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“Geeks and She-eks”: The Relationship Between Younger Women’s Experiences in Popular Geek Culture and Their Interest in STEM Fields

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ABSTRACT

"Geeks and She-eks": The Relationship Between Younger Women's Experiences in Popular Geek Culture and Their Interest in STEM Fields

Madeleine D. Butcher

There is conflicting evidence about whether women's participation in recreational, popular geek culture (e.g., gaming, fandom, science fiction consumption) can help close the gender gap in STEM fields. On one hand, these leisure activities can give women skills and experience that they can employ in STEM activities and culture. However, research also suggests that experiencing sexism while participating in geek culture activities can lower women's motivation to participate in STEM. This thesis proposed that womens' engagement in geek culture correlated with STEM efficacy and an interest in the STEM field. However, the type of experiences women have in geek culture were expected to moderate the effect of geek culture engagement on STEM-related efficacy and interest in STEM careers. Specifically, positive, affirming social experiences in geek culture were expected to enhance this effect while, negative experiences (e.g., harassment, exclusion, and sexism), were expected to decrease this effect. To test these predictions, this study employed an online survey of both MTurk users (N=77) and undergraduate university students (N=172) under the age of 30. The results showed a correlation between geek culture activities and STEM career interest with STEM efficacy acting as a mediating variable. Two conditional process models were run to examine positive and negative experiences as separate moderators of the indirect effect of geek cultural engagement on interest in STEM through self-efficacy, but neither model showed evidence that experiences moderated this effect. However, a supplemental analysis showed that positive experiences did serially mediate the effect of geek culture engagement on interest in STEM. Specifically, greater engagement in geek culture led to more positive geek culture experiences, which increased women's STEM-related efficacy and their STEM career interest in turn. A second supplemental analysis examining negative experiences and STEM-related efficacy as serial mediators was not significant. These findings suggest that women can benefit from participating in geek culture activities in terms of their efficacy and interest in STEM. These benefits are stronger when women report positive and welcoming experiences during their geek culture activities, thus increasing the importance of ensuring geek culture spaces become more inclusive and safer for all. Because negative experiences did not affect STEM efficacy and were associated with greater STEM career interest, this finding suggests that women who have negative experiences in geek spaces may have developed some resistance to toxic geek masculinity, making them able to handle some challenges they could encounter in STEM fields.

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This thesis is dedicated to the memory of my Grandma Jojo. Although I can no longer sit with you on the porch to explain what this paper means, I know that you would be excited and proud of me, which helped and will continue to help me through my academic journey and life.

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CHAPTER I

Literature has established that there is a gender gap in women's participation in the Science, Technology, Engineering and Mathematics (STEM) fields as women are often under-represented or the women who are in STEM careers are often unevenly distributed amongst the different STEM departments (National Science Board, 2020, Funk & Parker, 2018a). Evidence suggests that women are discouraged from the STEM field both by perceptions that it is male-dominated (Beasley & Fischer, 2012; Simon, Wagner, & Killion, 2016) and experiences of sexism (Leaper & Starr, 2019). Because of this gender gap within the STEM fields, there have been active efforts, both from researchers and education institutions, to understand why this gap exists and to encourage interest in STEM careers within populations of young women (Spieler, Krnjic, & Slany, 2019; Raabe, Boda, & Stadtfeld, 2019).

Encouragingly, past research suggests that there is a connection between engaging in geek-related activities and being involved in or capable of STEM pursuits (Dabney, Tai, Almarode, Miller-Friedmann, Sonnert, Sadler, & Hazari, 2012; Giammarco, Schneider, Carswell, & Knipe, 2015). Research has found that implementing geek activities into education plans or participating in geek-related hobbies both have the potential to increase women's efficacy in STEM and motivation to pursue STEM careers (Ball, Huang, Cotton, & Rikard, 2020; Spieler, Krnjic, & Slany, 2019). Based on this research, these geek culture activities could provide women with benefits towards their STEM confidence and sense of belonging in STEM fields.

However, evidence also suggests that women face sexism in geek culture from hostile members of geek communities who perceive a threat towards masculinity (Salter & Blodgett, 2017). For instance, previous studies have documented rampant harassment and exclusion of

women within gaming culture (Fox & Yen Tang, 2017; Kaye & Pennington, 2016; McLean & Griffiths, 2019). It stands to reason that this abuse could have impacts on women beyond their geek hobbies, possibly even affecting their interests in STEM fields.

The goal of this thesis is to demonstrate that womens' engagement in geek culture is positively related to interest in STEM, an effect that is mediated by increases in their self-efficacy to succeed in STEM. However, I will argue that not all of womens' experiences with geek pop culture activities will have this positive effect on efficacy and interest in STEM. Using a survey of women with social experiences in geek culture, I will test whether positive social experiences with geek activities (e.g., feeling welcome and affirmed) can increase womens' self-efficacy to succeed in STEM, while negative experiences (e.g., sexual harassment, social exclusion) can actually dampen the effect of geek engagement on womens' self-efficacy. If the findings of this thesis are supported, there will be evidence to support that geek culture activities can provide benefits to women and help close the gender gap; however, the harassment and exclusion of women in geek-related spaces could further deny them from these potential benefits and continue to fuel the existing gender gap that is present within STEM fields.

Literature Review

The Gender Gap in STEM Fields

The gender gap in STEM fields is well-established. In 2017, women only consisted of 29% of the total science and engineering workforce, despite finding that 52% of the entire college-educated workforce were women (National Science Board, 2020). In 2018, data found that 47% of the total STEM workforce consisted of women but varied on specific STEM departments (Funk & Parker, 2018a). Although women represented nearly half of life science (47%), and mathematical workers (46%), they were underrepresented in the natural sciences

(39%), and even larger gender gaps existed in computer (25%) and engineering fields (14%). Other statistics from the National Science Board (2020) showed that although women accounted for nearly half of the workforce for life sciences, psychology, and social sciences in 2017, they only accounted for 29% of workers in physical sciences, 27% of workers in computer and mathematical science, and 16% of workers in engineering.

These persistent gender disparities in STEM appear to be, in part, a product of stereotypes and social norms which reinforce both men's and women's perceptions that women do not belong in these fields. Women engineering students have reported fears of being underestimated within the field and ridiculed for their choice in career due to their gender identity (Mozahem, Ghanem, Hamieh, & Shoujaa, 2019). Similarly, Beasley and Fischer (2012) looked at factors contributing to women and minorities leaving STEM fields and found that a lack of interest in the subject matter was not the reason for attrition, but instead the belief that women are not competent in STEM was a more influential factor in their decision.

The belief that the STEM fields are not appropriate career paths for women likely stems from a broader perception that femininity is incompatible with STEM. Makarova, Aeschlimann, and Herzog (2019) found that secondary students rated chemistry, physics, and math in particular as being highly masculine, and Simon, Wagner, and Killion (2016) found that women who scored higher on ratings of femininity were less likely to major in a STEM field. This is consistent with other research which indicates that students who aspire to engage in STEM and who enact heteronormative femininity ("girly stuff" like interest in fashion and emotional engagement in relationships) encounter more challenges to their identity as scientists (Archer et al., 2012).

Notably, Simon et al. (2016) found that the "femininity penalty" only applies to women;

men who had higher ratings of femininity were not any less likely to report majoring in STEM fields. According to the authors, this finding suggests that highly feminine "girly girls" may be directed towards careers in fields considered to be more suitable for women by parents and educators. They also found that, for women who do enter the technology field, one way to achieve more success and acceptance from peers involves their ability to downplay their femininity in order to be accepted as "one of the guys." Alfrey and Twine (2017) found similar results in downplaying femininity when they found that cisgender women received more workplace benefits when they performed more gender fluidity and presented themselves as less feminine. Based on this research, one barrier for women entering and participating in STEM fields is that the current STEM culture does not accept femininity as compatible with women in STEM positions. Outright signs of femininity are punished, not by outright discrimination in this instance, but instead by challenges to their identities as scientists (Archer et al., 2012), and perceptions that others will ridicule or dismiss women in STEM fields (Mozahem et al., 2019).

