use and usefulness have stronger effects in terms of game acceptance. Hwang *et al.,* (Hwang, Hong, Cheng, Peng, & Wu, 2013) applied an extended TAM model to explore 6th grade Taiwanese children's acceptance of a game to explain differences in boys/girls' cognitive load and competition anxiety when playing the game synchronously . Differences in load and anxiety were found between gender, where it was concluded that game designers should consider reducing competition anxiety and cognitive load by extending time allotted for learning to play the game for female students (Hwang et al., 2013). Rajan *et al.,* (Rajan et al., 2014) examined the impact of the video game, "Engineering Heights – The Design Process in Action" using a Likert rating scale from 1 (strongly disagree) to 5 (strongly agree), on a group of high school seniors found that on average, majority of the students' perceived usefulness, perceived subject matter learning and ease of use were good. Researchers such as (A. A. Butt, Anwar, & Menekse, (Accepted: June 27 - 30, 2021). ; A. A. Butt, Anwar, & Menekse, (Submitted: 2020)) adapted the TAM to create an educational technologies user experience instrument, using self-determination theory in a sequential mixed methods research study to design, evaluate, and validate the educational application instrument. They found that students needed clarity on the design of educational applications as it related to the interface navigation of related components, and its connection to course content.

### *2.3. Serious and Online Game Studies that Examine Results as a Function of Engineering Subgroup demographics (all ages)*

Though all of the studies in engineering educational games indicate the importance of connecting the gaming aspects with engineering concepts and principles, few considered gendered or intersectional influences on its learners. As such, there is a need to further understand why some engineering educational online games benefit some students while disadvantaging others. While the technology acceptance model provides a meaningful initial step towards understanding why some students accept/don't accept an engineering game as a vital learning tool, we conjecture that ease of use (a critical component of the TAM) is further linked to aspect of cultural and socioeconomical background, although it hasn't been explored. This study will serve as an initial step in this direction.

Tawfik *et al.,* (Tawfik, He, Vo, & Ieee, 2009) conducted a small study (5 men and 5 women) on undergraduate (UG) students from an introductory health and science class to play the game, *Immune Attack*, which is an educational video game created by the Federation of American Scientists to instruct high school and UG college students about human immunology. They found that men UGs improved on posttest scores more than their women counterparts, and that men

UGs had more experience with video games than their woman counterparts, which they concluded impacted the outcome on student's posttest scores. In particular, they speculated that disparity in prior experiences with video games and minimal game instructions placed impediments towards certain students learning the educational content. On the other hand, Joiner *et al.,* (Joiner et al., 2011) incorporated the game "Race Academy" as a learning tool for a mechanical engineering class comprising 138 UGs (11% women) and found that there was no significant difference between men and women students in "motivation towards engineering" (4.2 $\pm$ 0.5, pre- and post-survey results for women) or in "perceived engineering competence" (3.4 $\pm$ 0.7, pre-survey to 3.3 $\pm$ 0.4, post-survey for women) although no statistical ANOVA was performed to ascertain the significance of the comparison of the two groups. Yucel *et al.,* (Yucel & Rizvanoglu, 2019) conducted a study on middle school children ages 11 to 14 (8 males and 8 females) on the use of a code-learning game, *Code Combat*, (launched in 2013), which intertwines programming concepts with medieval adventure and player controls (7 female and 9 male avatars). The students selected for the game all had to be middle school age, experienced computer users, with no experience using a coding-learning game. The attributes examined were perceived computer competence, perceived coding difficulty, identification, perceived game difficulty, perceived success, level of enjoyment, level of anxiety, likelihood of playing it the game another time, and likelihood of trying new game features. The team found that there were important gender differences in these attributes and that the "game environment broadcast a masculinity that made girls feel excluded from the coding area. As a result of these findings, the authors argued that a genderless coding learning environment are irrelevant to girls' abilities, identities, and interests.

Alserri *et al.,* (Alserri, Zin, Wook, & Ieee, 2017) examined women's preferences in digital games and the social and cultural factors that influences female's engagement in Information and Communication Technology. In their work, they concluded that women valued specific elements in digital games: 1) the ability to explore the tools and actions offered in the game, 2) character customization, 3) multimedia elements (video, audio, animation and graphic), 4) storyline, 5) social interaction, 6) collaboration, 7) challenges that are *not too hard* but motivation, 8) fun, 9) skills, 10) feedback, and 11) concentration. One might argue that these elements would ring true for all genders. However, how these elements are incorporated into a game to enrich the learning environment for all genders is not easily defined. For example, Alserri *et al.,* (2017) concluded that women prefer to customize their avatar characters as a means of self-expression and try to make the avatars look like themselves or a fantasy form of themselves, while men treated their avatar characters as puppets rather than people. This team also indicated that girls preferred fantasy education games, along with role playing and virtual environment because they provided opportunities to include story lines, emotion, and nature (Benton, Vasalou, Gooch, & Khaled, 2014). *Few <u>engineering undergraduate</u> studies (with the exception of* Cook-Chennault and Villanueva (2019a, 2019b, 2020a)) *examine games' impact as a function of other engineering subgroups, e.g. race/ethnicity, student age, sexuality, or the intersection of the subgroups*. The preliminary work of Cook-Chennault and Villanueva has shown that gamer experience in a classroom environment may vary based on the gender, race and video game experience of the undergraduate student. This paper **contributes** to our need to better understand these influences, particularly for intersectional women in engineering.

## 3. Research Method

The goals of this project were to explore the perceived usefulness, ease of use, and effectiveness of an online engineering educational tool on a diverse population of engineering students through the lens of the Technology Acceptance Model (Bagozzi, Davis, & Warshaw, 1992; Davis, 1989, 1993). Specifically, this work focused on determining if students' perceptions of the tool varied as a function of gender and race; and whether this population of students expected aspects of their ethnicity or culture to be incorporated into the game. Towards achieving this goal, a Mixed-Method Sequential Exploratory Research Design Method (Creswell & Plano Clark, 2018) was proposed and approved by the primary Institutional Review Board of the first author and a cede of that IRB from the institution (at the time of the study) for the second author. The study took place at a Research-1 (*The Carnegi Classification of Institutions of High Education*, 2019), research-intensive institution in the Northeastern region of the United States. The data described herein represents some phases of a multi-year study. All participants in the study were undergraduate engineering students from the School of Engineering. Students provided demographic information such as age range, gender, race/ethnicity, undergraduate major and experience with online learning tools.

This research design is also premised on the authors' positionalities as intersectional women in engineering and engineering education who have also experienced and witnessed first-hand the role that educational materials in engineering can have in a woman's overall sense of belonging and formation as an engineer.

### *3.1. Research Questions*

The research questions for this study are provided below.

*a)* Was the online engineering game accepted by the students as an effective educational tool (*Technology Acceptance Model)*?

*b)* Did students believe online engineering learning games for classroom instruction should reflect aspects of their ethnicity or culture? Why or why not?

*d)* How did playing the online game influenced students' perceptions of themselves as engineers?

*e)* How does prior gaming experiences, unrelated to the class, influenced students' perception of the game's usefulness?

### *3.2 Demographics of Participants*

One hundred and thirty-two undergraduate engineering students (freshman through junior level) participated in an on-campus study that introduced the online engineering educational game, *Civil-Build*[1]. A pseudonym is used here for the game to protect both the students and instructor's identities. The demographics for the study according to self-identification of gender are provided in TABLE 1, where the students selected from options: male, female, non-binary and

[1] Pseudonym used to represent the online engineering game used in the study.

*other*. The numerical count of each group along with their respective percentage of the entire population is provided in this table. The percentage of the total female, male, non-binary and *other* undergraduate participants were ~44%, 52%, 2% and 2%, respectively. In addition, the demographics of the population as a function of race/ethnicity is provided in TABLE 1, where 57% of the women, 54% of the men and 50% of the non-binary participants were of colour (LatinX, African American, or Asian). Students were recruited to participate through engineering courses (engineering mechanics statics and dynamics) and engineering organizations. Students who were recruited from classes were given extra credit for participation in the study.

### *3.3. Online Engineering Education Game*

This online educational tool emphasizes the structural stability of truss structures, which is a topic covered in the traditional undergraduate engineering mechanics statics course. The game *Civil-Build*[1] was selected for this study because it is presently used as an educational tool in an existing engineering statics course at the university. Engineering instructors that opted to use this tool in the classroom believe that it supports student learning of engineering statics and is used to supplement course materials such as the textbook and in-class lectures. Specifically, this software was used by instructors who have taught the course for at least 5 years and who have taught both honors and general population classes. The software used in this study was encouraged and suggested by these instructors as they had used the software for three years in a honors engineering mechanics class.

The goal of the game *Civil-Build*[1] is to assist students in developing engineering intuition of truss structure behavior when subjected to loads. The software tool is based on finite strain theory that enables the user to visualize material and geometric nonlinearities and dynamic movement of failed/compromised structures. Users play the game by positioning bars and joints to construct a truss structure that can support an external mass and the weight of the truss structure itself. The structure the player builds must consist of joints and bars, where the bars are connected via the joints. Players are rewarded with nut(s) and points based on the player's ability to create a structure of minimal weight and optimal structural stability. The number of nuts and points rewarded to the players are based on the structure's ability to support the given load while minimizing the overall weight of the support structure. Participants move the location of the bars and joints on the screen of the game interface while manipulating the weight of the truss and by adjusting the thickness of the bars. Participants visualize the success or failure of their structure in real-time, as the structures visibly collapse or maintain their position once the truss structure is completed. The collapse of the structure is punctuated with clanging sounds associated with the destruction of the structure. The bars subjected to loading from the weights change color (shades of blue and red) to illustrate compression and tension of the bars.

The tool is designed to teach students intuition about the relationship between truss structural design, material and geometric nonlinearities, and dynamic failure. No written clues are provided during the game. Also, there are no instructions or rules furnished in the game interface. However, supplemental resources are available such as document downloads and videos on the software website and in YouTube videos. No supplemental resources were provided as a part of this study to maintain the intent of the original intent of the engineering instructors to teach engineering design *intuition,* which is apprehension or direct knowledge about a subject without instruction pertaining to the science or engineering governing the mechanical structures. Students

Table 1. Demographics of the participants according to race and gender, where count (number of participants) and percentage of the total participants is presented*. The percentages of the total count are provided in parentheses.

| | **African American/Black** Count (% of total) | **Caucasian/White** Count (% of Total) | **Latinx** Count (% of Total) | **Asian** Count (% of Total) | **Mixed-Race** Count (% of Total) | **Other** Count (% of Total) | **Total** Count (Σ of row) (% of Total) |
|---|---|---|---|---|---|---|---|
| **Male** | 0 (0%) | 25 (19%) | 4 (3%) | 33 (25%) | 7 (5%) | 0 (0%) | **69 (52%)** |
| **Female** | 2 (2%) | 23 (17%) | 4 (3%) | 27 (21%) | 1 (2%) | 1 (2%) | **58 (44%)** |
| **Non-binary** | 0 (0.0%) | 1 (2%) | 0 (0%) | 1 (2%) | 0 (0%) | 0 (0%) | **2 (2%)** |
| **Other** | 0 (0.0%) | 1 (2%) | 1 (2%) | 0 (0%) | 0 (0%) | 1 (2%) | **3 (2%)** |
| **Total** Σ of column (% of Total) | **2 (2%)** | **50 (38%)** | **9 (7%)** | **61 (46%)** | **8 (6%)** | **2 (2%)** | **132 (100%)** |

*Values have been rounded up to the nearest whole number.

who reported on their experiences with this online learning tool within the context of a classroom environment (during the focus group discussion) were given one in-class lecture by a teaching assistant on the operation of the game and interpretation of the game results in a class the year previous to their participation in this study.

### *3.4. Data Collection Procedure*

An overview of the data collection process is provided in Figure 1. The students first played the engineering game for 20 minutes, completed a questionnaire (questions provided in Table 2) and then participated in a focus group discussion for ~1 to 1.5 hours. The questionnaire included Likert-scaled questions pertaining to their experiences with the game, demographic student information and previous experiences with playing video games. The Likert-scale ranges included: Strongly Agree (1), Agree (2), Somewhat Agree (3), Neither Agree nor Disagree (4), Somewhat Disagree (5), Disagree (6) and Strongly Disagree (7), where Strongly Agree and Strongly Disagree were ranked 1 and 7, respectively. During the focus group, participants discussed their perceptions of the game as an engineering educational learning and motivational tool. Selected questionnaire questions were repeated during the focus group along with several additional questions. These questions are also provided in TABLE 2. The focus group questions enabled a more in-depth discussion of the topics described in the Technology Acceptance Model (TAM), i.e. perceived usefulness and ease-of-use of the game. The students played the game in a quiet computer laboratory with section partitions around each player to limit interaction of participants while playing the game. Students wore noise cancelling headsets attached to their computers that allowed them to hear the sounds of the game. Some of the students played games where the sound was turned off. The focus group was conducted in a conference room, which was separate from the computer room.

Several additional questions were included along with the questionnaire questions during the focus group discussion to facilitate the exploration of student's opinions regarding their prior experiences with video games, enjoyment playing the *Civil-Build* game and whether their ethnicity or culture should be included in the design of online engineering educational learning games. Focus group participants were assigned into groups based on gender and availability of schedule date/time, where each group consisted of 4 – 6 participants. All of 132 students participated in the focus group discussions, where they were in groups of 4 – 6 participants. The data was collected from during three semesters, Spring 2018, Spring 2019, and Fall 2019. A quantitative analysis of pre- and post-survey responses are examined, in addition to written

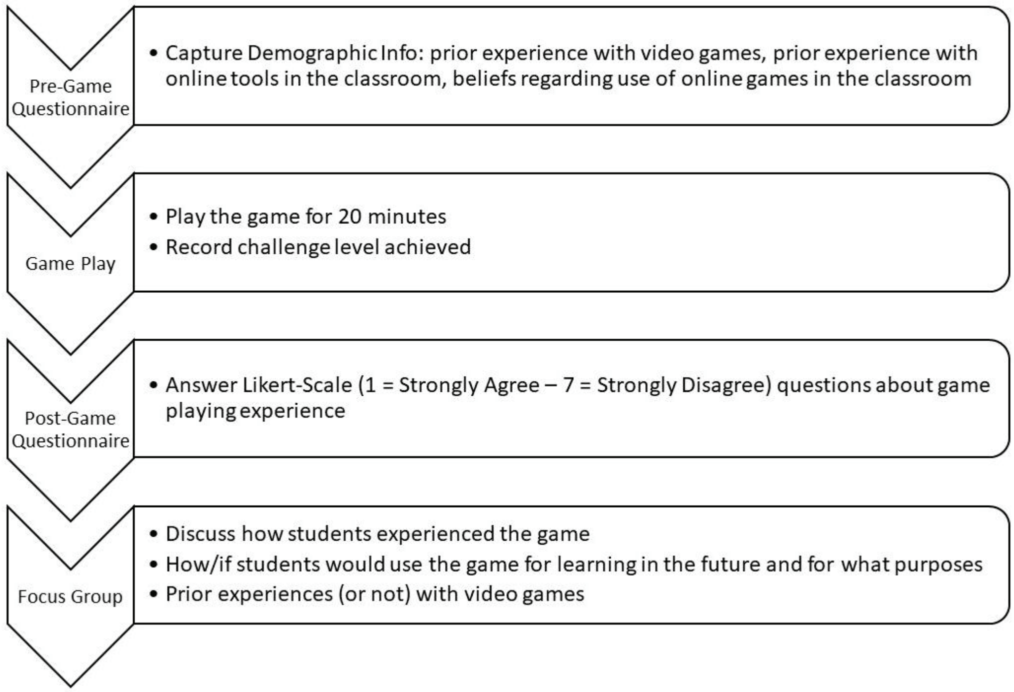


Figure 1: Overview of the data collection process where prior to playing the game, students provide demographic information pertaining to their prior experiences with online learning tool and video game usage, followed by 20 minutes of engineering game play. Subsequent to playing the engineering game, students answer questions about their perception

responses to open ended questions in the post-survey. Aggregate statistical means of the responses to questionnaire questions for the 132 respondents are provided in TABLE 2. Data from students who did not complete the questionnaire was discarded.