Notably, this penalty associated with femininity is not only internal feelings one does not belong in STEM but also manifests in surrounding peers' perceptions that STEM and femininity do not co-exist. Past research has found that, when participants are presented with photographs of women and asked to rate each photo based on femininity, likelihood of career, and capability of career (between scientist and early childhood educator), increased ratings of femininity had negative implications for partcipant's perceptions of their capability to pursue STEM fields (Banchefsky, Westfall, Park, & Judd, 2016). The authors discuss how merely looking feminine could have negative implications for women in STEM, as femininity resulted in lower ratings of perceived capability. Depictions such as these may give women and men alike the impression that women and femininity do not belong in STEM culture. Collectively, this research creates an

argument that displays of femininity in the STEM field are punishable offenses. If there is a perception that feminine women are less capable of achieving in STEM fields (Banchefsky et al., 2016), there is the possibility of differential treatment from peers, professors, and co-workers.

The gender gap is not only a product of perception, it can also be attributed to how women are treated in STEM fields. Research suggests that women who do engage in STEM are often subjected to discrimination and harassment. Leaper and Starr (2019) found that 60% of women undergraduate students in STEM were subjected to some form of bias, where the student felt they were treated differently by instructors, classmates, or friends due to their gender, and 78% reported experiences of sexual harassment during their studies, primarily by instructors. The results found that this maltreatment was negatively correlated to their motivation to remain in the field. Similar results were found in a report of undergraduate women in physics, in which the researchers found 74.3% of participants experienced some type of sexual harassment in the last two years (Aycock, Hazari, Brewe, Clancy, Hodapp, & Goertzen, 2019). Other research found that, in 2017, 50% of the total women in STEM jobs had experienced workplace discrimination due to their gender (Funk & Parker, 2018b). The same study found that, for women whose STEM workplace consisted of mostly men, 48% reported that their gender made it more difficult to succeed in their career and for this subsection of women in STEM, 78% experienced gender-related discrimination at work.

Geek Culture and Participation in STEM

Participation in geek (pop) culture activities and interests outside of the workplace has the potential to help close the gender gap by increasing women's comfort and confidence in STEM-related pursuits. According to the Merriam-Webster dictionary (n.d.), a "nerd" is defined as an unstylish, unattractive, or socially inept person, especially one slavishly devoted to

intellectual or academic pursuits. Likewise, a “geek” is defined as 1) a person often of an intellectual bent who is disliked, 2) an enthusiast or expert especially in a technological field or activity, or 3) a carnival performer (Merriam-Webster, n.d.). The slang usage of these labels is often used to refer to people who are intelligent, but also obsessive, freakish, socially awkward, isolated, unmasculine, and unkempt. Geeks and nerds are also stereotyped as spending a great deal of time on hobbies and interests that have (at least traditionally) been considered to fall outside of mainstream social trends.

There is much overlap between stereotypical geek activities that fall under the umbrella of STEM fields (e.g., math, engineering, computer programming) and pop culture hobbies and leisure activities that people engage in for fun (e.g., reading and watching science fiction, engaging in fantasy role-playing and cosplay, and playing video games) (Salter & Blodgett, 2017). For this reason, perhaps unsurprisingly, there is also evidence that participation in geeky pop culture leisure pursuits is also associated with a greater interest in (inherently geeky) STEM-related pursuits. For instance, Dabney et al. (2012) found that students who read non-fiction and science fiction during their leisure time were significantly more likely to choose STEM careers compared to students who did not. Their results indicate that leisure interests could positively predict STEM career interest and could help increase students’ self-efficacy with STEM abilities. One way that pop culture recreational activities can encourage people to adopt STEM careers is by increasing peoples’ confidence to participate in these domains. Ball et al. (2020) provided a weeklong training to teachers to implement computer activities (e.g., digital presentations, blogging, and computer programing) and games into fourth-, and fifth-grade classrooms so the research team could explore how positive experiences could affect computer-use related stress, self-efficacy with computers, and STEM attitudes. They found that students who played video

games more frequently and had less stress about using a computer felt more capable using technology and had less negative attitudes about the STEM fields. The positive and frequent video game experiences also led to higher interest ratings in pursuing a STEM career. This research reported that students had high self-efficacy for STEM fields and STEM requirements after leisure-oriented geek activities, which provides further support that participating in leisure geek activities has to potential to provide space to practice skills that transfer to the STEM field and help bolster confidence (Dabney et al., 2012; Ball et al., 2020).

The benefits of participating in leisure geek activities may be particularly pronounced for women who, as previously discussed, are more likely to doubt their STEM-related competencies. Giammarco, et al. (2015) showed that people who reported higher motivations to engage in competitive video gaming also expressed more interest in STEM-related careers, but notably, this association was particularly strong for women. Spieler, Krnjic, and Slany (2019) created a girls-only coding week for teenage women to design and code their own mobile game. Their quantitative analysis after the "coding week" event showed that it had a positive effect on intrinsic motivation to code, high reports of self-efficacy to use the app software presented to help with coding, and the young women also reported greater interest in coding along with better knowledge of the process. Their results provide unique implications in which young women who had a shared interest in coding and video game playing were able to practice these skills around other women with similar hobbies and interests. The positive effects of geeky hobbies on girls' interest in STEM appear to be strengthened when they have female peers who share their interests (Raabe, Boda, & Stadtfeld, 2019).

Collectively, this research suggests that the more experience women have with geeky leisure pursuits the more interest and comfort they should have with STEM-related professional

pursuits. This is likely not only because women can nurture their geeky interests, geek identity, and acquire different STEM-related technical knowledge and skills through said interests and activities, but they can also gain experience navigating the social atmosphere of different geek cultures (e.g., fan communities and conventions, or gaming communities). Because, like STEM fields, these geek cultures also tend to be male-dominated and women who identify with these cultures can practice pursuing their interests in a "man's world," so to speak. However, for some women, these geek recreational experiences could have the opposite effect. If, instead of being supported in their geeky hobbies, women are undermined or harassed, these experiences could have a negative effect on their efficacy to succeed in STEM and their intentions to pursue STEM as a career.

Toxic Geek Masculinity

Like STEM fields, geek cultures tend to be white- and male-dominated. Kendall (1999) found that due to the stereotype of a nerd being a white man, many of the participants of the online forums were assumed to fit this demographic until they disclosed otherwise. However, research suggests that women and minorities are nonetheless common participants. For instance, despite the perception of all video gamers being men, in actuality, 41% of all gamers are women (Gough, 2020). Attendance at fan conventions ("cons") is evenly split between men and women, and the majority of participants who participate in serious cosplay (64%) are women (Eventbrite, 2015). If geek pop culture activities, such as gaming, are associated with greater interest in STEM (Giammarco et al., 2015), then the high participation rate of women in geek culture should be associated with higher interest in STEM fields too. Yet, as previously discussed, the statistics do not bear this out given that a wide STEM gender gap persists despite a high number of women participating in geeky recreational activities.

This raises the question of why women's involvement in geek culture does not always translate to involvement in STEM? In this thesis, I propose that the positive influence of participation in geek cultures on participation in STEM is likely conditional on the experiences women have in these cultures. Although women can potentially benefit from participating in nerdy activities and geek culture, toxic experiences of exclusion or harassment likely mitigate these positive effects. Put differently, even if women enjoy geek pop culture-related activities in their leisure, if they feel unwelcome or less competent, these perceptions should dampen their efficacy to succeed in STEM fields by extension.