To ascertain if there were any statistical differences between independent groups within the statics classes in terms of gender and race/ethnicity, two one-way analyses of variance (ANOVA) were conducted. Two-Way multivariate analyses (MANOVA) were conducted to understand if *intersectional* women of colour (non-white women engineering students) experienced aspects of the online educational engineering game differently than their peers and had different expectations regarding inclusion of their culture/identity in engineering online games. In addition, a multivariate analysis was performed to understand how the experiences of *intersectional* women of colour who have experience playing online computer games on their computers may vary with those who do not. The hypotheses associated with this investigation are provided in TABLE 3. The quantitative data from the questionnaire responses are triangulated with open-ended responses from students on the questionnaire and in-person focus group discussions. An open coding approach (Saldana, 2015) was employed to categorize similar statements, opinions and experiences discussed during the focus group.

Table 2. Questionnaire and Focus Group Questions, Association with Research Questions, Participant Means and Standard Deviations (Number of Participants = 132), where means are based on a Likert Scale: Strongly Agree = 1 and Strong Disagree = 6.

| **Questionnaire Questions** | **Mean $\pm$ Std. Dev.** | **Research Questions** |
|---|---|---|
| Q1. The learning lessons or goals of each challenge are defined in enough detail to play the game. | 3.79 $\pm$ 1.61 | Was the online engineering game accepted by the students as an effective educational tool (Technology Acceptance Model)? |
| Q2. This game is easy to play. | 2.83 $\pm$ 1.36 | |
| Q3. I got frustrated playing this game. | 3.23 $\pm$ 1.45 | |
| Q4. I would recommend that this game be used in classrooms in the future. | 2.67 $\pm$ 1.47 | |
| Q5. This game helped me to understand engineering truss structures. | 2.68 $\pm$ 1.09 | |
| Q6. Were there aspects of the game that you found distracting to your learning of the concepts? | 4.23 $\pm$ 1.73 | |
| Q7. The ways to advance to higher levels in the game are easy to understand. | 2.92 $\pm$ 1.57 | |
| Q8. I was able to advance to the higher levels of the game using my engineering skills. | 3.20 $\pm$ 1.34 | |
| Q9. Do you think engineering video games may help you to better learn engineering topics? | 2.17 $\pm$ 0.95 | |
| Q10. Did you enjoy playing this game? | 2.48 $\pm$ 1.12 | |
| Q11. This game reflected aspects of my culture and/or identity. | 5.26 $\pm$ 1.55 | Do you believe online engineering learning games for classroom instruction should reflect aspects of you ethnicity/identity culture? If true or not true, why? |
| Q12. I think engineering learning tools *should* reflect aspects of my culture and/or identity. | 4.95 $\pm$ 1.51 | |
| Q13. Going to the next challenge level in the game made me feel like I had increased my knowledge. | 3.16 $\pm$ 1.69 | How did playing the game influence students' perceptions of themselves as engineers? |
| Q14. This game helped me view myself as an engineer. | 3.13 $\pm$ 1.31 | |
| Q15. Playing the game makes me feel confident in my engineering skills. | 3.93 $\pm$ 1.47 | |
| Q16. The engineering concepts presented in the game were intuitive to me student. | 3.56 $\pm$ 0.97 | |
| **Demographic Questions** | | |
| D1. Please indicate your gender by selecting from the following options: male, female, non-binary, other | | |
| D2. Please indicate your race/ethnicity by selecting from the following options: Caucasian, African American/Black, Asian, LatinX, Bi-racial, Other | | |
| D3. Do you play video games on your phone? | | |
| D4. Do you play video games on your computer? | | |
| Q5. Have you ever had a class that uses video games or serious learning games for teaching? | | |
| **Focus Group Questions** | | |
| F1. If you played the game in a previous class, what was your experience with the game? How was the game incorporated into the course? | | |
| F2. Do you play video games on your computer? If you do, what games do you play and why? If not, why not? | | |
| F3. Would you use this game to prepare for an exam or quiz in the statics course? | | |

Table 3: One-Way, two-way, and multivariate ANOVA hypotheses to understand student's potential differences between perceptions and expectations of online engineering games.

| **One-way ANOVA** | **Null and Research Hypothesis statements** |
|---|---|
| Hypothesis 1 | $H_{0,1}$: All genders (women/men/binary/other) experience the online game the same by average, i.e., same statistical average score for each question on the Likert-scale. **(Independent variable = gender)** |
| | $H_{a,1}$: At least one of the groups (in terms of gender) experiences the games differently that the other group(s). |
| Hypothesis 2 | $H_{0,2}$: All races/ethnicities experience the online game the same by average, i.e., same statistical average score for each question on the Likert-scale. **(Independent variable = race/ethnicity)** |
| | $H_{a,2}$: At least one of the groups (in terms of race/ethnicity) experiences the games differently that the other group(s). |
| **Two-way MANOVA** | **Null and Research Hypothesis statements.** |
| Hypothesis 4 | $H_{0,4}$: All students experience the online game the same by average, i.e., same statistical average score for each question on the Likert-scale. **(Independent variables: race/ethnicity and gender)** |
| | $H_{a,4}$: There is a difference in mean responses in terms of race/ethnicity. |
| | $H_{b,4}$: There is a difference in mean responses in terms of gender. |
| | $H_{c,4}$: There is an interaction between the two independent variables: race/ethnicity and gender. |
| Hypothesis 5 | $H_{0,5}$: All students experience the online game the same by average, i.e., same statistical average score for each question on the Likert-scale. **(Independent variables = race/ethnicity and previous computer game experience)** |
| | $H_{a,5}$: There is a difference in mean responses in terms of race/ethnicity. |
| | $H_{b,5}$: There is a difference in mean responses in terms of computer game experience. |
| | $H_{c,5}$: There is an interaction between the two independent variables: race/ethnicity and computer game experience. |
| Hypothesis 6 | $H_{0,6}$: All students experience the online game the same by average, i.e., same statistical average score for each question on the Likert-scale. **(Independent variables = gender and previous computer game experience)** |
| | $H_{a,6}$: There is a difference in mean responses in terms of gender. |
| | $H_{b,6}$: There is a difference in mean responses in terms of computer game experience. |
| | $H_{c,6}$: There is an interaction between the two independent variables: gender and computer game experience. |

## 4. Results and Discussion

The mean and standard deviation of the undergraduate respondents to the questionnaire for the entire population are presented in Table 2. The questions from the questionnaire were ranked on a Likert-Scale (1 = Strongly Agree, 2 = Agree, 3 = Somewhat agree, 4 = Neither agree, nor disagree, 5 = Somewhat disagree, 6 = Disagree, 7 = Strongly disagree). A total of 132 participants participated in the study and answered the questions in the questionnaire. Incomplete responses (2 responses) were removed from the data sample and are not included in this the reported findings.

### 4.1. *Comparison of Aggregate Population Means as a Function of Gender, Race/Ethnicity and Prior Experience with Video Game Use on the Computer*

Aggregate means of the student responses to questionnaire questions are presented in aggregate in Table 2, as a function of gender, race/ethnicity and video game use on the computer in Table 5, Table 7 and Table 9. The responses in the tables are averages and standard deviations of responses on a Likert scale where 1 = Strongly Agree, 2 = Agree, 3 = Somewhat Agree, 4 = Neither Agree nor Disagree, and 5 = Somewhat Disagree, 6 = Disagree, and 7 = Strongly Disagree. The student responses provided in Table 2 indicated that on average, students agreed or somewhat agreed ($Q \leq 3.5$) that the game was easy to play and enjoyable ( Q2 = 2.83 $\pm$ 1.36 and Q10 = 2.48 $\pm$ 1.12), provoked frustration (Q3 = 3.23 $\pm$ 1.45), helped them understand truss structures better (Q5 = 2.68 $\pm$ 1.09), and helped them view themselves as an engineer (Q14 = 3.13 $\pm$ 1.31). In addition, majority of the students also agreed or somewhat agreed that ($Q \leq 3.5$) the way to advance to higher challenge levels was easy to understand (Q7 = 2.92 $\pm$ 1.57), they used their engineering skills to advance to higher levels (Q8 = 3.20 $\pm$ 1.34, and that advancing to higher challenge levels in the game made them feel as though they had increased their knowledge of engineering (Q13 = 3.16 $\pm$ 1.69). In addition, as a whole, students indicated that they would recommend use of this game in engineering classes in the future (Q4 = 2.67 $\pm$ 1.47) and that engineering video games/apps could help students better understand engineering topics and games/apps (Q2.17 $\pm$ 0.95). The responses of the students as a homogenous group partially support the TAM, which states that students are more likely to incorporate a new technology if they find it to be easy to learn and supported the notion that students found value in playing the game as they indicated that they would recommend its use in other classes. However, students' responses also contradicted the idea that the game was easy to play. For example, students also indicated that they neither agreed nor disagreed that the learning lessons or goals of each challenge are provided in enough detail to play the game (Q1 = 3.79 $\pm$ 1.61). There were aspects of the game that were distracting (Q6 = 4.23 $\pm$ 1.73). The game made students feel confident in their engineering skills (Q15 = $\pm$ 1.47) and the engineering concepts were intuitive (Q16 = 3.56 $\pm$ 0.97). These ambivalent responses indicated that while students would recommend the game, it was not intuitive and did not enhance their feelings of confidence in the engineering field.

Students had the strongest responses about whether the engineering game studied reflected identity (Q11 = 5.26 $\pm$ 1.55) or *should* include aspects of their culture and identity (Q12 = 4.95 $\pm$ 1.51). In aggregate, these responses may indicate that students do not connect the value of the engineering game with the game's ability to reflect aspects of their identity. Only fifteen students (out of 65) stated that inclusion of culture and/or ethnicity *should* be embedded in the engineering games in focus group discussions, while more indicated agreement of this on their responses to the question in the questionnaire, where 3.8% of the subjects indicated that they either strongly agreed or agreed with this statement, while 18.2% somewhat agreed with this statement as indicated in Table 4.

Table 4: Responses to Q12 - I think engineering learning tools should reflect aspects of my culture and/or identity.

| | | **Frequency** | **Percent** | **Valid Percent** | **Cumulative Percent** |
|---|---|---|---|---|---|
| Q12 - I think engineering learning tools should reflect aspects of my culture and/or identity. | Strongly agree | 2 | 1.5 | 1.5 | 1.5 |
| | Agree | 3 | 2.3 | 2.3 | 3.8 |
| | Somewhat agree | 24 | 18.2 | 18.2 | 22.0 |
| | Neither agree nor disagree | 26 | 19.7 | 19.7 | 41.7 |
| | Somewhat disagree | 9 | 6.8 | 6.8 | 48.5 |
| | Disagree | 52 | 39.4 | 39.4 | 87.9 |
| | Strongly disagree | 16 | 12.1 | 12.1 | 100.0 |
| | Total | 132 | 100.0 | 100.0 | |

### 4.2 *Comparison of Student Responses in Terms of Gender, One-Way ANOVA*

In order to answer the first two hypotheses concerning whether there was differentiation in responses from the aggregate population with regard to gender, race/ethnicity and prior video game usage on their computer, one-way ANOVA analyses were conducted for each population. The mean responses of the students in terms of gender are presented in Table 5 and all of the one-way ANOVA results as a function of gender are provided in the Appendix, in Table 6. The questions that had significant variance in terms of gender ($p \leq 0.05$) are highlighted in dark gray along with those with less significant variance ($p \leq 0.09$) (highlighted in light gray) in *Table 6*. According to the means shown in TABLE 5: where Q1 – Q4 and Q10 indicated significant variance in terms of gender groups ($p \leq 0.05$) and Q6 and Q12 indicated moderate variance ($p \leq 0.095$). The one-way ANOVA analysis of the participant responses indicated that there was variability in responses for five of the sixteen questions when analyzed in terms of gender: Q1 (p-value = 0.008), Q2 (p-value = 0.009), Q3 (p-value = 0.004), Q4 (p-value = 0.022), and Q10 (p-value = 0.001). These results indicate that there were gender differences in perceptions/beliefs for the aforementioned questions, but not for Q5-9, Q11 and Q13-Q16. Specifically, on average, men agreed that the learning lessons or goals of the game are defined in enough detail to play the game ($M_{men} = 3.35 \pm 1.46$) while women, non-binary and students who self-identified as "other" disagreed with this statement, with means of $M_{women} = 4.22 \pm 1.7$, $M_{non\text{-}bin} = 4.50 \pm 0.70$, and $M_{non\text{-}bin} = 5.00 \pm 0.0$. Similarly, men indicated to a higher degree that they found the game easy to play ($M_{men} = 2.46 \pm 1.26$) while the majority of the women and non-binary respondents only somewhat agreed or neither agreed or disagreed with this sentiment ($M_{women} = 3.28 \pm 1.41$ and $M_{non\text{-}bin} = 3.00 \pm 0.0$), respectively. Most students indicated in the focus group that while the game was "easy" to play, advancing to levels beyond the $4^{th}$ challenge was extremely difficult, with some students admitting that they struggled and at times became frustrated within the 20 minutes of playing time. Most students indicated that playing the game was "easy to play", but "winning the game", i.e., designing structures that did not fail beyond Challenge Level 4 was "hard". They expressed frustration at not knowing or understanding why their structures failed and not knowing any details about the design conditions that they typically used in making calculations in the class. For example, students indicated that they were not given quantitative information like, mass, dimensions, etc., which were all elements they typically used in analyzing structures in their classrooms. So, while the game was "easy" to engage in, where they understood how to use the interface to the build structures; it was not apparent to them why some structures failed, while others were stable. Students were also asked to provide an explanation for their rating of game ease in the questionnaire. Sixty-five of the students indicated in the survey text box that they deemed the game to be "easy to play", however, 23 of the 132 women stated that they would have liked to have hints or explanations about why certain structures failed, in comparison to 6 responses from men. Instead, men frequently stated that the game became easy after a few initial tries, whereas several of them indicated that they understood how to play the game within 30 seconds or a minute. Men also stated how easy was the game to operate (19 out of 132) while far fewer women (7/132) indicated that they game became easy after a few tries. We conjecture those students that indicated that they understand the game after a few tries have an intuition that is closer to the goals of the intended game designers, contrary to women players. However, it is not clear why the game appeared to be easy for some after a few trials than for others. For example, two men pointed out that the game was like an arcade style or simple "UI" (user interface) game, where one could easily decipher how to navigate the game interface. None of the women respondents used terminology like "arcade style" or "UI".