One reason is that there are relatively few representations of women geeks in the media, compared to men geeks (Hamlen & Imbesi, 2020; Long, Steinke, Applegate, Lapinski, Johnson, & Ghosh, 2010), and women who are portrayed as geeks are often depicted as unfeminine and/or less endearing than their man counterparts (Blodgett, 2015; McIntosh, 2014). For instance, in an analysis of a woman geek character on the sitcom, *Big Bang Theory*, Blodgett (2015) notes how the character's lack of feminine experiences growing up is a repeated source of comedy. Taber and Woloshyn (2011) conducted a content analysis to look at the gendered differences between female and male characters in children's books that were centered around the protagonists being geeks. The authors found that female characters were depicted as either feminine, pretty, mean bullies, or nice, insecure, geeky outcasts that lacked femininity, further perpetrating the notion that girl nerds cannot be popular, feminine, or pretty. A similar dichotomy did not exist for the portrayal of the male characters. This narrative that geeky women cannot be feminine is harmful because it perpetuates the perception that geek activities and femininity cannot co-exist. Additionally, because geek women are under-represented in media representations, this may leave viewers with the impression that women are not participating in geeky activities as much

as men. These media portrayals, collectively, create a message that women and femininity are incompatible with geek culture.

Furthermore, women who do become involved with geek culture are likely to encounter sexism and hostility. Salter and Blodgett (2017) argue that geek culture is plagued by what they term, "toxic geek masculinity." Traditional toxic masculinity refers to behaviors, beliefs, and norms which are associated with masculinity but become harmful to all individuals and society due to harmful practices and emphasis on achieving these masculine traits (Sculos, 2017). Some examples of how toxic masculinity manifests include, but is not limited to: hyper-competitiveness, chauvinism, sexism, misogyny, strict concepts on sex/gender identity and roles, entitlement to attention from women, and the objectification or infantilization of women. Toxic *geek* masculinity refers to similar concerns and practices from traditional toxic masculinity but has rooted into geek culture, where these same harmful practices and emphasis on masculinity are practiced by men who feel geek culture is something created by and exclusively for other men. Some examples of this toxic geek masculinity can be seen by reports of men harassing and abusing women in online forums and gathering places for geeks (Massanari, 2017; Nic Giolla Easpaig & Humphrey, 2017), normalized aggression with online behavior (Hilvert-Bruce & Neill, 2020), repeated instances of sexual harassment or questioning of women's abilities in video gaming (Fox & Yen Tang, 2017; McLean & Griffiths, 2019; Nic Giolla Easpaig, 2018) and efforts to create a definition of "geek" that purposefully exclude women or femininity (Reagle, 2015).

Salter and Blodgett (2017) explain that men who were unable to succeed at the traditional, machismo aspects of masculinity, embraced an identity as nerds or geeks. Identifying as geeks permitted men to derive a sense of superiority through their dedication and high level of

expertise and skills in different niche, geek arenas (e.g., technology, science fiction, etc.). Identifying as a geek was also relatively exclusive because few people had this type of specialized knowledge. For this reason, geeks could reject the groups that they felt rejected by—both women and hypermasculine men (i.e., stereotypical "jocks" or "frat boys"). Salter and Blodgett (2017) argue that toxic geek masculinity arose from a sense of entitlement and territoriality that men who identify as geeks feel. To help explain why toxic geek members feel threatened by femininity in this space, Tajfel and Turner's Social Identity Theory can provide theoretical reasoning on these actions (1979).

Social Identity Theory (SIT) relies on the assumption that humans categorize other people into social groups to organize and understand their surroundings (Tajfel & Turner, 1979). SIT states that people will not only categorize others but will also use others' groups as a frame of reference for their own position within society and are constantly striving to have a positive social group identity since this will maintain one's self-esteem towards themselves and their in-group. Salter and Blodgett (2017) explain that toxic geek masculinity is a result of men feeling rejected by traditionally masculine groups. Using the lens of SIT (Tajfel & Turner, 1979), this occurred because this social group (geek men) looked to other social groups (traditionally masculine men and women) to determine their own social group's location on the social hierarchy. Because these men saw themselves as unable to fit traditional masculine roles and being lower on a social hierarchy, this created a threat to their self-esteem. SIT explains that, if an individual perceives that their social group identity is poor, that person will take measures to either leave their social group or change the situation (Tajfel & Turner, 1979). One method in doing so is social creativity, where members will reframe their own social group to put a positive light on an element of their social group that may have been stigmatized in the past. To rectify

their low social group identity, the men who could not fill those traditional masculine roles formed their own social group revolving around geek culture, as a way to reclaim power and masculinity through their geek-related knowledge and by distinguishing a separate social group of similar individuals. This action would result in boosting in-group self-esteem, as these members are creating their own social group and redefining what makes a person powerful and masculine within their group.

However, many activities that white male geeks once staked a claim to as their own have become increasingly mainstream. Over the past few decades, aspects of geek culture that were formerly only accessed by people with high levels of technical knowledge or interest have become available to anyone with Internet access. For instance, before the widespread adoption of the Internet, "hardcore fandom" was limited to a relatively small number of people who participated in activities such as attending fan conventions, but now virtually anyone can engage in hardcore fandom by participating in online fan communities or distributing fan fiction online. Now, almost anyone can teach themselves coding, play role-playing games online, or obsessively research a science fiction story. As geek culture becomes accessible to more individuals, SIT predicts that toxic geek members look at their social group and compare it to other similar groups to establish their self-esteem and their location on a social hierarchy, which in this instance is women geeks (Tajfel & Turner, 1979). The social group of women geeks now presents two threats to geek men: femininity, which opposes this group's reclaimed geek masculinity, and, as indicated by SIT, a lower-ranking social group that is attempting to reclaim similar resources and treatment that the higher social groups receive. As a result of the increasing popularity of these activities, more women and minorities identify as fans, gamers, and geeks, posing a threat to geek masculinity (Salter & Blodgett, 2017).

In response to this threat, men who identify as geeks often engage in gatekeeping to exclude people who do not fit the traditional image of geeks. Tajfel and Turner (1979) explain that, for social groups that are near the top of social hierarchies, any lower-ranking groups attempting to receive similar treatment or additional resources are seen as a threat towards the top members' current resources and status quo. Social group members at the top of social hierarchies will respond to this threat in an attempt to maintain the current status quo. With the increase in accessibility to geek culture, this perceived threat to toxic geek members' resources can be seen by women geeks going to more geek culture activities, redefining terms that were used to segregate them (girl gamers, geeky girls, etc.), or by the inclusion of women characters in popular geek media (Blodgett & Salter, 2018a; Blodgett & Salter, 2018b). When these perceived threats occur, toxic geek members will result in gatekeeping to ensure their social group and its resources are protected.

Toxic members will set rules that derogate women and minorities to determine who is "truly a geek," a "real fan," or a "serious gamer," versus "a poser." In one example of this sort of identity policing, Blodgett and Salter (2018a) provide an analysis of two recent geek-related films (*Star Wars: The Last Jedi* and *Marvel: Black Panther*) which featured non-white or non-male lead characters. The researchers looked at back-lash that the films received from male fans, including rejection of the film as a part of the franchise history and petitions to revoke the plot from being canon, racist language towards the cast and supporters, and online groups to combat against the inclusion of "SJW messages" in fandom stories (Blodgett & Salter, 2018a). The researchers explain that this specific occurrence can be used as a symbol for what is happening with geek fandoms as well. This instance provides an example of how this toxic geek masculinity can create specific rules to exclude others when the threat of femininity is presented

to their interests. For instance, women who identify with the new woman lead in the latest Star Wars movie and express these notions are now deemed " not true fans" by toxic members who reject the film as a part of the history of the franchise since it does not resemble their version of a "traditional Star Wars" (for having a female lead). This can now occur even if women meet other criteria such as devoting time to it, being a fan for multiple years prior, or identifying as a fellow Star Wars geek. This is one example of geek men using the ambiguous definition of "geek" to their advantage in order to protect their social group and the status quo.