There were also significant differences between the genders in response to question 3, which questions whether students experienced frustration while playing the game. In particular, women more strongly agreed with the sentiment that playing the game induced a higher degree of frustration, which may indicate a higher degree of cognitive load investment in playing the game. Coupling the responses to Q1 (learning lessons not fully defined in enough detail to play) and Q3 (game frustration), could indicate that women were more frustrated due to perceived lack of clarity of game rules/objectives than their male counterparts, which could have also influenced their game performance, as many have noted that enhanced cognitive load and frustration in learning influences learning accuracy and performance (Beege, Nebel, Schneider, & Rey; Paas, Renkl, & Sweller, 2003). The majority of the women who were frustrated playing the game indicated (in text boxes for comments in the questionnaire) that this frustration was due to not understanding the game goals, scoring and rationale for failed structures, which they attributed to lack of instructions due to the intuitive thematic landscape of the game. For example, one woman (Likert rating of '3') noted, "I got a little frustrated trying to figure out why the score was low, but after a while I figured out what the game was trying to tell me and it became interesting to me," while a woman who strongly agreed (Likert scale of '7') with the statement that the game was frustrating commented, "I didn't thoroughly understand the concepts, so I was very frustrated". On the other hand, the majority of the men did not indicate heightened senses of frustration, where they gave feedback such as, *"No frustration. When I was unsuccessful, I just kept tying until I got it right," while others commented, "Sometimes I was frustrated, but I think that us part of the learning process and motivates me to continue learning."* Interestingly, women participants found the intuitive learning environment to be more frustrating than their male counterparts, they were also the population to have had less experience with playing video games prior to the course. These results do not sufficiently support the idea that the software will be readily or easily adapted into a classroom setting according to the TAM.

According to the TAM model, users' frustration in using technology should be minimized (playing the game should be perceived to be easy), while gains (additional engineering skills) should be optimized from the technology usage. Though there is a statistical difference in responses for Q4 – "I would recommend use of this game in classrooms in the future", the results are inconclusive regarding differentiation mean and women and other. Specifically, while men and women agree with Q4, those classified as "other" do not. Those students in this group indicated that the game would need to include instructions before it would be an ideal learning tool. They also indicated that "There are better learning games out there," which indicates prior experience with use of engineering learning tools. Also, while majority of the men and women "somewhat agreed" that the game would be a good learning tool for classes in the future, several indicated issues that limited its applicability. For example, a male student stated, "*While the game was fun, I do not think it is a learning tool, unless there is an element of calculation involved. I do not believe that guessing where to place a truss would be beneficial in the long run.*" The findings also indicate that men enjoyed playing the game more than women (Q10) and those who identified as "non-binary" strongly agreed with this statement in comparison to those who are designated as other. While the sample data for non-binary and other student populations are too small to make statistically significant conclusions, differences between men and women are. Though women stated that there were aspects of the game that they found enjoyable, ambivalence towards playing the game may be attributed to frustration that they encountered.

Q6 did not indicate significant differences in response to the question about whether there were aspects of the game that students found distracting, where the majority of the people were ambivalent i.e., they did not agree or disagree with this statement. The vast majority of the students cited that the lack of instructions, confusion over scoring and lack of feedback (*intuitiveness)* of the game was distracting, where 14 women explicitly commented that the lack of instructions, goals and feedback distracted them, in comparison to 15 men. Men and women also indicated that they became more interested in understanding the scoring to *win* the game rather than learning (3 women and 6 men). The second highest distracting element of the game for the women (all and intersectional) compared to men was the *game noise* that was used as feedback for their performance in the game (11 versus 2 participants, respectively). During the game, structures that failed would collapse while making a clanging sound. For example, one woman explained, "*The sound effects were loud and jarring.*" Another woman commented, "*I think that the sounds that were there when you got something wrong triggered me and distracted my mind from completely focusing.*" The second most noted distracting feature of the game for men was difficulty using their fingers and mouse to navigate the game interface to design the structures, where coordination and movement of the joints and members were cited as points of irritation for 11 men, in comparison to two women who indicates issues with navigating the game interface using finger and/or mouse slides/clicks. For example, one man stated, "*Sometimes I wouldn't be able to connect members. The game would keep trying to zoom in and out and this was somewhat frustrating,*" while another commented, "My thumbs were too big, when it came to accurately placing structures where I wanted them." Several men blamed the game interface, listing "*inaccurate touch controls*" as a reason for distraction.

Differences in response to Q12 were not statistically significant (0.07), where the vast majority of participants did not agree that engineering games should include aspects of their culture or identity. Women participants had a higher score about this sentiment (mean 5.17 $\pm$

1.403) in comparison to their men counterparts (mean 4.74 ± 1.569). Women indicated that they did not "expect" aspects of their identity of culture to be included in game design. These findings are compelling as men and students with higher cultural capital (social class as measured by parental education, number of books in the home, visits to the museum, etc.) have reported higher engineering and science aspirations, whereas those with higher cultural capital had less gender related effects in aspirations towards science professions (Moote, Archer, DeWitt, & MacLeod, 2020). In fact, (Moote et al., 2020) suggest that the engineering might broaden the participation of women by *rebranding its culture* to emphasize "creativity" for a profession that traditionally associates itself culturally with masculinity, thereby leveraging "feminine" attributes that are traditionally associated with notions of creativity. The majority of the participants did not think engineering was related to culture at all. In fact, several students indicated that to include aspects of culture or identity would have a negative effect on the effectiveness of the game for diverse populations of students. For example, one Caucasian woman wrote, "*Engineering may have different values to different people. I think less people would play if it were more focused on culture and identity rather than engineering,*" while another Caucasian woman wrote that inclusion of culture or identity in the game would, "*distract from the game itself.*" Similarly, several Caucasian shared these opinions, "*I think if engineering learning tools incorporated cultural aspects, it would feel to a user as if those aspects are only included to try to appeal to an audience and not for a different, more authentic reason.*" On the other hand, several students indicated that there may be some value to inclusion of identity or culture to educational games. Ironically, only two students from the 132 participants strongly agreed that culture and ethnicity should be included when designing engineering video games, and these two participants were two Caucasian males.

### *4.3. Comparison of Student Responses in Terms of Race/Ethnicity*

The averaged values of the subject's responses to the questionnaire questions as a function of race/ethnicity are presented in Table 7 and the one-way ANOVA in terms of the race/ethnicity of the respondents are presented in ethnicity Table 8. Questions 8 and 15 are highlighted because according to the ANOVA of the responses in terms of race/ethnicity, the differences in the means for the different races/ethnicities were statistically significantly different.

Difference in participant response were found to occur as a function of race/ethnicity for Q8 ($p = 0.035$) and Q15 ($p = 0.058$). There were significant differences between the responses of LatinX, African American and Asian and Caucasian participants in their perception of their ability to use their engineering skills to advance to higher levels in the game, where the former group agreed with this statement, while the others did not. This sentiment paired well with Q15, where participant responses also varied. Q15 questioned whether participants felt that playing the game made them feel more confident in their engineering abilities, whereas LatinX and African American students mildly agreed with this statement, while Caucasian and Asian students did not agree or disagree with this statement. The quantitative means for Q8 are perplexing because the majority of students indicated that while the game was easy to play, winning the game and advancing beyond Challenge Level 4 was difficult, since some structures did not appear to be realistic or align with design principals learned in class. Others indicated that they used trial and error to win Challenge levels. African American and LatinX students most agreed with the sentiment that playing the game made them feel more like an engineer

($M_{AA}$ = 1.50 $\pm$ 0.71 and $M_{LX}$ = 2.78 $\pm$ 1.302). *This finding may suggest that inclusion of engineering games like this into the classroom environment may enhance students' identification with the engineering field although additional participants are needed to confirm this further.*

### *4.4. One-Way ANOVA of prior use and experience with video games*

A one-way ANOVA was conducted to ascertain the differences between subjects in their responses to the questionnaire as a function of prior experience playing video games on their computers. Significant differences in participant responses were found for Q1, Q5 and Q15. The means and standard deviation values for each of the questions as a function of use of the computer to play video games is provided in Table 9 and the ANOVA results that indicate questions where there are significant or non-significant differences are provided in Table 10. The results indicate that students that play video games on their computer i.e., are part of the gaming community/culture found that the learning lessons and goals for each challenge were defined in enough detail to play (Q1) (M = 3.5 $\pm$ 1.6) as opposed to those who do not play video games on their computer (M = 4.3 $\pm$ 1.4). Also, those students who play video games also felt that the engineering game helped them to better understand truss structures (M = 2.5 $\pm$ 1.6) that those who do not play video games (M = 2.9 $\pm$ 1.2). This could be related to the additional cognitive load that those without computer experience expended in learning to navigate the game and subsequent frustration that may not have been experienced/perceived by those who have regularly play computer games on their computers. Similarly, this group benefits from feeling more confidence in their engineering skills when playing the game (M = 3.7 $\pm$ 1.4) than their peers who do not play video games (M = 4.3 $\pm$ 1.5). Hence, these results indicate that inclusion of engineering educational games may enhance student confidence in their engineering skills, and confidence in one's skills has been shown to enhance student's academic performance(Alias & Hafir, 2009). On the other hand, those who do not play video games may not experience the direct benefits from playing games in terms of confidence building in engineering skills.

### *4.5. Two-way MANOVA of prior experience with video games on the computer and gender.*

A two-way multivariate analysis was conducted to understand the relationship between gender and race/ethnicity in terms of perceptions of usefulness and ease of use of the engineering game. The descriptive statistics of these populations as a function of only gender are found in Table 1 multivariate test results comprising the Pillai's Trace, Wilks's Lambda and Hotelling's Trace and MANOVA tests of between-subject effects for both gender and race are described in Table 12 and Table 13, respectively. The results are determined for the confidence interval of 95%, where there are three null hypotheses. The first null hypothesis is that there is no difference in group means at any level of the gender variable on the rating of the questions. The second null hypothesis is that there is no difference in the group means at the level of race/ethnicity variable on the rating. These two hypotheses are examined via the one-way ANOVA analyses described in Table 6 and Table 8. The third null hypothesis is that there is no interaction between gender and race/ethnicity. In other words, the gender ratings do not depend on the effect of race/ethnicity. Since the hypothesis degrees of freedom are each greater than 1, the four statistics in Table 12 and Table 13 lead to the same result, which is that there is no statistically significant interaction between the effects Gender and Race/Ethnicity. However, this preliminary result is most likely due to the low number of African American and LatinX participants ($N_{AA}$ =

2 and $N_{LX}$ = 9 out of 132 participants). Hence, these results are inconclusive and more definitive results will come with further investigation.

To illustrate this point, the data was grouped in terms of combined scores, a statistically significant interaction was detected for question 13, as shown in Table 12. The data was analyzed by grouping the responses in three groups, where Group 1 comprised: African American, LatinX, Mixed-Race and Other (Middle Eastern) participants, Group 2 comprised: Caucasians, and Group 3 comprised: Asians. The multivariate test and MANOVA results for these groups. When data was grouped, Group 1 and Group 3 women agreed more with the statement that going to the next challenge level in the game made them feel as though they had increased their knowledge of truss structures more than their Caucasian women counterparts, with means of M=2.5 $\pm$ 1.2, M=3.0 $\pm$ 1.7 and M=3.4 $\pm$ 1.7, respectively. These results though preliminary indicate that use of serious games that are effective in assisting with enhancement of knowledge may enhance women of *colour*'s confidence in their engineering skills, which has been proven to enhance student academic performance (Alias & Hafir, 2009).

*4.6. Two-way MANOVA of prior experience with video games on the computer and gender.*

A Two-way MANOVA was conducted to examine how student gender and prior video game usage/experience. In this analysis, gender and video game usage are independent variables and the ratings on the Likert scale were the dependent variables. The results are determined for the confidence interval of 95%. The two-way descriptive statistics for gender and video game usage, MANOVA results and multivariate tests are provided in Table 17, Table 18, and Table 19, respectively. The results indicate that there is no interaction between gender and prior video game usage. In other words, the effect of gender does not depend on whether or not the individual has prior video game experience. It is important to note that the distribution of data for each category is not equally distributed. This means that the data for males and females should be considered for analysis because there are large data samples for both groups. However, the Non-binary and Others group categories have a very low sampling number. The Prior Video Game Experience has almost equal data distribution in the two levels (Yes and No).

*4.7. Two-way MANOVA of prior experience with serious games and race/ethnicity*

A Two-way MANOVA was conducted to investigate whether prior video game experience and race/ethnicity affect the rating of each question, where prior video game experience and race/ethnicity are the independent variables, and the question ratings are the dependent variables. The results are determined for the confidence interval of 95%. The descriptive statistics, multivariate variable analysis test and MANOVA results are provided in Table 14, Table 15, and Table 16, respectively. The preliminary results are inconclusive due to the small numbers of African American and Latinx participants. However, the results do indicate significant differences in means for Q1 (0.049) and Q14 (0.043). In particular, majority of the students who play video games indicated that the learning lessons or goals of each challenge were defined in enough detail to play the game, while those students who do not regularly play video games on their computer did not agree with the statement that the game rules were defined in enough detail to play the game. The LatinX population was the only population of students that did not agree with this trend, where those LatinX students who play video games indicated that the game was not defined in enough detail to play the game ($M_{LX-G}$ =

3.50 $\pm$ 1.9) in comparison to those who did not play video games ($M_{LX\text{-}NoG}$ = 5.67 $\pm$ 1.2). The majority of the students of colour (Asian, African American and LatinX) who did play video games on their computers indicated that playing the engineering game made them to view themselves as an engineer ($M_A$ = 2.94 $\pm$ 1.3 , $M_{AA}$ = 1.00 $\pm$ 0.0, $M_{LX}$ = 2.00 $\pm$ 1.00) to a higher degree than those who did not play video games on their computer ($M_{A\text{-}No\text{-}G}$ = 3.64 $\pm$ 1.4, $M_{AA\text{-}No\text{-}G}$ = 2.00 $\pm$ 0.0, $N_{LX\text{-}NoG}$ = 3.17 $\pm$ 1.3) . This result was different for Caucasian students, where those who did not play video games on their computer indicated that playing the engineering game enhanced their ability to view themselves as engineers (MC-NoG = 2.72 $\pm$ 1.0) to a high degree than those who did play video games on their computers (MC = 3.41 $\pm$ 1.3). *This result gives an indication of an added benefit to playing video games, may foster students who play engineering game's identification with the engineering field , which may encourage them to continue on their path in a STEM career(Villanueva & Nadelson, 2017).*

## 5. Conclusions and Application to Classroom and Serious Game Designers

One limitation to the conclusions drawn from this study is the small sample sizes of African American and LatinX men and women included in this study. The small sample size of these groups diminishes the ability of this work to represent the perspectives and experiences of these groups in a statistically meaningful way. Also, the relationship between the technology acceptance of the game and the impact of the game intervention on student performance in the class cannot be predicted from this work.

The preliminary work of Cook-Chennault and Villanueva (Cook-Chennault & Villanueva, 2019a, 2019b, 2020a, 2020b) has shown that gamer experience in a classroom environment may vary based on the gender, race, and video game experience of the undergraduate student. For example, significant differences in serious game experience were observed as a function of gender in terms of presentation of game detail for advancement to high challenge levels, frustration levels when playing the game, recommendation of use of the game in future classes, and enjoyment playing the game. In particular, men deemed the degree of game goals were presented in enough detail to succeed to a higher degree than women. Men also indicated that the serious game was easier to play than women. These results support the findings that women indicated higher levels of frustration when playing the game than the men. The majority of the students of colour (Asian, African American and LatinX) who did not play video games indicated that playing the engineering game helped them to view themselves as an engineer. This sentiment was ranked even higher for those students who did play video games on their computers. Hence, *these exploratory findings suggest that engineering courses that include online games may enhance students of colours' identification with the engineering field, which may encourage them to continue on their path in a STEM career*. Though women of colour indicated that going to the next challenge level in the game made them feel as though they had increased their engineering knowledge to a higher degree than their male counterparts, this group also indicated higher levels of frustration than their male and Caucasian woman counterparts. These results also indicate that additional studies are needed with higher populations of women of colour to make more conclusive findings.

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Appendix

Table 5:

| Gender | | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Male (N = 69)** | Mean | 3.35 | 2.46 | 3.64 | 2.78 | 2.81 | 4.36 | 2.90 | 3.04 | 2.35 | 2.25 | 5.12 | 4.74 | 3.12 | 3.32 | 3.97 | 3.57 |
| | Std. Dev. | 1.464 | 1.255 | 1.534 | 1.504 | 1.167 | 1.689 | 1.673 | 1.265 | 1.027 | 0.946 | 1.762 | 1.569 | 1.650 | 1.388 | 1.495 | 1.050 |
| **Female (N = 58)** | Mean | 4.22 | 3.28 | 2.86 | 2.48 | 2.50 | 4.12 | 2.95 | 3.36 | 1.98 | 2.72 | 5.41 | 5.17 | 3.07 | 2.86 | 3.84 | 3.59 |
| | Std. Dev. | 1.697 | 1.412 | 1.235 | 1.314 | 0.960 | 1.758 | 1.527 | 1.410 | 0.827 | 1.167 | 1.257 | 1.403 | 1.632 | 1.176 | 1.449 | 0.879 |
| **Non-binary (N = 2)** | Mean | 4.50 | 3.00 | 2.00 | 1.00 | 3.00 | 6.00 | 3.00 | 4.50 | 1.50 | 1.00 | 4.00 | 3.50 | 5.50 | 4.00 | 4.50 | 3.00 |
| | Std. Dev. | 0.707 | 0.000 | 0.000 | 0.000 | 1.414 | 0.000 | 0.000 | 2.121 | 0.707 | 0.000 | 0.000 | 0.707 | 2.121 | 1.414 | 2.121 | 1.414 |
| **Other (N = 3)** | Mean | 5.00 | 2.67 | 2.00 | 4.67 | 3.00 | 2.33 | 2.67 | 3.00 | 2.33 | 4.00 | 6.33 | 6.33 | 4.33 | 3.33 | 4.33 | 3.33 |
| | Std. Dev. | 0.000 | 0.577 | 0.000 | 2.309 | 1.732 | 1.155 | 0.577 | 1.000 | 0.577 | 1.732 | 1.155 | 0.577 | 3.055 | 1.528 | 1.528 | 0.577 |
| **Total (N = 132)** | Mean | 3.79 | 2.83 | 3.23 | 2.67 | 2.68 | 4.23 | 2.92 | 3.20 | 2.17 | 2.48 | 5.26 | 4.95 | 3.16 | 3.13 | 3.93 | 3.56 |

| Table 6: One-way ANOVA of questionnaire responses where the factor = gender. | | | | | | |
|---|---|---|---|---|---|---|
| | | Sum of Squares | df | Mean Square | F | Sig. |
| Q1 | Between Groups (Combined) | 29.822 | 3 | 9.941 | 4.101 | 0.008 |
| | Within Groups | 310.238 | 128 | 2.424 | | |
| | Total | 340.061 | 131 | | | |
| Q2 | Between Groups (Combined) | 20.921 | 3 | 6.974 | 4.032 | 0.009 |
| | Within Groups | 221.412 | 128 | 1.730 | | |
| | Total | 242.333 | 131 | | | |
| Q3 | Between Groups (Combined) | 26.881 | 3 | 8.960 | 4.646 | 0.004 |
| | Within Groups | 246.839 | 128 | 1.928 | | |
| | Total | 273.720 | 131 | | | |
| Q4 | Between Groups (Combined) | 20.445 | 3 | 6.815 | 3.318 | 0.022 |
| | Within Groups | 262.889 | 128 | 2.054 | | |
| | Total | 283.333 | 131 | | | |
| Q5 | Between Groups (Combined) | 3.586 | 3 | 1.195 | 1.000 | 0.395 |
| | Within Groups | 153.051 | 128 | 1.196 | | |
| | Total | 156.636 | 131 | | | |
| Q6 | Between Groups (Combined) | 18.956 | 3 | 6.319 | 2.170 | 0.095 |
| | Within Groups | 372.764 | 128 | 2.912 | | |
| | Total | 391.720 | 131 | | | |
| Q7 | Between Groups (Combined) | 0.282 | 3 | 0.094 | 0.037 | 0.990 |
| | Within Groups | 323.801 | 128 | 2.530 | | |
| | Total | 324.083 | 131 | | | |
| Q8 | Between Groups (Combined) | 6.711 | 3 | 2.237 | 1.252 | 0.294 |
| | Within Groups | 228.766 | 128 | 1.787 | | |
| | Total | 235.477 | 131 | | | |
| Q9 | Between Groups (Combined) | 5.191 | 3 | 1.730 | 1.981 | 0.120 |
| | Within Groups | 111.802 | 128 | 0.873 | | |
| | Total | 116.992 | 131 | | | |
| Q10 | Between Groups (Combined) | 18.534 | 3 | 6.178 | 5.476 | 0.001 |
| | Within Groups | 144.398 | 128 | 1.128 | | |
| | Total | 162.932 | 131 | | | |
| Q11 | Between Groups (Combined) | 9.434 | 3 | 3.145 | 1.325 | 0.269 |
| | Within Groups | 303.808 | 128 | 2.374 | | |
| | Total | 313.242 | 131 | | | |
| Q12 | Between Groups (Combined) | 15.882 | 3 | 5.294 | 2.414 | 0.070 |
| | Within Groups | 280.747 | 128 | 2.193 | | |
| | Total | 296.629 | 131 | | | |
| Q13 | Between Groups (Combined) | 15.696 | 3 | 5.232 | 1.860 | 0.140 |
| | Within Groups | 359.963 | 128 | 2.812 | | |
| | Total | 375.659 | 131 | | | |
| Q14 | Between Groups (Combined) | 8.262 | 3 | 2.754 | 1.628 | 0.186 |
| | Within Groups | 216.549 | 128 | 1.692 | | |
| | Total | 224.811 | 131 | | | |
| Q15 | Between Groups (Combined) | 1.674 | 3 | 0.558 | 0.254 | 0.858 |
| | Within Groups | 280.712 | 128 | 2.193 | | |
| | Total | 282.386 | 131 | | | |
| Q16 | Between Groups (Combined) | 0.823 | 3 | 0.274 | 0.289 | 0.834 |
| | Within Groups | 121.692 | 128 | 0.951 | | |
| | Total | 122.515 | 131 | | | |

Table 7**:** Mean and standard deviation of the responses of subjects in terms of race/ethnicity.

| **Race/Ethnicity** | | **Q1** | **Q2** | **Q3** | **Q4** | **Q5** | **Q6** | **Q7** | **Q8** | **Q9** | **Q10** | **Q11** | **Q12** | **Q13** | **Q14** | **Q15** | **Q16** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| African American/ Black (N = 2) | Mean | 3.50 | 3.00 | 3.00 | 2.50 | 1.50 | 4.50 | 3.50 | 5.50 | 1.00 | 2.00 | 4.50 | 4.50 | 1.00 | 1.50 | 2.50 | 2.50 |
| | Std. Dev. | 2.121 | 0.000 | 0.000 | 0.707 | 0.707 | 2.121 | 0.707 | 0.707 | 0.000 | 1.414 | 0.707 | 2.121 | 0.000 | 0.707 | 0.707 | 0.707 |
| Caucasian (N = 50) | Mean | 3.72 | 2.62 | 3.24 | 2.74 | 2.60 | 4.44 | 2.84 | 2.88 | 2.08 | 2.48 | 5.32 | 5.10 | 3.12 | 3.16 | 3.78 | 3.60 |
| | Std. Dev. | 1.591 | 1.008 | 1.465 | 1.509 | 0.969 | 1.680 | 1.658 | 1.189 | 0.804 | 1.092 | 1.491 | 1.568 | 1.710 | 1.267 | 1.250 | 0.969 |
| LatinX (N = 9) | Mean | 4.22 | 3.56 | 3.33 | 2.33 | 2.44 | 4.33 | 3.78 | 3.22 | 1.78 | 2.33 | 4.44 | 5.78 | 3.78 | 2.78 | 3.22 | 3.22 |
| | Std. Dev. | 1.922 | 1.590 | 1.414 | 1.414 | 1.667 | 2.291 | 1.641 | 1.394 | 0.667 | 1.225 | 1.740 | 0.833 | 1.922 | 1.302 | 1.787 | 0.833 |
| Asian (N = 61) | Mean | 3.90 | 2.93 | 3.21 | 2.74 | 2.84 | 3.97 | 2.93 | 3.44 | 2.38 | 2.54 | 5.31 | 4.77 | 3.13 | 3.23 | 4.31 | 3.66 |
| | Std. Dev. | 1.650 | 1.621 | 1.473 | 1.482 | 1.113 | 1.712 | 1.601 | 1.420 | 1.098 | 1.134 | 1.608 | 1.499 | 1.727 | 1.383 | 1.576 | 0.998 |
| Mixed-Race (N = 8) | Mean | 3.00 | 2.50 | 3.63 | 1.75 | 2.38 | 5.00 | 2.25 | 2.75 | 2.00 | 2.00 | 5.50 | 4.38 | 3.38 | 2.88 | 3.25 | 3.25 |
| | Std. Dev. | 0.926 | 0.926 | 1.598 | 0.707 | 0.518 | 1.604 | 0.463 | 1.035 | 0.535 | 0.756 | 1.309 | 1.408 | 0.916 | 0.835 | 1.035 | 0.886 |
| Other (N = 2) | Mean | 3.50 | 3.00 | 2.00 | 4.00 | 3.50 | 3.50 | 2.50 | 3.50 | 2.00 | 3.50 | 5.50 | 5.50 | 3.50 | 3.50 | 3.50 | 3.50 |
| | Std. Dev. | 2.121 | 0.000 | 0.000 | 2.828 | 2.121 | 0.707 | 0.707 | 0.707 | 0.000 | 2.121 | 2.121 | 2.121 | 2.121 | 2.121 | 0.707 | 0.707 |
| Total (N = 132) | Mean | 3.79 | 2.83 | 3.23 | 2.67 | 2.68 | 4.23 | 2.92 | 3.20 | 2.17 | 2.48 | 5.26 | 4.95 | 3.16 | 3.13 | 3.93 | 3.56 |
| | Std. Dev. | 1.611 | 1.360 | 1.445 | 1.471 | 1.093 | 1.729 | 1.573 | 1.341 | 0.945 | 1.115 | 1.546 | 1.505 | 1.693 | 1.310 | 1.468 | 0.967 |

Table 8: One-way ANOVA of questionnaire responses of subjects as a function of race/ethnicity.

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Q1 | Between Groups (Combined) | 8.015 | 5 | 1.603 | 0.608 | 0.694 |
| | Within Groups | 332.045 | 126 | 2.635 | | |
| | Total | 340.061 | 131 | | | |
| Q2 | Between Groups (Combined) | 8.593 | 5 | 1.719 | 0.926 | 0.466 |
| | Within Groups | 233.740 | 126 | 1.855 | | |
| | Total | 242.333 | 131 | | | |
| Q3 | Between Groups (Combined) | 4.495 | 5 | 0.899 | 0.421 | 0.834 |
| | Within Groups | 269.225 | 126 | 2.137 | | |
| | Total | 273.720 | 131 | | | |
| Q4 | Between Groups (Combined) | 11.910 | 5 | 2.382 | 1.106 | 0.361 |
| | Within Groups | 271.423 | 126 | 2.154 | | |
| | Total | 283.333 | 131 | | | |
| Q5 | Between Groups (Combined) | 7.178 | 5 | 1.436 | 1.210 | 0.308 |
| | Within Groups | 149.458 | 126 | 1.186 | | |
| | Total | 156.636 | 131 | | | |
| Q6 | Between Groups (Combined) | 12.465 | 5 | 2.493 | 0.828 | 0.532 |
| | Within Groups | 379.254 | 126 | 3.010 | | |
| | Total | 391.720 | 131 | | | |
| Q7 | Between Groups (Combined) | 11.570 | 5 | 2.314 | 0.933 | 0.462 |
| | Within Groups | 312.513 | 126 | 2.480 | | |
| | Total | 324.083 | 131 | | | |
| Q8 | Between Groups (Combined) | 21.093 | 5 | 4.219 | 2.479 | 0.035 |
| | Within Groups | 214.385 | 126 | 1.701 | | |
| | Total | 235.477 | 131 | | | |
| Q9 | Between Groups (Combined) | 7.429 | 5 | 1.486 | 1.709 | 0.137 |
| | Within Groups | 109.563 | 126 | 0.870 | | |
| | Total | 116.992 | 131 | | | |
| Q10 | Between Groups (Combined) | 4.804 | 5 | 0.961 | 0.766 | 0.576 |
| | Within Groups | 158.128 | 126 | 1.255 | | |
| | Total | 162.932 | 131 | | | |
| Q11 | Between Groups (Combined) | 8.058 | 5 | 1.612 | 0.665 | 0.650 |
| | Within Groups | 305.184 | 126 | 2.422 | | |
| | Total | 313.242 | 131 | | | |
| Q12 | Between Groups (Combined) | 12.911 | 5 | 2.582 | 1.147 | 0.339 |
| | Within Groups | 283.717 | 126 | 2.252 | | |
| | Total | 296.629 | 131 | | | |
| Q13 | Between Groups (Combined) | 13.498 | 5 | 2.700 | 0.939 | 0.458 |
| | Within Groups | 362.161 | 126 | 2.874 | | |
| | Total | 375.659 | 131 | | | |
| Q14 | Between Groups (Combined) | 7.873 | 5 | 1.575 | 0.915 | 0.474 |
| | Within Groups | 216.937 | 126 | 1.722 | | |
| | Total | 224.811 | 131 | | | |
| Q15 | Between Groups (Combined) | 22.669 | 5 | 4.534 | 2.200 | 0.058 |
| | Within Groups | 259.718 | 126 | 2.061 | | |
| | Total | 282.386 | 131 | | | |
| Q16 | Between Groups (Combined) | 4.689 | 5 | 0.938 | 1.003 | 0.419 |
| | Within Groups | 117.826 | 126 | 0.935 | | |
| | Total | 122.515 | 131 | | | |