In a similar analysis, Salter and Blodgett (2018b) examined the comment section of the 2017 *Ghostbusters* movie trailer that featured an all-female cast there is, again, an instance in which a traditional piece of geek media (the original *Ghostbusters* film) was recreated and introduces elements of femininity by recasting an all-female cast. The researchers explain that, because the film received internet backlash for the casting choices, they were able to look at how toxic geek masculinity manifested within alt-right members' comments on the online trailer. Two main themes that contribute to the purposes of this research were that the men used the comment section to express vivid anti-feminism remarks (such as claiming that feminism ruins classic series), and contained sexist/misogynistic comments about the actors and fan base of the movie. These themes found within the analysis are representative of the toxic concerns within geek culture and the methods used to ensure toxic geek member's social group remains intact. Similar to the study in the paragraph above, this expression of sexism and misogyny paired with the retaliation against new geek-related media that features women creates an unwelcome environment for women and newcomers and allows for gatekeeping by distinguishing that this version of *Ghostbusters* is not the "real" *Ghostbusters*.

This gatekeeping and specific rules of what makes a person an authentic part of the geek

community presents a significant problem when toxic members can select criteria to choose who is and is not accepted within. Since women present an inherent threat by introducing femininity into this space, toxic members can easily exclude women by using whatever criteria they deem to be salient (e.g. “she doesn’t have the knowledge, she doesn’t like the right fandom, or she’s a newb”). SIT explains that toxic geek members would perceive this new social group of women geeks as a threat to their social group’s current location on the top of the hierarchy, and thus use gatekeeping strategies to distinguish the differences between the two social groups and rationalize that women do not deserve the same resources. They deny that they are intentionally excluding women, instead insisting that the exclusion is because she is “simply not a true geek.”

Another method used by toxic men in geek culture to protect their space is out-right harassment and abuse towards women. Within an online gaming forum, researchers analyzed the methods in which geeks debated the topic of sexism in gaming (Nic Giolla Easpaig, 2018). The analysis found a reoccurring theme in which gamers on this forum, when confronted with the notion that sexism and harassment occur in the community, would repeatedly defend the notion that these victims of harassment must have been interpreting competition as harassment. In addition to defending the idea that the harassment victims were not understanding the situation, the analysis found additional themes in which the gamers on the forum would continually defend that only “real women gamers” should have their claims of harassment and sexism taken seriously and that, the people who are complaining about the sexism and harassment must not be “real gamers” (Nic Giolla Easpaig, 2018). This literature begins to show how harassment of women in geek and nerd culture (Nic Giolla Easpaig, 2018; Salter & Blodgett, 2017; Rott, 2014) and sexist and misogynistic language towards other members or public symbols of femininity (Byerly, 2020; Blodgett & Salter, 2018a) has become common, especially within the popular

geek activity of gaming. Additionally, it is not purely acts of aggression towards women, as research had found that, specifically within gaming, general aggression is expected and normative in these spaces (Hilvert-Bruce & Neill, 2020). Instead, it is sexist aggression in which the perpetrators will emphasize the victim's gender in their efforts of harassment or abuse (Fox & Yen Tang, 2017). An argument can be made that this treatment of women becomes normative as it is reoccurring in the literature, unchallenged by the majority of the community, and women take safety measures of avoiding this treatment before it happens (Nic Giolla Easpaig, & Humphrey, 2017, Byerly, 2020), thus harassment and abuse towards women becomes the unfortunate status quo.

Toxic geek masculinity is particularly prevalent in the gaming community, a geeky subculture where women struggle for acceptance and legitimacy. As Paaßen, Morgenroth, and Stratemeyer (2017) explain, there is a pervasive chauvinism to gaming that can be seen in the discrepancy between gamer identity and femininity; gamers are often forced to choose between being a "gamer" or "feminine". This separation of female or femininity and gaming is seen within other literature as well (Kaye & Pennington, 2016) where researchers found that women who were reminded of the stereotype of women being bad at gaming performed worse than the control - with the exception of the women who were told they were an exception to this stereotype since they were "gamers", who then outperformed both the stereotype and control conditions. This separation of female or femininity and gaming could be the product of gatekeeping from other members of the gaming community and feeling separated from the core community. Looking specifically at the eSports community, Paaßen et al. (2017) found that besides game difficulty, time investment, self-identification, and skill level, being a man was a criterion that gamers used when determining a person's gamer identity or identity as a fellow

gamer. Not only do women have difficulty being regarded as legitimate gamers, but they are also met with suspicion. Nic Giolla Easpaig and Humphrey (2017) found women in gaming were often faced with suspicion about their intentions, often being accused of playing games to meet men or of actually being men but just posing as a woman.

Furthermore, several studies have also documented how people who identify as women (or are suspected of being women) are harassed in community gaming spaces. Since gaming is a geek-related activity, SIT states that these toxic members will be looking to other social groups to establish their in-group's social location and self-esteem (Tajfel & Turner, 1979). When presented with an increase of women gamers, who represent femininity and a threat to the current perceived status quo, toxic members feel the need to react to protect their social group's current position on top, which results in harassment and sexism. One now infamous example of toxic geek masculinity was #Gamergate, in which, women game developers were specifically targeted with a campaign of doxing and rape and death threats from anonymous harassers opposed to the influence of women in the gaming industry (Massanari, 2017; Rott, 2014). Other forms of gaming harassment include sexist comments to suggest superiority over women and characterizing women as manipulative (hostile sexism), sexist comments that are patronizing, imply that women are fragile, and that they need to be protected by men (benevolent sexism), and suggestive or discriminating comments about completing sexual acts, about their bodies, or unwelcome advances (sexual harassment) (Yen Tang & Fox, 2016). Although some aggression is par for the course in competitive gaming spaces (Hilvert-Bruce & Neill, 2020), the harassment women experience is uniquely sexist. As Yen Tang and Fox explain, although some hostility can be explained as a byproduct of competition, because the harassment of women persists for women in games that focus on collaboration too, this suggests that women are targeted because

of their sex and femininity.

Harassment for women in gaming is not limited to the type of genre, but instead to the fact that the player identifies as a woman and represents a threat to geek masculinity in gaming. Notably, men are not the only ones to harass women in these spaces. Nic Giolla Easpaig and Humphrey (2017) found that some women (participants in their study labeled them, "Queen Bees") embraced toxically masculine behaviors in gaming, such as bullying and harassing other women, gamers with lower skills, and overall hyper-competitiveness, so that these women could better fit in with the perception of gamer identity and with the established groups of gaming men.

Womens' Responses to Toxic Geek Masculinity

Research on how women respond to toxic geek masculinity has primarily focused on womens' experiences in gaming spaces. Women gamers attempt to cope with online harassment with tactics such as including playing with individuals they are familiar with to avoid strangers (McLean & Griffiths, 2019), disguising their gender identity by not using online chat or changing online avatars (Nic Giolla Easpaig & Humphrey, 2017; McLean & Griffiths, 2019), choosing to participate in the activities while denying the identity and title of being "a gamer" (Paaßen, et al., 2017, Yodovich, 2016), or withdrawal from the game entirely (Fox & Yen Tang, 2017). These coping strategies tend to conceal womens' presence in gaming communities and feminine presence remains invisible (Kendall, 1999; Nic Giolla Easpaig & Humphrey, 2017; Orme 2016; Paaßen et al., 2017). For instance, if the women who are playing video games choose to disguise their avatars, opt-out of voice chat, claim they are "not really gamers" in an effort to avoid criticism and harassment, or lie when confronted about their gender identity, the assumed stereotype that they are men (until proven otherwise) persists.

Research has found that withdrawal from gaming was not impacted by general "trash-

talking" about the person's skill level, but withdrawal was significantly impacted by sexual harassment received by other players (Fox & Yen Tang, 2017). These findings suggest that women are not withdrawing from games due to competitive talk, aggressive "trash-talk", or disinterest, but that specific instances of sexual harassment that is used to target and exclude women. The authors found that women gamers even expected or assumed there would be aggression in these online spaces; however, the sexist aggression and sexual harassment caused women gamers to withdraw. McLean and Griffiths (2019) discuss this harassment towards women in their qualitative study of women gamers' experiences with online harassment and their methods of social support. They found women reporting lack of social, emotional, and instrumental support from other gamers, stress, anxiety, and insecurity from this lack of support and harassment, and required them to hide their gender in online platforms or seek groups to play with that they knew outside of the game (McLean & Griffiths, 2019).

Toxic Geek Experiences and Interest in STEM

However, the ill-treatment women receive in gaming spaces may not only adversely affect their willingness to participate in certain gaming activities, but could also have more far-reaching implications on their career interests and ambitions more broadly. Looking back at the series of studies conducted by Fordham, Ratan, Huang, and Silva (2020), the research team wanted to find out how stereotype threat impacted participants' gameplay and if this could extend into their perceptions of women in STEM fields. To test this, the research team conducted two studies (the method of the second study will be described as it was an extension on study 1's small sample size and sample pool of solely female participants) in which they randomly assigned participants in 2x2 experiments to receive either subtle or blatant stereotype threats and either a female or male opponent in the game. Pre- and post-tests were then used to measure

game performance and perceptions of men and women in STEM. They found that women who received blatant stereotype threats had worse game performance and reported that they believed men are better suited for STEM fields compared to women; furthermore, participants who believed their opponents were men rated that STEM fields were better suited for men compared to women more so than participants who believed their opponent was a female. Although it is unclear how long-lasting these effects are, these findings strongly suggest that the quality of womens' experiences in geek culture—the extent to which they are or are not exposed to toxic geek masculinity, can have an influence on their STEM-related ambitions.

Predicted Model

Research shows that there is a gender gap in STEM pursuits (Funk & Parker, 2018a). Reasons for this gap include (but are not limited to STEM being perceived as masculine, and unfeminine pursuits (Makarova et al., 2019; Simon et al., 2016; Mozahem, et al., 2019), the widespread patterns of abuse and harassment towards women in these fields (Aycock et al., 2019; Funk & Parker, 2018b; Leaper & Starr, 2019), and women a sense of lacking efficacy and belonging in STEM (Beasley & Fisher, 2012).

Womens' participation in geek cultural activities may help close the STEM gender gap by improving their confidence to engage in STEM pursuits (Giammarco et al., 2015). After all, there are many cultural and knowledge overlaps between geek culture and STEM (Dabney et al., 2012; Hosein, 2016; Salter & Blodgett, 2017). By gaining experience in one, women should feel more confident about their ability to succeed in the other. For this reason, the following hypotheses are proposed:

H1: *There will be a positive association between engagement in geek culture and interest in STEM.*

H2: *Self-Efficacy to succeed in STEM will mediate the relationship between engagement in geek culture and interest in STEM.*

Finally, although engagement in geek culture can potentially provide valuable experiences for women, that can increase their STEM-related efficacy, this effect is likely contingent on how positive or negative these experiences are. Past research found that gaming had a positive influence on interest in STEM careers for women and that there were benefits to gain from positive experiences when participating in geek culture (Giammarco et al., 2015). Furthermore, research has found higher ratings of STEM efficacy when women were provided a positive environment to participate in geek activities (Spieler et al., 2019). SIT indicates that one's perceptions of their social group are formed by comparison to other social groups and will help form self-esteem and ego, therefore, if women have positive and welcoming experiences from other social groups in these geek environments, it is likely to increase their perception of their in-group belonging in that geek culture and spaces similar, like STEM careers (Tajfel & Turner, 1979). Accordingly, this thesis predicted the following:

H3: *The indirect effect of geek culture engagement on STEM interest will be moderated by the positivity of experience, such that the more positive their experiences are the more they should benefit from these experiences (i.e., higher STEM-related efficacy and thus higher interest in STEM careers). The more positive their experiences in geek culture, the more women will have STEM-related efficacy and interest in pursuing STEM as a career.*

However, research has also found when women were presented with negative stereotype threat while gaming it led to poor performance within the game and, ultimately, negative perceptions of women's belongingness in STEM pursuits (Fordham et al., 2020). This suggests

that women can receive benefits towards their STEM aspirations when there are positive experiences related to their geek activities; however, maltreatment from the geek community (e.g., harassment, exclusion, condescension), may mitigate the effects of positive experiences or perhaps even lessen womens' efficacy and interest in STEM as a career. It is possible that, upon receiving negative feedback from similar social groups in geek spaces, women will receive feedback on their own social group that they do not belong or are not welcome, thus negating the potential benefits and further harming women's perception of their in-group belonging in geek spaces and STEM fields. Thus, the final hypothesis is proposed:

> **H4**: *The indirect effect of geek culture engagement on STEM interest will be moderated by the negativity of experience, such that only women who report more negative experiences will receive fewer benefits from their engagement (i.e., less STEM-related efficacy and thus less interest in STEM careers). The more negative their experiences in geek culture, the less women will have efficacy and interest in pursuing STEM as a career.*

Figure 1 and Figure 2 display the models predicted in H3 and H4, respectively.

Figure 1. Proposed Model for Hypothesis 3

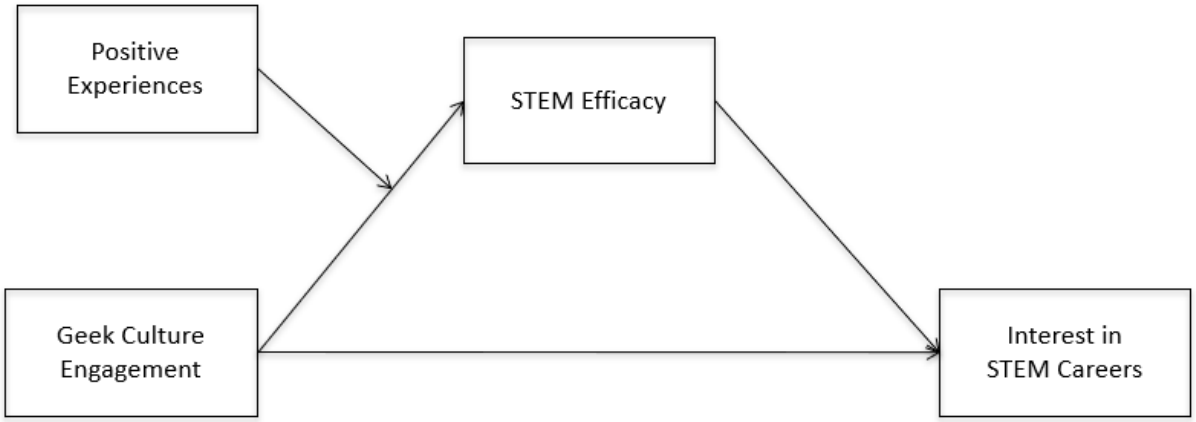
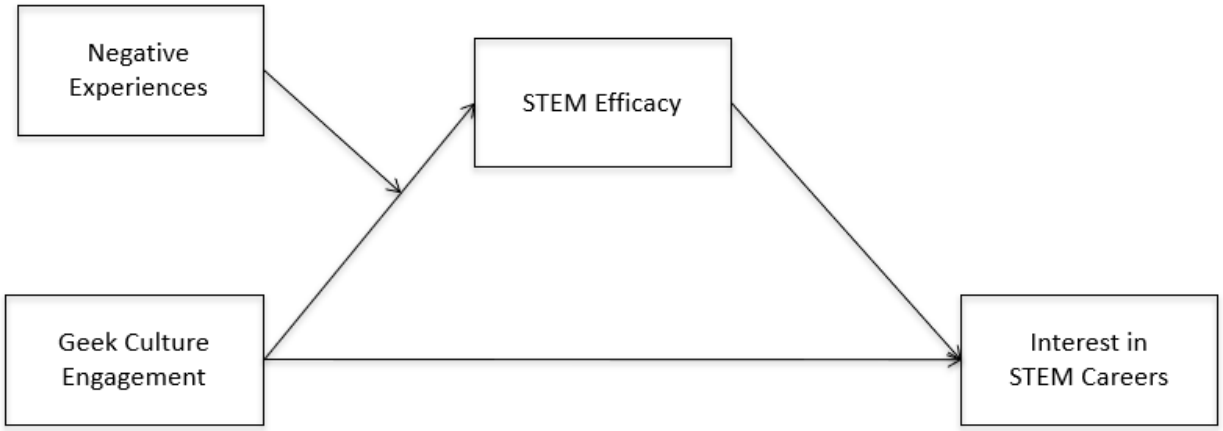