Table 9: The mean response data from the subjects, where responses to the questionnaire are a function of whether the students had prior experience playing video games on their computer.

| Do you play video games on your computer? | | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 | Q10 | Q11 | Q12 | Q13 | Q14 | Q15 | Q16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Yes (N=79) | Mean | 3.5 | 2.7 | 3.4 | 2.7 | 2.5 | 4.2 | 2.9 | 3.1 | 2.2 | 2.4 | 5.3 | 5.0 | 3.1 | 3.1 | 3.7 | 3.5 |
| | Std. Dev. | 1.6 | 1.3 | 1.5 | 1.4 | 1.0 | 1.7 | 1.6 | 1.2 | 0.9 | 1.1 | 1.6 | 1.5 | 1.6 | 1.3 | 1.4 | 1.0 |
| No (N = 53) | Mean | 4.3 | 3.0 | 3.0 | 2.7 | 2.9 | 4.4 | 3.0 | 3.4 | 2.2 | 2.6 | 5.2 | 4.9 | 3.2 | 3.2 | 4.3 | 3.6 |
| | Std. Dev. | 1.4 | 1.5 | 1.3 | 1.6 | 1.2 | 1.8 | 1.6 | 1.5 | 1.0 | 1.2 | 1.5 | 1.5 | 1.8 | 1.3 | 1.5 | 1.0 |
| Total (N = 132) | Mean | 3.8 | 2.8 | 3.2 | 2.7 | 2.7 | 4.2 | 2.9 | 3.2 | 2.2 | 2.5 | 5.3 | 4.9 | 3.2 | 3.1 | 3.9 | 3.6 |
| | Std. Dev. | 1.6 | 1.4 | 1.4 | 1.5 | 1.1 | 1.7 | 1.6 | 1.3 | 0.9 | 1.1 | 1.5 | 1.5 | 1.7 | 1.3 | 1.5 | 1.0 |

Table 10: One-Way ANOVA of the subject responses as a function of prior experience playing video games on their computer.

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Q1 | Between Groups (Combined) | 21.711 | 1 | 21.711 | 8.866 | 0.003 |
| | Within Groups | 318.350 | 130 | 2.449 | | |
| | Total | 340.061 | 131 | | | |
| Q2 | Between Groups (Combined) | 3.700 | 1 | 3.700 | 2.016 | 0.158 |
| | Within Groups | 238.633 | 130 | 1.836 | | |
| | Total | 242.333 | 131 | | | |
| Q3 | Between Groups (Combined) | 4.884 | 1 | 4.884 | 2.362 | 0.127 |
| | Within Groups | 268.835 | 130 | 2.068 | | |
| | Total | 273.720 | 131 | | | |
| Q4 | Between Groups (Combined) | 0.014 | 1 | 0.014 | 0.006 | 0.936 |
| | Within Groups | 283.319 | 130 | 2.179 | | |
| | Total | 283.333 | 131 | | | |
| Q5 | Between Groups (Combined) | 5.217 | 1 | 5.217 | 4.479 | 0.036 |
| | Within Groups | 151.420 | 130 | 1.165 | | |
| | Total | 156.636 | 131 | | | |
| Q6 | Between Groups (Combined) | 1.354 | 1 | 1.354 | 0.451 | 0.503 |
| | Within Groups | 390.366 | 130 | 3.003 | | |
| | Total | 391.720 | 131 | | | |
| Q7 | Between Groups (Combined) | 0.615 | 1 | 0.615 | 0.247 | 0.620 |
| | Within Groups | 323.468 | 130 | 2.488 | | |
| | Total | 324.083 | 131 | | | |
| Q8 | Between Groups (Combined) | 2.645 | 1 | 2.645 | 1.477 | 0.227 |
| | Within Groups | 232.833 | 130 | 1.791 | | |
| | Total | 235.477 | 131 | | | |
| Q9 | Between Groups (Combined) | 0.098 | 1 | 0.098 | 0.109 | 0.742 |
| | Within Groups | 116.894 | 130 | 0.899 | | |
| | Total | 116.992 | 131 | | | |
| Q10 | Between Groups | 0.698 | 1 | 0.698 | 0.559 | 0.456 |
| | Within Groups | 162.234 | 130 | 1.248 | | |
| | Total | 162.932 | 131 | | | |
| Q11 | Between Groups | 0.013 | 1 | 0.013 | 0.006 | 0.941 |
| | Within Groups | 313.229 | 130 | 2.409 | | |
| | Total | 313.242 | 131 | | | |
| Q12 | Between Groups | 0.151 | 1 | 0.151 | 0.066 | 0.797 |
| | Within Groups | 296.478 | 130 | 2.281 | | |
| | Total | 296.629 | 131 | | | |
| Q13 | Between Groups | 0.658 | 1 | 0.658 | 0.228 | 0.634 |
| | Within Groups | 375.001 | 130 | 2.885 | | |
| | Total | 375.659 | 131 | | | |
| Q14 | Between Groups | 0.844 | 1 | 0.844 | 0.490 | 0.485 |
| | Within Groups | 223.967 | 130 | 1.723 | | |
| | Total | 224.811 | 131 | | | |
| Q15 | Between Groups | 12.128 | 1 | 12.128 | 5.834 | 0.017 |
| | Within Groups | 270.258 | 130 | 2.079 | | |
| | Total | 282.386 | 131 | | | |
| Q16 | Between Groups | 0.580 | 1 | 0.580 | 0.618 | 0.433 |
| | Within Groups | 121.936 | 130 | 0.938 | | |
| | Total | 122.515 | 131 | | | |

Table 11: Descriptive statistics as a function of race and gender.

| Question | Gender | Race/Ethnicity (N) | Mean | Std. Dev. | Question | Gender | Race/Ethnicity | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|---|
| Q1 | Male | Caucasian (25) | 3.24 | 1.451 | Q9 | Male | Caucasian (25) | 2.20 | 0.764 |
| | | LatinX (4) | 3.75 | 2.217 | | | LatinX (4) | 1.75 | 0.957 |
| | | Asian (33) | 3.52 | 1.523 | | | Asian (33) | 2.58 | 1.251 |
| | | Mixed-Race (7) | 2.71 | 0.488 | | | Mixed-Race (7) | 2.14 | 0.378 |
| | | Total (69) | 3.35 | 1.464 | | | Total (69) | 2.35 | 1.027 |
| | Female | African American/Black (2) | 3.50 | 2.121 | | Female | African American/Black (2) | 1.00 | 0.000 |
| | | Caucasian (23) | 4.13 | 1.660 | | | Caucasian (23) | 1.96 | 0.825 |
| | | LatinX (4) | 4.50 | 2.082 | | | LatinX (4) | 1.75 | 0.500 |
| | | Asian (27) | 4.37 | 1.735 | | | Asian (27) | 2.15 | 0.864 |
| | | Mixed-Race (1) | 5.00 | | | | Mixed-Race (1) | 1.00 | |
| | | Other (1) | 2.00 | | | | Other (1) | 2.00 | |
| | | Total (58) | 4.22 | 1.697 | | | Total (58) | 1.98 | 0.827 |
| | Non-binary | Caucasian (1) | 5.00 | | | Non-binary | Caucasian (1) | 1.00 | |
| | | Asian (1) | 4.00 | | | | Asian (1) | 2.00 | |
| | | Total (2) | 4.50 | 0.707 | | | Total (2) | 1.50 | 0.707 |
| | Other | Caucasian (1) | 5.00 | | | Other | Caucasian (1) | 3.00 | |
| | | LatinX (1) | 5.00 | | | | LatinX (1) | 2.00 | |
| | | Other (1) | 5.00 | | | | Other (1) | 2.00 | |
| | | Total (3) | 5.00 | 0.000 | | | Total (3) | 2.33 | 0.577 |
| Q2 | Male | Caucasian (25) | 2.20 | 0.577 | Q10 | Male | Caucasian (25) | 2.24 | 1.012 |
| | | LatinX (4) | 2.50 | 1.000 | | | LatinX (4) | 2.00 | 0.816 |
| | | Asian (33) | 2.64 | 1.655 | | | Asian (33) | 2.33 | 0.957 |
| | | Mixed-Race (7) | 2.57 | 0.976 | | | Mixed-Race (7) | 2.00 | 0.816 |
| | | Total (69) | 2.46 | 1.255 | | | Total (69) | 2.25 | 0.946 |
| | Female | African American/Black (2) | 3.00 | 0.000 | | Female | African American/Black (2) | 2.00 | 1.414 |
| | | Caucasian (23) | 3.04 | 1.224 | | | Caucasian (23) | 2.70 | 1.020 |
| | | LatinX (4) | 5.00 | 0.816 | | | LatinX (4) | 2.75 | 1.708 |
| | | Asian (27) | 3.30 | 1.564 | | | Asian (27) | 2.85 | 1.262 |
| | | Mixed-Race (1) | 2.00 | | | | Mixed-Race (1) | 2.00 | |
| | | Other (1) | 3.00 | | | | Other (1) | 2.00 | |
| | | Total (58) | 3.28 | 1.412 | | | Total (58) | 2.72 | 1.167 |
| | Non-binary | Caucasian (1) | 3.00 | | | Non-binary | Caucasian (1) | 1.00 | |
| | | Asian (1) | 3.00 | | | | Asian (1) | 1.00 | |
| | | Total (2) | 3.00 | 0.000 | | | Total (2) | 1.00 | 0.000 |
| | Other | Caucasian (1) | 3.00 | | | Other | Caucasian (1) | 5.00 | |
| | | LatinX (1) | 2.00 | | | | LatinX (1) | 2.00 | |
| | | Other (1) | 3.00 | | | | Other (1) | 5.00 | |
| | | Total (3) | 2.67 | 0.577 | | | Total (3) | 4.00 | 1.732 |
| Q3 | Male | Caucasian (25) | 3.88 | 1.536 | Q11 | Male | Caucasian (25) | 5.32 | 1.725 |
| | | LatinX (4) | 4.25 | 1.708 | | | LatinX (4) | 4.00 | 2.309 |
| | | Asian (33) | 3.33 | 1.514 | | | Asian (33) | 5.03 | 1.811 |
| | | Mixed-Race (7) | 3.86 | 1.574 | | | Mixed-Race (7) | 5.43 | 1.397 |
| | | Total (69) | 3.64 | 1.534 | | | Total (69) | 5.12 | 1.762 |
| | Female | African American/Black (2) | 3.00 | 0.000 | | Female | African American/Black (2) | 4.50 | 0.707 |
| | | Caucasian (23) | 2.65 | 1.112 | | | Caucasian (23) | 5.30 | 1.222 |
| | | LatinX (4) | 2.75 | 0.500 | | | LatinX (4) | 4.75 | 1.500 |
| | | Asian (27) | 3.11 | 1.450 | | | Asian (27) | 5.70 | 1.265 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Mixed-Race (1) | 2.00 | | | | Mixed-Race (1) | 6.00 | |
| | | Other (1) | 2.00 | | | | Other (1) | 4.00 | |
| | | Total (58) | 2.86 | 1.235 | | | Total (58) | 5.41 | 1.257 |
| | Non-binary | Caucasian (1) | 2.00 | | | Non-binary | Caucasian (1) | 4.00 | |
| | | Asian (1) | 2.00 | | | | Asian (1) | 4.00 | |
| | | Total (2) | 2.00 | 0.000 | | | Total (2) | 4.00 | 0.000 |
| | Other | Caucasian (1) | 2.00 | | | Other | Caucasian (1) | 7.00 | |
| | | LatinX (1) | 2.00 | | | | LatinX (1) | 5.00 | |
| | | Other (1) | 2.00 | | | | Other (1) | 7.00 | |
| | | Total (3) | 2.00 | 0.000 | | | Total (3) | 6.33 | 1.155 |
| Q4 | Male | Caucasian (25) | 2.84 | 1.375 | Q12 | Male | Caucasian (25) | 4.72 | 1.768 |
| | | LatinX (4) | 2.50 | 1.291 | | | LatinX (4) | 5.50 | 1.000 |
| | | Asian (33) | 2.97 | 1.704 | | | Asian (33) | 4.79 | 1.516 |
| | | Mixed-Race (7) | 1.86 | 0.690 | | | Mixed-Race (7) | 4.14 | 1.345 |
| | | Total (69) | 2.78 | 1.504 | | | Total (69) | 4.74 | 1.569 |
| | Female | African American/Black (2) | 2.50 | 0.707 | | Female | African American/Black (2) | 4.50 | 2.121 |
| | | Caucasian (23) | 2.57 | 1.532 | | | Caucasian (23) | 5.52 | 1.275 |
| | | LatinX (4) | 2.25 | 1.893 | | | LatinX (4) | 6.00 | 0.816 |
| | | Asian (27) | 2.52 | 1.122 | | | Asian (27) | 4.81 | 1.495 |
| | | Mixed-Race (1) | 1.00 | | | | Mixed-Race (1) | 6.00 | |
| | | Other (1) | 2.00 | | | | Other (1) | 4.00 | |
| | | Total (58) | 2.48 | 1.314 | | | Total (58) | 5.17 | 1.403 |
| | Non-binary | Caucasian (1) | 1.00 | | | Non-binary | Caucasian (1) | 4.00 | |
| | | Asian (1) | 1.00 | | | | Asian (1) | 3.00 | |
| | | Total (2) | 1.00 | 0.000 | | | Total (2) | 3.50 | 0.707 |
| | Other | Caucasian (1) | 6.00 | | | Other | Caucasian (1) | 6.00 | |
| | | LatinX (1) | 2.00 | | | | LatinX (1) | 6.00 | |
| | | Other (1) | 6.00 | | | | Other (1) | 7.00 | |
| | | Total (3) | 4.67 | 2.309 | | | Total (3) | 6.33 | 0.577 |
| Q5 | Male | Caucasian (25) | 2.76 | 1.012 | Q13 | Male | Caucasian (25) | 2.96 | 1.767 |
| | | LatinX (4) | 3.00 | 2.160 | | | LatinX (4) | 3.75 | 2.217 |
| | | Asian (33) | 2.91 | 1.259 | | | Asian (33) | 3.12 | 1.654 |
| | | Mixed-Race (7) | 2.43 | 0.535 | | | Mixed-Race (7) | 3.29 | 0.951 |
| | | Total (69) | 2.81 | 1.167 | | | Total (69) | 3.12 | 1.650 |
| | Female | African American/Black (2) | 1.50 | 0.707 | | Female | African American/Black (2) | 1.00 | 0.000 |
| | | Caucasian (23) | 2.48 | 0.947 | | | Caucasian (23) | 3.35 | 1.668 |
| | | LatinX (4) | 2.00 | 1.414 | | | LatinX (4) | 3.00 | 0.816 |
| | | Asian (27) | 2.70 | 0.912 | | | Asian (27) | 3.00 | 1.710 |
| | | Mixed-Race (1) | 2.00 | | | | Mixed-Race (1) | 4.00 | |
| | | Other (1) | 2.00 | | | | Other (1) | 2.00 | |
| | | Total (58) | 2.50 | 0.960 | | | Total (58) | 3.07 | 1.632 |
| | Non-binary | Caucasian (1) | 2.00 | | | Non-binary | Caucasian (1) | 4.00 | |
| | | Asian (1) | 4.00 | | | | Asian (1) | 7.00 | |
| | | Total (2) | 3.00 | 1.414 | | | Total (2) | 5.50 | 2.121 |
| | Other | Caucasian (1) | 2.00 | | | Other | Caucasian (1) | 1.00 | |
| | | LatinX (1) | 2.00 | | | | LatinX (1) | 7.00 | |
| | | Other (1) | 5.00 | | | | Other (1) | 5.00 | |
| | | Total (3) | 3.00 | 1.732 | | | Total (3) | 4.33 | 3.055 |
| | | Caucasian (25) | 4.32 | 1.626 | | | Caucasian (25) | 3.28 | 1.339 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Q6 | Male | LatinX (4) | 4.50 | 2.380 | Q14 | Male | LatinX (4) | 3.25 | 1.500 |
| | | Asian (33) | 4.18 | 1.704 | | | Asian (33) | 3.45 | 1.523 |
| | | Mixed-Race (7) | 5.29 | 1.496 | | | Mixed-Race (7) | 2.86 | 0.900 |
| | | Total (69) | 4.36 | 1.689 | | | Total (69) | 3.32 | 1.388 |
| | Female | African American/Black (2) | 4.50 | 2.121 | | Female | African American/Black (2) | 1.50 | 0.707 |
| | | Caucasian (23) | 4.57 | 1.779 | | | Caucasian (23) | 3.09 | 1.240 |
| | | LatinX (4) | 5.00 | 2.000 | | | LatinX (4) | 2.25 | 1.258 |
| | | Asian (27) | 3.63 | 1.690 | | | Asian (27) | 2.89 | 1.121 |
| | | Mixed-Race (1) | 3.00 | | | | Mixed-Race (1) | 3.00 | |
| | | Other (1) | 4.00 | | | | Other (1) | 2.00 | |
| | | Total (58) | 4.12 | 1.758 | | | Total (58) | 2.86 | 1.176 |
| | Non-binary | Caucasian (1) | 6.00 | | | Non-binary | Caucasian (1) | 3.00 | |
| | | Asian (1) | 6.00 | | | | Asian (1) | 5.00 | |
| | | Total (2) | 6.00 | 0.000 | | | Total (2) | 4.00 | 1.414 |
| | Other | Caucasian (1) | 3.00 | | | Other | Caucasian (1) | 2.00 | |
| | | LatinX (1) | 1.00 | | | | LatinX (1) | 3.00 | |
| | | Other (1) | 3.00 | | | | Other (1) | 5.00 | |
| | | Total (3) | 2.33 | 1.155 | | | Total (3) | 3.33 | 1.528 |
| Q7 | Male | Caucasian (25) | 2.92 | 1.730 | Q15 | Male | Caucasian (25) | 3.72 | 1.208 |
| | | LatinX (4) | 4.25 | 2.217 | | | LatinX (4) | 3.50 | 1.732 |
| | | Asian (33) | 2.85 | 1.698 | | | Asian (33) | 4.36 | 1.674 |
| | | Mixed-Race (7) | 2.29 | 0.488 | | | Mixed-Race (7) | 3.29 | 1.113 |
| | | Total (69) | 2.90 | 1.673 | | | Total (69) | 3.97 | 1.495 |
| | Female | African American/Black (2) | 3.50 | 0.707 | | Female | African American/Black (2) | 2.50 | 0.707 |
| | | Caucasian (23) | 2.74 | 1.685 | | | Caucasian (23) | 3.91 | 1.345 |
| | | LatinX (4) | 3.75 | 0.957 | | | LatinX (4) | 2.25 | 1.258 |
| | | Asian (27) | 3.04 | 1.531 | | | Asian (27) | 4.19 | 1.469 |
| | | Mixed-Race (1) | 2.00 | | | | Mixed-Race (1) | 3.00 | |
| | | Other (1) | 2.00 | | | | Other (1) | 3.00 | |
| | | Total (58) | 2.95 | 1.527 | | | Total (58) | 3.84 | 1.449 |
| | Non-binary | Caucasian (1) | 3.00 | | | Non-binary | Caucasian (1) | 3.00 | |
| | | Asian (1) | 3.00 | | | | Asian (1) | 6.00 | |
| | | Total (2) | 3.00 | 0.000 | | | Total (2) | 4.50 | 2.121 |
| | Other | Caucasian (1) | 3.00 | | | Other | Caucasian (1) | 3.00 | |
| | | LatinX (1) | 2.00 | | | | LatinX (1) | 6.00 | |
| | | Other (1) | 3.00 | | | | Other (1) | 4.00 | |
| | | Total (3) | 2.67 | 0.577 | | | Total (3) | 4.33 | 1.528 |
| Q8 | Male | Caucasian (25) | 2.76 | 1.012 | Q16 | Male | Caucasian (25) | 3.64 | 0.995 |
| | | LatinX (4) | 3.50 | 2.082 | | | LatinX (4) | 3.00 | 0.816 |
| | | Asian (33) | 3.27 | 1.353 | | | Asian (33) | 3.64 | 1.141 |
| | | Mixed-Race (7) | 2.71 | 1.113 | | | Mixed-Race (7) | 3.29 | 0.951 |
| | | Total (69) | 3.04 | 1.265 | | | Total (69) | 3.57 | 1.050 |
| | Female | African American/Black (2) | 5.50 | 0.707 | | Female | African American/Black (2) | 2.50 | 0.707 |
| | | Caucasian (23) | 3.04 | 1.397 | | | Caucasian (23) | 3.61 | 0.941 |
| | | LatinX (4) | 3.00 | 0.816 | | | LatinX (4) | 3.50 | 1.000 |
| | | Asian (27) | 3.56 | 1.450 | | | Asian (27) | 3.67 | 0.832 |
| | | Mixed-Race (1) | 3.00 | | | | Mixed-Race (1) | 3.00 | |
| | | Other (1) | 3.00 | | | | Other (1) | 4.00 | |
| | | Total (58) | 3.36 | 1.410 | | | Total (58) | 3.59 | 0.879 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Non-binary | Caucasian (1) | 3.00 | | | Non-binary | Caucasian (1) | 2.00 | |
| | | Asian (1) | 6.00 | | | | Asian (1) | 4.00 | |
| | | Total (2) | 4.50 | 2.121 | | | Total (2) | 3.00 | 1.414 |
| | Other | Caucasian (1) | 2.00 | | | Other | Caucasian (1) | 4.00 | |
| | | LatinX (1) | 3.00 | | | | LatinX (1) | 3.00 | |
| | | Other (1) | 4.00 | | | | Other (1) | 3.00 | |
| | | Total (3) | 3.00 | 1.000 | | | Total (3) | 3.33 | 0.577 |