Figure 2. Proposed Model for Hypothesis 4



CHAPTER II

Method

Recruitment and Participants

In an effort to increase the demographic diversity of the respondent pool, participants were recruited from both introduction communication courses offered at a large mid-Atlantic university, and the online crowdsourcing service, Amazon's Mechanical Turk.[1] Only women were invited to participate in this research; however, no screening questions were included within the actual survey. Additionally, because this study sought to learn about the experiences of individuals who were more likely to still be in the process of contemplating and choosing career paths, a relatively younger adult sample of participants (between the age of 18 and 29) was specifically targeted. A total of 463 participants were recruited, however only a little more than half of these respondents were eligible to be included in the final analyses. Eighteen respondents who did not complete a majority of the survey were omitted from the final sample. Additionally, despite efforts to restrict recruitment to younger women, 96 respondents who reported identifying as a man or were over the age of 30 were also omitted. Finally, and notably, 99 women—nearly a 3rd of the younger women, sampled reported that they had not had any

[1] MTurk provides a crowdsourcing marketplace for companies to out-source virtual tasks that require human intelligence, such as data validation, market research, surveys, or content moderation (Amazon Mechanical Turk). This platform allows for anyone to sign-up as a MTurk worker, select and complete online tasks in exchange for financial compensation (Amazon Mechanical Turk, n.d.). Goodman and Paolacci (2017) looked at trends within research that used MTurk to collect their data and provides guidelines on how to collect data in a manner that is ethical, effective, and to minimize validity threats. One guideline, which was followed within the data collection, indicates using the quality filers to require workers meet a 95% approval standard based on their past tasks. Although the researchers found that MTurk participants in the meta-analysis tended to be younger (29-35 age range), more educated, and lower income, other research has found that the participants tend to be more representative of the US population compared to college samples, in-person samples, or other online sources (Owens & Hawkins, 2019) and was racially similar to the general population (Burnham, Le, & Piedmont, 2018).

social experiences in geek culture. Because these women could not report on the positivity or negativity of their experiences in geek culture, they were also removed from the sample in the final analyses. This left a final sample of 249 (university students, *N* = 172; MTurk, *N* = 77).

All participants identified as cisgender women, a majority of them reported their race as White/Caucasian (78.7%), and the average age of the sample was 21.78 (*SD* = 3.002). The sample was well educated. A majority of participants had some college education (54.6%), a bachelor's degree (17.7%), and an overwhelming majority of these respondents (93.2%) indicated that they were seeking or had plans to seek some higher education. Of the participants who had some college education or greater, a fifth of them (20.4%) were in or pursuing a STEM-related area of study[2]. Other areas of study that were represented amongst participants with some or more college education included 18.9% in healthcare fields, 16.9% in business fields, 13.4% in communication studies, and 12.5% in psychology or other social science fields.

Procedure

Once the study received acknowledgment by the Institutional Review Board (IRB) at West Virginia University, an advertisement was posted to MTurk to begin the participant recruitment from the MTurk population (see Appendix B). A link for the survey was also posted to an online undergraduate research subject recruitment board hosted by the University's communication department. A limiter was placed on the MTurk advertisement, such that only workers who were registered as women aged 18-29 were able to see the advertisement and participate in the research, and the advertisement posted to the undergraduate research opportunity board requested that only women volunteer to participate. Research has found that

[2] STEM related studies were limited to Natural Science fields, Technology, Engineering, and Mathematic fields and did not include other science fields such as the social sciences (psychology, communications, etc.) or medical fields (nursing, physical therapy, etc.).

questions regarding participants' social groups can introduce stereotype threat effects (Danaher & Crandall, 2008). To avoid stereotype threat effects associated with women and geek activities or STEM pursuits, screening questions were not included within the survey. To avoid self-selection, both advertisements were framed as a research survey to learn more about the leisure activity and career preferences broadly. Once participants selected the survey on MTurk or the department webpage, a link to a Qualtrics-hosted survey was provided. The first page of the survey contained a cover letter to describe the study and the respondents' rights as participants (see Appendix A for cover letter wording). If the participant agreed, they proceeded to complete an online questionnaire containing questions that measure their engagement with geek-related activities, the positivity and negativity of their geek culture experiences, their STEM-related efficacy, their interest in pursuing STEM, and, at the end of the survey, general demographics (additional measures will be included within this research for supplemental analyses if needed; all of the items included on the questionnaire can be found in Appendix D). The study took approximately 10-15 minutes to compete. MTurk workers, who complete at least 90% of the questionnaire, were compensated 80 cents. Undergraduate students were given course credit in exchange for participation.

Measures

Engagement in Geek Culture. This study employed the 14-item Geek Engagement Scale – Short Form (GCES-S; McCain, Gentile, & Campbell, 2015) to measure what geeky hobbies, interests, and activities participants engage in. Some examples of survey activities include engaging with science fiction or tabletop roleplaying games. In an effort to obtain an even more comprehensive view of participants' involvement in geek culture, an additional 17 geek activity items were created for this study (e.g., computer programming for fun). Participants

were asked to indicate the frequency that they have participated in each activity using a seven-point scale ranging from 1 (Not at all) to 7 (Frequently). Three factors emerged from a principle components factor analysis of all 31 items but only one had factor loadings exceeding .600. After five items with cross-loadings across the three factors were removed, the analysis showed that the remaining 26 items loaded on a single factor, with factor loadings ranging between .632 and .854. The average of participants' responses to these items was used to form a single, index of geek cultural engagement (M = 1.71, SD =.84, McDonald's ω = .97).

Positive and Negative Experiences in Geek Culture. Because this study is concerned with the quality of womens' *social* experiences in geek culture (rather than their solitary geek experiences), after answering questions about their geek activities, survey respondents then asked to consider all the geek activities they've participated in and estimate how social these experiences have been on a whole, on a scale of 1 – "Not at All Social", to 7 – "Extremely Social" (M = 4.32, SD =1.83). If participants did not have any social geek experiences, they were asked to select an 8th answer option. Only participants who indicated that they at least had some social geek experiences were asked to indicate their response on a 5-point scale (1 = Not at All; 3 = Sometimes; 5 = Frequently) to a series of 22 items created for this study, which inquired about how often they had a variety of positive and negative social experiences while engaging in geek activities. Some examples of positive experiences include feeling welcome, being complimented on your skills or abilities, and being made to feel to belong. Some examples of negative experiences included: being discriminated against because of your sex or gender, having your skills insulted, and feeling threatened. Two mostly distinct factors emerged from an exploratory, principle axis factor analysis, however, two items had cross-loadings with a difference that was less than .50. Once these items were deleted, a second principle axis factor analysis revealed two

distinct positive and negative dimensions with factor loadings ranging from .639 to .822. From this, two scales were constructed. A negative experience scale was calculated from the mean of participants' responses to 15 items (M = 2.43, SD =.92, McDonald's ω = .943), and a positive experience scale was calculated from the mean responses to 5 items (M = 3.33, SD =.85, McDonald's ω = .87). A paired samples t-test showed that the positive experiences (M = 3.32) was significantly greater than the negative experiences (M= 2.43), $t(247) = 10.78$, $p < .001$.

STEM-Related Efficacy. Participants' sense of success self-efficacy with STEM was measured using created for this study. Participants indicated their agreement with 7-statements about their ability to succeed on STEM-related tasks and in STEM settings given the resources and background, on a seven-point scale ranging from 1 (Disagree Strongly) to 7 (Strongly Agree). Some sample items include, "Even if STEM-related theories and concepts are difficult to understand, I am capable of learning them", "I know that I can succeed in a STEM-related culture", and "If I set my mind to it, I can perform well on STEM-related tasks". A composite score was created from the scores on all of these items. Higher scores will be indicative of greater efficacy (M = 4.40, SD =1.51, McDonald's ω = .94).

Interest in STEM. To measure STEM interest, participants were asked to respond to a 3-item measure created for this study that asks them to indicate how much they agree with statements about them being interested in STEM careers. This measure consisted of the following items: "I am interested in having a career that is rooted in natural science, technology, engineering, or mathematics now or in the future", "It is likely that I will pursue an educational degree or a career rotted in natural science, technology, engineering, or mathematics (or complete a degree that I am currently pursuing in this area)", and "I think I would enjoy working in natural science, technology, engineering, or mathematics in the future". Respondents indicated

how much they agree with these statements on a seven-point scale ranging from 1 (Disagree Strongly) to 7 (Strongly Agree), (M = 3.45, SD =2.00, McDonald's ω = .95).

CHAPTER III

Results

Preliminary Analyses

Zero-order correlations and descriptive statistics were run between the 5 variables of interest. The results are displayed in Table 1. There was a positive correlation between geek cultural engagement and both negative experiences, $r(248) = .441$, $p<.001$, and positive experiences, $r(248)= .193$, $p=.002$. Furthermore, participants who reported greater amounts of geek culture engagement also reported higher amounts of perceived STEM efficacy, $r(247) = .275$, $p<.001$, and interest in pursuing STEM careers, $r(248) =.408$, $p<.001$. There was no relationship between positive social geek experiences and negative experiences, $r(248) = -.088$, $p=.167$. Positive experiences were positively correlated with STEM efficacy, $r(247)=.194$, $p =.002$, but they were unrelated to interest in STEM careers, $r(248) = .109$, $p=.087$. Negative experiences, however, were unrelated to efficacy $r(247) = -.001$, $p=.994$, but positively related to interest in STEM careers, $r(248) = .130$, $p = .04$.

Table 1.
Zero-Order Correlations

Variables	1.	2.	3.	4.	5.
1. Geek Culture Engagement	-	.441***	.193**	.275***	.408***
2. Negative Experiences		-	-.088	-.001	.130*
3. Positive Experiences			-	.194**	.109
4. STEM Efficacy					.615***
5. Interest in STEM					-
M	1.71	2.44	3.33	4.40	3.44
SD	0.84	0.92	0.85	1.51	2.00

*Note. *p<.05, **p<.01, *** p<.001*

Two *t*-tests showed that participants recruited on MTurk differed from participants recruited from the college sample in a couple of notable ways. Because Levene's test indicated

that variances were unequal, the degrees of freedom for these tests were adjusted from 247 to 95, and from 247 to 108, respectively. The participants in the MTurk sample reported engaging in more geek activities (M = 2.27, SD = 1.07), compared to participants in the college sample (M = 1.56, SD = 4.56), $t(95) = 6.21$, $p < .001$. On average, the MTurk sample was also older (M = 26.26, SD = 2.40) than the college sample (M = 20.23, SD = 1.62), $t(108) = 16.76$, $p < .001$. Because of these differences, the sample source (MTurk or college campus) was entered as a control variable in each analysis.

Hypotheses Tests

Hypotheses 1 – 4 predicted that womens' participation in geek activities would be associated with an increased interest in STEM careers, an effect that would be mediated by increased feelings of efficacy to succeed in STEM. But the effect of geek activities on efficacy was expected to be moderated by the quality of their experiences. Positive, affirming experiences were expected to increase the effect of geek activities on STEM efficacy, while negative, hostile experiences were expected to decrease the effect of geek activities on efficacy. Two conditional process models (corresponding with Figures 1 and 2) were run to examine these predictions. In each case, the PROCESS macro for SPSS (version; Hayes, 2018) was used to run model 7 with 10,000 bootstrap samples for percentile bootstrap confidence intervals. Sample source was included as a control variable in both models.

In support of H1, the direct effect of geek activities on interest in STEM careers was significant in both models (c' = .6139, SE = 1297, $p < .001$, CI: .3584, .8693). H2 predicted that this effect would be mediated by increased STEM-related efficacy, but H3 and H4 predicted that this mediated effect would be conditional on the quality of women's experiences with geek culture activities. However, the index of moderated mediation (IMM) was not significant in

either model, indicating that the indirect effect of geek activities on STEM interest through efficacy was not conditional on either good experiences (IIM = .0128, $_{Boot}$CI: -.1707, .1890), nor bad experiences (IIM = .0652, $_{Boot}$CI: -.0601, .1910). Thus, H3 and H4 were not supported. To directly examine H2, a separate PROCESS Model (Model 4) was run with 10,000 bootstrap samples, controlling for sample source, to examine whether STEM-related efficacy mediated the relationship between geek activities and STEM career interest. In support of H2, this indirect effect was significant (*ab* = .2820, *SE* = .0689, CI: .1518, .4225); participation in geek activities was associated with increased STEM-related efficacy (*a* = .3891, *SE* = .1215, *p* = .002, CI: .1497, .6285) and in turn, STEM-related efficacy was associated with increased interest in STEM careers (*b* = .7248, *SE* = .0669, *p* < .001, CI: .5930, .8566).

Supplemental Analyses

The logic of this thesis's predictions has been premised on the assumption that womens' participation in geek pop culture activities should be tied to their STEM efficacy, but that the strength of this relationship would be conditional on—moderated by, how positive or negative their social experiences were with these activities. The results did not bear these models out, however. In hindsight, it seems possible that conceptualizing the quality of women's experiences as a moderator was inaccurate. However, although the positivity and negativity of women's geek experiences do not affect the strength of the relationship between geek activities and STEM efficacy, it stands to reason that instead, positive and negative experiences could *explain* part of the reason that there is a relationship between geek activities and efficacy. Put differently, the quality of experiences women have might not change the relationship between geek activities and STEM efficacy, but it may determine why this relationship occurs. Women who engage in geek culture and have positive experiences should have increased STEM-related efficacy as a

result. However, women who participate but have more negative experiences should have decreased STEM-related efficacy. To examine, this possibility, and test whether positive and negative experiences mediate the relationship between geek activities and STEM efficacy, two serial mediation models (PROCESS Model 6) were run with 10,000 bootstrapped samples. These two models were nearly identical, differing only in regard to whether positive experiences or negative experiences were included as a mediator. Participation in geek activities (X) served as the independent variable, and interest in STEM careers (Y) was entered as the dependent variable. In one model, positive experiences (M1) and STEM-related efficacy (M2) were entered as serial mediators. In the second model, negative experiences (M1) and STEM-related efficacy (M2) were entered as serial mediators. Once again, sample source was included as a control variable.

The results revealed a significant indirect effect of participation in geek activities on interest in STEM careers through positive experiences and STEM-related efficacy. As illustrated in Figure 3, greater participation in geek cultural activities is associated with having more positive geek-related experiences, and this leads to increased STEM-related efficacy and interest in STEM careers, $a_1db_2 = .0529$, $_{Boot}SE = .0221$, $_{Boot}$CI: .0137, .1009. Negative experiences and STEM-related efficacy, however, did not serially mediate the effect of geek engagement on STEM career interest, $a_1db_2 = .0529$, $_{Boot}SE = .0221$, $_{Boot}$CI: .0137, .1009. Although geek engagement was positively associated with negative experiences $a = .5685$, $SE = .0688$, $p < .001$, CI: .4330, .0740, these bad experiences had no bearing on STEM-related efficacy, $d = -.2171$, $SE = .1125$, $p = .0547$, CI: -.4837, .0044.