Table 12: MANOVA tests of between subject effects, which indicate interaction between women of *colour* (Group 1, Group 2 and Group 3).

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Gender * Group | Q1 | 0.807 | 4 | 0.202 | 0.080 | 0.988 |
| | Q2 | 2.344 | 4 | 0.586 | 0.334 | 0.855 |
| | Q3 | 8.669 | 4 | 2.167 | 1.112 | 0.354 |
| | Q4 | 2.068 | 4 | 0.517 | 0.250 | 0.909 |
| | Q5 | 4.816 | 4 | 1.204 | 1.016 | 0.402 |
| | Q6 | 5.856 | 4 | 1.464 | 0.504 | 0.733 |
| | Q7 | 1.493 | 4 | 0.373 | 0.142 | 0.966 |
| | Q8 | 4.247 | 4 | 1.062 | 0.602 | 0.662 |
| | Q9 | 0.872 | 4 | 0.218 | 0.255 | 0.906 |
| | Q10 | 1.041 | 4 | 0.260 | 0.226 | 0.923 |
| | Q11 | 4.426 | 4 | 1.107 | 0.457 | 0.767 |
| | Q12 | 5.015 | 4 | 1.254 | 0.560 | 0.692 |
| | Q13 | 27.121 | 4 | 6.780 | 2.488 | 0.047 |
| | Q14 | 7.954 | 4 | 1.989 | 1.186 | 0.320 |
| | Q15 | 11.889 | 4 | 2.972 | 1.479 | 0.213 |
| | Q16 | 2.190 | 4 | 0.547 | 0.576 | 0.681 |

Table 13: MANOVA Tests of Between-Subjects Effects (Gender/Race)

| Source | Type III Sum of Squares | | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Gender *Race/Ethnicity | Q1 | 4.796 | 6 | 0.799 | 0.314 | 0.928 |
| | Q2 | 10.323 | 6 | 1.720 | 0.992 | 0.434 |
| | Q3 | 9.486 | 6 | 1.581 | 0.783 | 0.585 |
| | Q4 | 8.741 | 6 | 1.457 | 0.705 | 0.646 |
| | Q5 | 7.313 | 6 | 1.219 | 1.027 | 0.411 |
| | Q6 | 12.441 | 6 | 2.074 | 0.699 | 0.651 |
| | Q7 | 5.022 | 6 | 0.837 | 0.319 | 0.926 |
| | Q8 | 5.495 | 6 | 0.916 | 0.526 | 0.788 |
| | Q9 | 1.722 | 6 | 0.287 | 0.327 | 0.922 |
| | Q10 | 6.044 | 6 | 1.007 | 0.874 | 0.517 |
| | Q11 | 5.575 | 6 | 0.929 | 0.380 | 0.890 |
| | Q12 | 9.014 | 6 | 1.502 | 0.669 | 0.675 |
| | Q13 | 25.766 | 6 | 4.294 | 1.561 | 0.165 |
| | Q14 | 8.989 | 6 | 1.498 | 0.874 | 0.516 |
| | Q15 | 14.071 | 6 | 2.345 | 1.133 | 0.348 |
| | Q16 | 3.133 | 6 | 0.522 | 0.537 | 0.779 |

Table 14: Descriptive means of the participants experience with video games as a function of race/ethnicity.

| Race/Ethnicity | | Experience with computer games (N) | Mean | Std. Dev. | Race/Ethnicity | | Experience with computer games (N) | Mean | Std. Dev. |
|---|---|---|---|---|---|---|---|---|---|
| Q1. | African American/Black | Yes (1) | 2.00 | | Q9. | African American/Black | Yes (1) | 1.00 | |
| | | No (1) | 5.00 | | | | No (1) | 1.00 | |
| | | Total (2) | 3.50 | 2.121 | | | Total (2) | 1.00 | 0.000 |
| | Caucasian | Yes (32) | 3.56 | 1.684 | | Caucasian | Yes (32) | 2.03 | 0.740 |
| | | No (18) | 4.00 | 1.414 | | | No (18) | 2.17 | 0.924 |
| | | Total (50) | 3.72 | 1.591 | | | Total (50) | 2.08 | 0.804 |
| | LatinX | Yes (3) | 5.67 | 1.155 | | LatinX | Yes (3) | 1.67 | 0.577 |
| | | No (6) | 3.50 | 1.871 | | | No (6) | 1.83 | 0.753 |
| | | Total (9) | 4.22 | 1.922 | | | Total (9) | 1.78 | 0.667 |
| | Asian | Yes (36) | 3.39 | 1.661 | | Asian | Yes (36) | 2.33 | 1.095 |
| | | No (25) | 4.64 | 1.350 | | | No (25) | 2.44 | 1.121 |
| | | Total (61) | 3.90 | 1.650 | | | Total (61) | 2.38 | 1.098 |
| | Mixed-Race | Yes (6) | 2.67 | 0.516 | | Mixed-Race | Yes (6) | 2.17 | 0.408 |
| | | No (2) | 4.00 | 1.414 | | | No (2) | 1.50 | 0.707 |
| | | Total (8) | 3.00 | 0.926 | | | Total (8) | 2.00 | 0.535 |
| | Other | Yes (1) | 2.00 | | | Other | Yes (1) | 2.00 | |
| | | No (1) | 5.00 | | | | No (1) | 2.00 | |
| | | Total (2) | 3.50 | 2.121 | | | Total (2) | 2.00 | 0.000 |
| | Total | Yes (79) | 3.46 | 1.647 | | Total | Yes (79) | 2.15 | 0.907 |
| | | No (53) | 4.28 | 1.433 | | | No (53) | 2.21 | 1.007 |
| | | Total (132) | 3.79 | 1.611 | | | Total (132) | 2.17 | 0.945 |
| Q2. | African American/Black | Yes (1) | 3.00 | | Q10. | African American/Black | Yes (1) | 1.00 | |
| | | No (1) | 3.00 | | | | No (1) | 3.00 | |
| | | Total (2) | 3.00 | 0.000 | | | Total (2) | 2.00 | 1.414 |
| | Caucasian | Yes | 2.53 | 0.915 | | Caucasian | Yes | 2.59 | 1.132 |
| | | No | 2.78 | 1.166 | | | No | 2.28 | 1.018 |
| | | Total | 2.62 | 1.008 | | | Total | 2.48 | 1.092 |
| | LatinX | Yes | 4.33 | 2.082 | | LatinX | Yes | 2.00 | 1.000 |
| | | No | 3.17 | 1.329 | | | No | 2.50 | 1.378 |
| | | Total | 3.56 | 1.590 | | | Total | 2.33 | 1.225 |
| | Asian | Yes | 2.69 | 1.508 | | Asian | Yes | 2.44 | 1.107 |
| | | No | 3.28 | 1.745 | | | No | 2.68 | 1.180 |
| | | Total | 2.93 | 1.621 | | | Total | 2.54 | 1.134 |
| | Mixed-Race | Yes | 2.67 | 1.033 | | Mixed-Race. Provide text to describe. | Yes | 1.83 | 0.753 |
| | | No | 2.00 | 0.000 | | | No | 2.50 | 0.707 |
| | | Total | 2.50 | 0.926 | | | Total | 2.00 | 0.756 |
| | Other | Yes | 3.00 | | | Other - Provide text to describe. | Yes | 2.00 | |
| | | No | 3.00 | | | | No | 5.00 | |
| | | Total | 3.00 | 0.000 | | | Total | 3.50 | 2.121 |
| | | Yes | 2.70 | 1.285 | | | Yes | 2.42 | 1.093 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Total | No | 3.04 | 1.454 | | Total | No | 2.57 | 1.152 |
| | | Total | 2.83 | 1.360 | | | Total | 2.48 | 1.115 |
| Q3. | African American/Black | Yes | 3.00 | | Q11. | African American/Black | Yes | 4.00 | |
| | | No | 3.00 | | | | No | 5.00 | |
| | | Total | 3.00 | 0.000 | | | Total | 4.50 | 0.707 |
| | Caucasian | Yes | 3.44 | 1.544 | | Caucasian | Yes | 5.16 | 1.668 |
| | | No | 2.89 | 1.278 | | | No | 5.61 | 1.092 |
| | | Total | 3.24 | 1.465 | | | Total | 5.32 | 1.491 |
| | LatinX | Yes | 2.67 | 0.577 | | LatinX | Yes | 5.33 | 1.528 |
| | | No | 3.67 | 1.633 | | | No | 4.00 | 1.789 |
| | | Total | 3.33 | 1.414 | | | Total | 4.44 | 1.740 |
| | Asian | Yes | 3.33 | 1.621 | | Asian | Yes | 5.36 | 1.552 |
| | | No | 3.04 | 1.241 | | | No | 5.24 | 1.715 |
| | | Total | 3.21 | 1.473 | | | Total | 5.31 | 1.608 |
| | Mixed-Race | Yes | 4.17 | 1.472 | | Mixed-Race. Provide text to describe. | Yes | 5.67 | 1.366 |
| | | No | 2.00 | 0.000 | | | No | 5.00 | 1.414 |
| | | Total | 3.63 | 1.598 | | | Total | 5.50 | 1.309 |
| | Other | Yes | 2.00 | | | Other - Provide text to describe. | Yes | 4.00 | |
| | | No | 2.00 | | | | No | 7.00 | |
| | | Total | 2.00 | 0.000 | | | Total | 5.50 | 2.121 |
| | Total | Yes | 3.39 | 1.539 | | Total | Yes | 5.27 | 1.558 |
| | | No | 3.00 | 1.271 | | | No | 5.25 | 1.543 |
| | | Total | 3.23 | 1.445 | | | Total | 5.26 | 1.546 |
| Q4. | African American/Black | Yes | 2.00 | | Q12. | African American/Black | Yes | 6.00 | |
| | | No | 3.00 | | | | No | 3.00 | |
| | | Total | 2.50 | 0.707 | | | Total | 4.50 | 2.121 |
| | Caucasian | Yes | 2.84 | 1.417 | | Caucasian | Yes | 5.06 | 1.625 |
| | | No | 2.56 | 1.688 | | | No | 5.17 | 1.505 |
| | | Total | 2.74 | 1.509 | | | Total | 5.10 | 1.568 |
| | LatinX | Yes | 1.33 | 0.577 | | LatinX | Yes | 6.33 | 0.577 |
| | | No | 2.83 | 1.472 | | | No | 5.50 | 0.837 |
| | | Total | 2.33 | 1.414 | | | Total | 5.78 | 0.833 |
| | Asian | Yes | 2.78 | 1.436 | | Asian | Yes | 4.92 | 1.442 |
| | | No | 2.68 | 1.574 | | | No | 4.56 | 1.583 |
| | | Total | 2.74 | 1.482 | | | Total | 4.77 | 1.499 |
| | Mixed-Race. | Yes | 1.83 | 0.753 | | Mixed-Race. Provide text to describe. | Yes | 4.17 | 1.472 |
| | | No | 1.50 | 0.707 | | | No | 5.00 | 1.414 |
| | | Total | 1.75 | 0.707 | | | Total | 4.38 | 1.408 |
| | Other - Provide text to describe. | Yes | 2.00 | | | Other - Provide text to describe. | Yes | 4.00 | |
| | | No | 6.00 | | | | No | 7.00 | |
| | | Total | 4.00 | 2.828 | | | Total | 5.50 | 2.121 |
| | Total | Yes | 2.66 | 1.386 | | Total | Yes | 4.97 | 1.510 |
| | | No | 2.68 | 1.603 | | | No | 4.91 | 1.510 |
| | | Total | 2.67 | 1.471 | | | Total | 4.95 | 1.505 |
| Q5. | African American/Black | Yes | 1.00 | | Q13. | African American/Black | Yes | 1.00 | |
| | | No | 2.00 | | | | No | 1.00 | |
| | | Total | 1.50 | 0.707 | | | Total | 1.00 | 0.000 |
| | | Yes | 2.59 | 0.946 | | | Yes | 3.06 | 1.703 |
| | | No | 2.61 | 1.037 | | | No | 3.22 | 1.768 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Caucasian | Total | 2.60 | 0.969 | | Caucasian | Total | 3.12 | 1.710 |
| | LatinX | Yes | 1.33 | 0.577 | | LatinX | Yes | 4.33 | 2.517 |
| | | No | 3.00 | 1.789 | | | No | 3.50 | 1.761 |
| | | Total | 2.44 | 1.667 | | | Total | 3.78 | 1.922 |
| | Asian | Yes | 2.61 | 1.076 | | Asian | Yes | 3.08 | 1.628 |
| | | No | 3.16 | 1.106 | | | No | 3.20 | 1.893 |
| | | Total | 2.84 | 1.113 | | | Total | 3.13 | 1.727 |
| | Mixed-Race. Provide text to describe. | Yes | 2.50 | 0.548 | | Mixed-Race. Provide text to describe. | Yes | 3.33 | 1.033 |
| | | No | 2.00 | 0.000 | | | No | 3.50 | 0.707 |
| | | Total | 2.38 | 0.518 | | | Total | 3.38 | 0.916 |
| | Other - Provide text to describe. | Yes | 2.00 | | | Other - Provide text to describe. | Yes | 2.00 | |
| | | No | 5.00 | | | | No | 5.00 | |
| | | Total | 3.50 | 2.121 | | | Total | 3.50 | 2.121 |
| | Total | Yes | 2.52 | 0.998 | | Total | Yes | 3.10 | 1.645 |
| | | No | 2.92 | 1.190 | | | No | 3.25 | 1.775 |
| | | Total | 2.68 | 1.093 | | | Total | 3.16 | 1.693 |
| Q6. | African American/Black | Yes | 6.00 | | Q14. | African American/Black | Yes | 1.00 | |
| | | No | 3.00 | | | | No | 2.00 | |
| | | Total | 4.50 | 2.121 | | | Total | 1.50 | 0.707 |
| | Caucasian | Yes | 4.13 | 1.561 | | Caucasian | Yes | 3.41 | 1.341 |
| | | No | 5.00 | 1.782 | | | No | 2.72 | 1.018 |
| | | Total | 4.44 | 1.680 | | | Total | 3.16 | 1.267 |
| | LatinX | Yes | 4.33 | 2.887 | | LatinX | Yes | 2.00 | 1.000 |
| | | No | 4.33 | 2.251 | | | No | 3.17 | 1.329 |
| | | Total | 4.33 | 2.291 | | | Total | 2.78 | 1.302 |
| | Asian | Yes | 3.94 | 1.756 | | Asian | Yes | 2.94 | 1.330 |
| | | No | 4.00 | 1.683 | | | No | 3.64 | 1.381 |
| | | Total | 3.97 | 1.712 | | | Total | 3.23 | 1.383 |
| | Mixed-Race. Provide text to describe. | Yes | 5.17 | 1.602 | | Mixed-Race. Provide text to describe. | Yes | 3.00 | 0.894 |
| | | No | 4.50 | 2.121 | | | No | 2.50 | 0.707 |
| | | Total | 5.00 | 1.604 | | | Total | 2.88 | 0.835 |
| | Other | Yes | 4.00 | | | Other - Provide text to describe. | Yes | 2.00 | |
| | | No | 3.00 | | | | No | 5.00 | |
| | | Total | 3.50 | 0.707 | | | Total | 3.50 | 2.121 |
| | Total | Yes | 4.15 | 1.695 | | Total | Yes | 3.06 | 1.324 |
| | | No | 4.36 | 1.788 | | | No | 3.23 | 1.296 |
| | | Total | 4.23 | 1.729 | | | Total | 3.13 | 1.310 |
| Q7. | African American/Black | Yes | 4.00 | | Q15. | African American/Black | Yes | 2.00 | |
| | | No | 3.00 | | | | No | 3.00 | |
| | | Total | 3.50 | 0.707 | | | Total | 2.50 | 0.707 |
| | Caucasian | Yes | 2.88 | 1.680 | | Caucasian | Yes | 3.63 | 1.157 |
| | | No | 2.78 | 1.665 | | | No | 4.06 | 1.392 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Total | 2.84 | 1.658 | | | Total | 3.78 | 1.250 |
| | LatinX | Yes | 3.33 | 1.528 | | LatinX | Yes | 3.00 | 2.646 |
| | | No | 4.00 | 1.789 | | | No | 3.33 | 1.506 |
| | | Total | 3.78 | 1.641 | | | Total | 3.22 | 1.787 |
| | Asian | Yes | 2.89 | 1.600 | | Asian | Yes | 3.92 | 1.538 |
| | | No | 3.00 | 1.633 | | | No | 4.88 | 1.481 |
| | | Total | 2.93 | 1.601 | | | Total | 4.31 | 1.576 |
| | Mixed-Race | Yes | 2.33 | 0.516 | | Mixed-Race. Provide text to describe. | Yes | 3.33 | 1.211 |
| | | No | 2.00 | 0.000 | | | No | 3.00 | 0.000 |
| | | Total | 2.25 | 0.463 | | | Total | 3.25 | 1.035 |
| | Other - Provide text to describe. | Yes | 2.00 | | | Other - Provide text to describe. | Yes | 3.00 | |
| | | No | 3.00 | | | | No | 4.00 | |
| | | Total | 2.50 | 0.707 | | | Total | 3.50 | 0.707 |
| | Total | Yes | 2.86 | 1.550 | | Total | Yes | 3.68 | 1.401 |
| | | No | 3.00 | 1.617 | | | No | 4.30 | 1.501 |
| | | Total | 2.92 | 1.573 | | | Total | 3.93 | 1.468 |
| Q8. | African American/Black | Yes | 6.00 | | Q16. | African American/Black | Yes | 2.00 | |
| | | No | 5.00 | | | | No | 3.00 | |
| | | Total | 5.50 | 0.707 | | | Total | 2.50 | 0.707 |
| | Caucasian | Yes | 2.78 | 0.975 | | Caucasian | Yes | 3.50 | 0.916 |
| | | No | 3.06 | 1.514 | | | No | 3.78 | 1.060 |
| | | Total | 2.88 | 1.189 | | | Total | 3.60 | 0.969 |
| | LatinX | Yes | 3.33 | 0.577 | | LatinX | Yes | 3.00 | 0.000 |
| | | No | 3.17 | 1.722 | | | No | 3.33 | 1.033 |
| | | Total | 3.22 | 1.394 | | | Total | 3.22 | 0.833 |
| | Asian | Yes | 3.31 | 1.411 | | Asian | Yes | 3.61 | 1.022 |
| | | No | 3.64 | 1.440 | | | No | 3.72 | 0.980 |
| | | Total | 3.44 | 1.420 | | | Total | 3.66 | 0.998 |
| | Mixed-Race. Provide text to describe. | Yes | 2.83 | 1.169 | | Mixed-Race. Provide text to describe. | Yes | 3.33 | 1.033 |
| | | No | 2.50 | 0.707 | | | No | 3.00 | 0.000 |
| | | Total | 2.75 | 1.035 | | | Total | 3.25 | 0.886 |
| | Other - Provide text to describe. | Yes | 3.00 | | | Other - Provide text to describe. | Yes | 4.00 | |
| | | No | 4.00 | | | | No | 3.00 | |
| | | Total | 3.50 | 0.707 | | | Total | 3.50 | 0.707 |
| | Total | Yes | 3.09 | 1.242 | | Total | Yes | 3.51 | 0.959 |
| | | No | 3.38 | 1.471 | | | No | 3.64 | 0.982 |
| | | Total | 3.20 | 1.341 | | | Total | 3.56 | 0.967 |

| Table 15: Multivariate Tests[a] Prior Experience playing video games and race/ethnicity. | | | | | | |
|---|---|---|---|---|---|---|
| **Effect** | | **Value** | **F** | **Hypothesis df** | **Error df** | **Sig.** |
| Prior Experience Playing Video Games * Race/Ethnicity | Pillai's Trace | 0.689 | 1.089 | 80.000 | 545.000 | 0.291 |
| | Wilks' Lambda | 0.466 | 1.097 | 80.000 | 509.788 | 0.277 |
| | Hotelling's Trace | 0.854 | 1.104 | 80.000 | 517.000 | 0.265 |
| | Roy's Largest Root | 0.366 | 2.492[c] | 16.000 | 109.000 | 0.003 |

| Table 16: MANOVA tests of Between-Subjects Effects of both prior video game experience and race/ethnicity. | | | | | | |
|---|---|---|---|---|---|---|
| **Source** | | **Type III Sum of Squares** | **df** | **Mean Square** | **F** | **Sig.** |
| Prior video game experience* race/ethnicity | Q1 | 27.378 | 5 | 5.476 | 2.300 | 0.049 |
| | Q2 | 6.992 | 5 | 1.398 | 0.747 | 0.590 |
| | Q3 | 9.178 | 5 | 1.836 | 0.862 | 0.509 |
| | Q4 | 14.263 | 5 | 2.853 | 1.331 | 0.256 |
| | Q5 | 9.987 | 5 | 1.997 | 1.788 | 0.120 |
| | Q6 | 12.504 | 5 | 2.501 | 0.823 | 0.536 |
| | Q7 | 2.287 | 5 | 0.457 | 0.177 | 0.971 |
| | Q8 | 2.026 | 5 | 0.405 | 0.231 | 0.948 |
| | Q9 | 0.904 | 5 | 0.181 | 0.200 | 0.962 |
| | Q10 | 9.025 | 5 | 1.805 | 1.459 | 0.208 |
| | Q11 | 11.718 | 5 | 2.344 | 0.959 | 0.446 |
| | Q12 | 12.781 | 5 | 2.556 | 1.135 | 0.346 |
| | Q13 | 5.994 | 5 | 1.199 | 0.404 | 0.845 |
| | Q14 | 19.469 | 5 | 3.894 | 2.380 | 0.043 |
| | Q15 | 3.773 | 5 | 0.755 | 0.373 | 0.866 |
| | Q16 | 1.649 | 5 | 0.330 | 0.343 | 0.886 |

Table 17: Two-Way descriptive statistics for the prior experience with playing video games on the computer and gender.

| Question | Gender | Do you play video games on your computer? | Mean | Std. Dev. | N |
|---|---|---|---|---|---|
| Q1 | Male | Yes | 3.06 | 1.405 | 48 |
| | | No | 4.00 | 1.414 | 21 |
| | | Total | 3.35 | 1.464 | 69 |
| | Female | Yes | 3.96 | 1.895 | 28 |
| | | No | 4.47 | 1.479 | 30 |
| | | Total | 4.22 | 1.697 | 58 |
| | Non-binary | Yes | 5.00 | | 1 |
| | | No | 4.00 | | 1 |
| | | Total | 4.50 | 0.707 | 2 |
| | Other | Yes | 5.00 | 0.000 | 2 |
| | | No | 5.00 | | 1 |
| | | Total | 5.00 | 0.000 | 3 |
| | Total | Yes | 3.46 | 1.647 | 79 |
| | | No | 4.28 | 1.433 | 53 |
| | | Total | 3.79 | 1.611 | 132 |
| Q2 | Male | Yes | 2.50 | 1.305 | 48 |
| | | No | 2.38 | 1.161 | 21 |
| | | Total | 2.46 | 1.255 | 69 |
| | Female | Yes | 3.04 | 1.261 | 28 |
| | | No | 3.50 | 1.526 | 30 |
| | | Total | 3.28 | 1.412 | 58 |
| | Non-binary | Yes | 3.00 | 0.000 | 1 |
| | | No | 3.00 | | 1 |
| | | Total | 3.00 | | 2 |
| | Other | Yes | 2.50 | 0.707 | 2 |
| | | No | 3.00 | | 1 |
| | | Total | 2.67 | 0.577 | 3 |
| | Total | Yes | 2.70 | 1.285 | 79 |
| | | No | 3.04 | 1.454 | 53 |
| | | Total | 2.83 | 1.360 | 132 |
| Q3 | Male | Yes | 3.65 | 1.604 | 48 |
| | | No | 3.62 | 1.396 | 21 |
| | | Total | 3.64 | 1.534 | 69 |
| | Female | Yes | 3.11 | 1.397 | 28 |
| | | No | 2.63 | 1.033 | 30 |
| | | Total | 2.86 | 1.235 | 58 |
| | Non-binary | Yes | 2.00 | 0.000 | 1 |
| | | No | 2.00 | | 1 |
| | | Total | 2.00 | | 2 |
| | Other | Yes | 2.00 | 0.000 | 2 |
| | | No | 2.00 | | 1 |
| | | Total | 2.00 | 0.000 | 3 |
| | | Yes | 3.39 | 1.539 | 79 |

| Question | Gender | Do you play video games on your computer? | Mean | Std. Dev. | N |
|---|---|---|---|---|---|
| Q9 | Male | Yes | 2.38 | 0.959 | 48 |
| | | No | 2.29 | 1.189 | 21 |
| | | Total | 2.35 | 1.027 | 69 |
| | Female | Yes | 1.79 | 0.686 | 28 |
| | | No | 2.17 | 0.913 | 30 |
| | | Total | 1.98 | 0.827 | 58 |
| | Non-binary | Yes | 1.00 | | 1 |
| | | No | 2.00 | | 1 |
| | | Total | 1.50 | 0.707 | 2 |
| | Other | Yes | 2.50 | 0.707 | 2 |
| | | No | 2.00 | | 1 |
| | | Total | 2.33 | 0.577 | 3 |
| | Total | Yes | 2.15 | 0.907 | 79 |
| | | No | 2.21 | 1.007 | 53 |
| | | Total | 2.17 | 0.945 | 132 |
| Q10 | Male | Yes | 2.31 | 1.014 | 48 |
| | | No | 2.10 | 0.768 | 21 |
| | | Total | 2.25 | 0.946 | 69 |
| | Female | Yes | 2.57 | 1.136 | 28 |
| | | No | 2.87 | 1.196 | 30 |
| | | Total | 2.72 | 1.167 | 58 |
| | Non-binary | Yes | 1.00 | 0.000 | 1 |
| | | No | 1.00 | | 1 |
| | | Total | 1.00 | | 2 |
| | Other | Yes | 3.50 | 2.121 | 2 |
| | | No | 5.00 | | 1 |
| | | Total | 4.00 | 1.732 | 3 |
| | Total | Yes | 2.42 | 1.093 | 79 |
| | | No | 2.57 | 1.152 | 53 |
| | | Total | 2.48 | 1.115 | 132 |
| Q11 | Male | Yes | 5.27 | 1.723 | 48 |
| | | No | 4.76 | 1.841 | 21 |
| | | Total | 5.12 | 1.762 | 69 |
| | Female | Yes | 5.25 | 1.295 | 28 |
| | | No | 5.57 | 1.223 | 30 |
| | | Total | 5.41 | 1.257 | 58 |
| | Non-binary | Yes | 4.00 | 0.000 | 1 |
| | | No | 4.00 | | 1 |
| | | Total | 4.00 | | 2 |
| | Other | Yes | 6.00 | 1.414 | 2 |
| | | No | 7.00 | | 1 |
| | | Total | 6.33 | 1.155 | 3 |
| | | Yes | 5.27 | 1.558 | 79 |

| | | | | | |
|---|---|---|---|---|---|
| | Total | No | 3.00 | 1.271 | 53 |
| | | Total | 3.23 | 1.445 | 132 |
| Q4 | Male | Yes | 2.85 | 1.444 | 48 |
| | | No | 2.62 | 1.658 | 21 |
| | | Total | 2.78 | 1.504 | 69 |
| | Female | Yes | 2.29 | 1.084 | 28 |
| | | No | 2.67 | 1.493 | 30 |
| | | Total | 2.48 | 1.314 | 58 |
| | Non-binary | Yes | 1.00 | | 1 |
| | | No | 1.00 | | 1 |
| | | Total | 1.00 | 0.000 | 2 |
| | Other | Yes | 4.00 | 2.828 | 2 |
| | | No | 6.00 | | 1 |
| | | Total | 4.67 | 2.309 | 3 |
| | Total | Yes | 2.66 | 1.386 | 79 |
| | | No | 2.68 | 1.603 | 53 |
| | | Total | 2.67 | 1.471 | 132 |
| Q5 | Male | Yes | 2.71 | 1.071 | 48 |
| | | No | 3.05 | 1.359 | 21 |
| | | Total | 2.81 | 1.167 | 69 |
| | Female | Yes | 2.25 | 0.844 | 28 |
| | | No | 2.73 | 1.015 | 30 |
| | | Total | 2.50 | 0.960 | 58 |
| | Non-binary | Yes | 2.00 | | 1 |
| | | No | 4.00 | | 1 |
| | | Total | 3.00 | 1.414 | 2 |
| | Other | Yes | 2.00 | 0.000 | 2 |
| | | No | 5.00 | | 1 |
| | | Total | 3.00 | 1.732 | 3 |
| | Total | Yes | 2.52 | 0.998 | 79 |
| | | No | 2.92 | 1.190 | 53 |
| | | Total | 2.68 | 1.093 | 132 |
| Q6 | Male | Yes | 4.23 | 1.640 | 48 |
| | | No | 4.67 | 1.798 | 21 |
| | | Total | 4.36 | 1.689 | 69 |
| | Female | Yes | 4.11 | 1.750 | 28 |
| | | No | 4.13 | 1.795 | 30 |
| | | Total | 4.12 | 1.758 | 58 |
| | Non-binary | Yes | 6.00 | | 1 |
| | | No | 6.00 | | 1 |
| | | Total | 6.00 | 0.000 | 2 |
| | Other | Yes | 2.00 | 1.414 | 2 |
| | | No | 3.00 | | 1 |
| | | Total | 2.33 | 1.155 | 3 |
| | Total | Yes | 4.15 | 1.695 | 79 |
| | | No | 4.36 | 1.788 | 53 |
| | | Total | 4.23 | 1.729 | 132 |
| | | Yes | 2.90 | 1.666 | 48 |
| | | No | 2.90 | 1.729 | 21 |

| | | | | | |
|---|---|---|---|---|---|
| | Total | No | 5.25 | 1.543 | 53 |
| | | Total | 5.26 | 1.546 | 132 |
| Q12 | Male | Yes | 4.77 | 1.519 | 48 |
| | | No | 4.67 | 1.713 | 21 |
| | | Total | 4.74 | 1.569 | 69 |
| | Female | Yes | 5.29 | 1.512 | 28 |
| | | No | 5.07 | 1.311 | 30 |
| | | Total | 5.17 | 1.403 | 58 |
| | Non-binary | Yes | 4.00 | | 1 |
| | | No | 3.00 | | 1 |
| | | Total | 3.50 | 0.707 | 2 |
| | Other | Yes | 6.00 | 0.000 | 2 |
| | | No | 7.00 | | 1 |
| | | Total | 6.33 | 0.577 | 3 |
| | Total | Yes | 4.97 | 1.510 | 79 |
| | | No | 4.91 | 1.510 | 53 |
| | | Total | 4.95 | 1.505 | 132 |
| Q13 | Male | Yes | 3.17 | 1.629 | 48 |
| | | No | 3.00 | 1.732 | 21 |
| | | Total | 3.12 | 1.650 | 69 |
| | Female | Yes | 2.89 | 1.548 | 28 |
| | | No | 3.23 | 1.716 | 30 |
| | | Total | 3.07 | 1.632 | 58 |
| | Non-binary | Yes | 4.00 | | 1 |
| | | No | 7.00 | | 1 |
| | | Total | 5.50 | 2.121 | 2 |
| | Other | Yes | 4.00 | 4.243 | 2 |
| | | No | 5.00 | | 1 |
| | | Total | 4.33 | 3.055 | 3 |
| | Total | Yes | 3.10 | 1.645 | 79 |
| | | No | 3.25 | 1.775 | 53 |
| | | Total | 3.16 | 1.693 | 132 |
| Q14 | Male | Yes | 3.23 | 1.403 | 48 |
| | | No | 3.52 | 1.365 | 21 |
| | | Total | 3.32 | 1.388 | 69 |
| | Female | Yes | 2.82 | 1.219 | 28 |
| | | No | 2.90 | 1.155 | 30 |
| | | Total | 2.86 | 1.176 | 58 |
| | Non-binary | Yes | 3.00 | | 1 |
| | | No | 5.00 | | 1 |
| | | Total | 4.00 | 1.414 | 2 |
| | Other | Yes | 2.50 | 0.707 | 2 |
| | | No | 5.00 | | 1 |
| | | Total | 3.33 | 1.528 | 3 |
| | Total | Yes | 3.06 | 1.324 | 79 |
| | | No | 3.23 | 1.296 | 53 |
| | | Total | 3.13 | 1.310 | 132 |
| | | Yes | 3.83 | 1.449 | 48 |
| | | No | 4.29 | 1.586 | 21 |

| | | | | | |
|---|---|---|---|---|---|
| Q7 | Male | Total | 2.90 | 1.673 | 69 |
| | Female | Yes | 2.82 | 1.442 | 28 |
| | | No | 3.07 | 1.617 | 30 |
| | | Total | 2.95 | 1.527 | 58 |
| | Non-binary | Yes | 3.00 | | 1 |
| | | No | 3.00 | | 1 |
| | | Total | 3.00 | 0.000 | 2 |
| | Other | Yes | 2.50 | 0.707 | 2 |
| | | No | 3.00 | | 1 |
| | | Total | 2.67 | 0.577 | 3 |
| | Total | Yes | 2.86 | 1.550 | 79 |
| | | No | 3.00 | 1.617 | 53 |
| | | Total | 2.92 | 1.573 | 132 |
| Q8 | Male | Yes | 3.02 | 1.246 | 48 |
| | | No | 3.10 | 1.338 | 21 |
| | | Total | 3.04 | 1.265 | 69 |
| | Female | Yes | 3.25 | 1.295 | 28 |
| | | No | 3.47 | 1.525 | 30 |
| | | Total | 3.36 | 1.410 | 58 |
| | Non-binary | Yes | 3.00 | | 1 |
| | | No | 6.00 | | 1 |
| | | Total | 4.50 | 2.121 | 2 |
| | Other | Yes | 2.50 | 0.707 | 2 |
| | | No | 4.00 | | 1 |
| | | Total | 3.00 | 1.000 | 3 |
| | Total | Yes | 3.09 | 1.242 | 79 |
| | | No | 3.38 | 1.471 | 53 |
| | | Total | 3.20 | 1.341 | 132 |
| Q15 | Male | Total | 3.97 | 1.495 | 69 |
| | Female | Yes | 3.39 | 1.286 | 28 |
| | | No | 4.27 | 1.484 | 30 |
| | | Total | 3.84 | 1.449 | 58 |
| | Non-binary | Yes | 3.00 | | 1 |
| | | No | 6.00 | | 1 |
| | | Total | 4.50 | 2.121 | 2 |
| | Other | Yes | 4.50 | 2.121 | 2 |
| | | No | 4.00 | | 1 |
| | | Total | 4.33 | 1.528 | 3 |
| | Total | Yes | 3.68 | 1.401 | 79 |
| | | No | 4.30 | 1.501 | 53 |
| | | Total | 3.93 | 1.468 | 132 |
| Q16 | Male | Yes | 3.56 | 1.070 | 48 |
| | | No | 3.57 | 1.028 | 21 |
| | | Total | 3.57 | 1.050 | 69 |
| | Female | Yes | 3.46 | 0.744 | 28 |
| | | No | 3.70 | 0.988 | 30 |
| | | Total | 3.59 | 0.879 | 58 |
| | Non-binary | Yes | 2.00 | | 1 |
| | | No | 4.00 | | 1 |
| | | Total | 3.00 | 1.414 | 2 |
| | Other | Yes | 3.50 | 0.707 | 2 |
| | | No | 3.00 | | 1 |
| | | Total | 3.33 | 0.577 | 3 |
| | Total | Yes | 3.51 | 0.959 | 79 |
| | | No | 3.64 | 0.982 | 53 |
| | | Total | 3.56 | 0.967 | 132 |

Table 18: MANOVA Tests of Between-Subjects Effects (Gender and Prior Video Game Experience)

| Source | | Type III Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Gender * Prior experience playing video games on computer | Q1 | 3.145 | 3 | 1.048 | 0.443 | 0.723 |
| | Q2 | 2.561 | 3 | 0.854 | 0.486 | 0.693 |
| | Q3 | 1.523 | 3 | 0.508 | 0.258 | 0.855 |
| | Q4 | 5.190 | 3 | 1.730 | 0.834 | 0.478 |
| | Q5 | 5.672 | 3 | 1.891 | 1.675 | 0.176 |
| | Q6 | 1.645 | 3 | 0.548 | 0.184 | 0.907 |
| | Q7 | 0.506 | 3 | 0.169 | 0.065 | 0.978 |
| | Q8 | 5.266 | 3 | 1.755 | 0.980 | 0.404 |
| | Q9 | 2.251 | 3 | 0.750 | 0.854 | 0.467 |
| | Q10 | 3.306 | 3 | 1.102 | 0.969 | 0.409 |
| | Q11 | 5.745 | 3 | 1.915 | 0.797 | 0.498 |
| | Q12 | 1.343 | 3 | 0.448 | 0.199 | 0.897 |
| | Q13 | 6.533 | 3 | 2.178 | 0.766 | 0.515 |
| | Q14 | 5.351 | 3 | 1.784 | 1.058 | 0.369 |
| | Q15 | 4.920 | 3 | 1.640 | 0.776 | 0.509 |
| | Q16 | 2.386 | 3 | 0.795 | 0.831 | 0.479 |

Table 19: Multivariate Test for correlation between gender and video game usage.

| Effect | | Value | F | Hypothesis df | Error df | Sig. |
|---|---|---|---|---|---|---|
| Gender* Experience playing video games on your computer | Pillai's Trace | 0.240 | 0.649 | 45.000 | 336.000 | 0.961 |
| | Wilks' Lambda | 0.777 | 0.644 | 45.000 | 327.563 | 0.963 |
| | Hotelling's Trace | 0.265 | 0.639 | 45.000 | 326.000 | 0.965 |
| | Roy's Largest Root | 0.138 | 1.027[c] | 15.000 | 112.000 | 0.433 |

a. Design: Intercept + D1 + D3 + D1 * D3

b. Exact statistic

c. The statistic is an upper bound on F that yields a lower bound on the significance level.

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