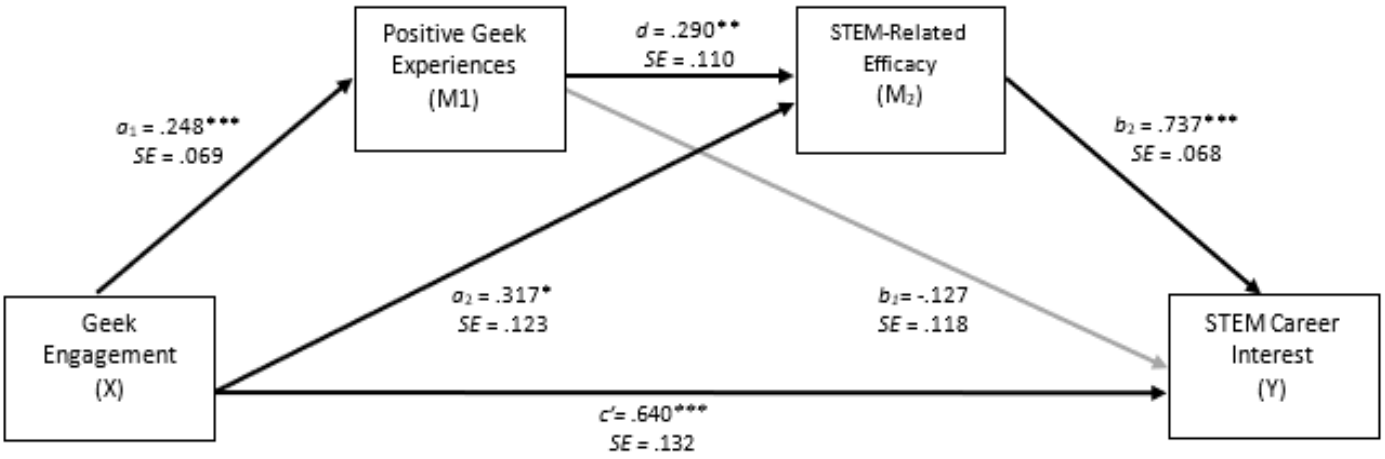


Figure 3. Unstandardized regression coefficients and standard deviations for the relationship between geek pop culture engagement and interest in STEM careers, as serially mediated by positive geek experiences and STEM-related efficacy. Sample source was included as a control variable. Statistically significant paths are illustrated in bold. *$p < .05$, ** $p < .01$, *** $p < .01$

CHAPTER V
Discussion

There is an established gender gap present within the STEM fields (Funk & Parker, 2018a; National Science Board, 2020). The attrition of women appears fueled by penalties against femininity and sometimes even harassment (Alfrey & Twine 2017; Beasley & Fischer, 2012; Simon et al., 2016). These barriers can prevent or deter women from participating or feeling capable of succeeding in STEM careers, which is a concern as this closes the door for careers that women could enjoy and deprives the STEM workplace of their input and contribution (Bert, 2018). This thesis proposed that engagement in geek culture could positively or negatively influence women's self-efficacy and interest in STEM careers fields depending on the positivity of their leisure experiences. These benefits were expected to be stronger if women have positive, supportive experiences in geek culture. However, drawing from past literature which has demonstrated that women are often harassed in geek cultures (McLean & Griffiths, 2019; Yen Tang & Fox, 2016) it was expected that women reporting negative experiences in geek culture will lack these benefits and have decreased ratings in their STEM self-efficacy and, by extension, STEM career pursuits.

As predicted, there was a positive association between geek culture engagement and interest in STEM, and this relationship was mediated by STEM-related self-efficacy. Past research supports these findings. For instance, Dabney et al. (2012) found that students who were non-fiction and sci-fi readers showed significantly more interest in STEM career pursuits compared to students who did not participate in these leisure activities. Furthermore, Giammarco et al. (2015) found a relationship between the motivation to play competitive games and interest in STEM careers, a relationship that was stronger for women. These findings underscore the contribution of leisure activities to women's interest in STEM careers. The results also establish

increased STEM-related efficacy as an explanation for why geek cultural engagement is related to interest in STEM. This echoes the results of Ball et al.'s (2020) study, which found that engaging in computer activities including video gaming for entertainment was positively correlated with interest in STEM, and this effect was mediated by computer-task self-efficacy. Similarly, Spieler et al. (2019) found that participating in a game coding camp increased young girls' coding self-efficacy and interest in coding. However, this study stands somewhat apart from both of these studies, which examined the effects of educational interventions on efficacy, by providing evidence that geek engagement can positively impact STEM-related efficacy, even outside of formal educational contexts.

Broadly, these findings highlight how leisure, "geeky" activities—even those done voluntarily for fun, can shape career ambitions by increasing confidence to succeed. The specific nature of this confidence boost, however, may be worth exploring. The measure of efficacy used in this study contained items that tapped into two potential sources of efficacy: womens' confidence to perform well on STEM-related tasks, and also their confidence to successfully navigate STEM culture. Thus, is possible that geek pop culture experiences help increase women's efficacy because they provide technical experience with the subject areas or tools necessary for their desired STEM field, or that their experiences help them feel more comfortable in a related, predominantly male-dominated field. Geek engagement could conceivably enhance STEM-related efficacy for one or both of these reasons, but additional research will be needed to explore what exactly it is about these experiences that is the most beneficial in this regard.

Past research has often tended to focus on women's negative experiences in geek culture (e.g., Fox & Yen Tang, 2017; Kaye & Pennington, 2016; Paaßen et al., 2017). Thus, a notable

contribution of the current research is its focus on the role of both positive and negatives experiences. However, contrary to the initial predictions, neither positive nor negative experiences moderated the indirect effect of geek engagement on STEM interest. However, in hindsight, the role of these experiences may have been misconceptualized as a moderator variable. Instead of examining the interaction between positive and negative experiences and STEM-related efficacy, supplemental analyses considered the possibility that these experiences could mediate the relationship between geek pop culture engagement and STEM-related efficacy. That is, rather than considering the quality of women's experiences as moderators of the effect of geek engagement on STEM-related efficacy, they were instead examined as a possible cause or *source* of efficacy. These analyses showed that increases in STEM-related efficacy could indeed be attributed to positive social experiences within geek culture. A reason that engagement in geeky pop culture activities can enhance women's STEM-related efficacy and interest in STEM careers is because they have positive, affirming social experiences which make them feel more confident in their abilities to succeed in the other male/masculine-dominated "geeky" arena of STEM. This implies that the positivity of women's experiences in geek pop culture matters, not only because women should be safe and welcome in their leisure pursuits, but because these positive experiences are associated with higher STEM efficacy and career interest.

These findings indicate that how women are treated in their leisure, recreational pursuits can have important consequences for their willingness to engage in other, professional-track arenas. Specifically, the results indicate that what geeky women do for fun, can have real (positive) implications for closing the STEM gender gap, provided that they feel supported and accepted. These results are important since the impacts of pop culture and entertainment can

often be underestimated. Cohen, Atwell Seate, Anderson, and Tindage (2017) discuss both the stigmatization of sci-fi fans and the underestimation in pop culture influence within their study of social stigma between sci-fi fans and sports fans. In their experiment, participants read a description of a fan's leisure activities, with adjustments to only change the fan's pronouns and if their activity was sci-fi or sports-related. Afterwards, participants were asked to complete a survey gauging the described fan's social, physical, and task attractiveness. They found that sci-fi fans were judged to be less physically and socially attractive compared to sports fans. The perception for female sci-fi fans was less strong, yet the authors discuss that women may be presented with a double edge sword of receiving the negative stigma for being a sci-fi fan while not being entirely included in geek culture. This research helps support that pop culture and entertainment should not be overlooked within research, since, specifically, geek pop culture involvement is associated with negative stigmas from others and could result in marginalization from others (Cohen et al., 2017). Pop culture involvement, especially geek pop culture, can present a situation in which individuals are stigmatized for their leisure pursuits and, with the findings of this thesis, can influence one's sense of efficacy and interest towards career pursuits.

When women have more engagement with geek pop culture at fan conventions, in online discussions, or even while playing games, they are also more likely to have experiences that make them feel welcome and competent, and this sense of belonging in geek-related spaces can translate into more confidence towards STEM activities. This correlation can be utilized to help women's STEM efficacy and career interest by fostering welcoming geek environments and ensuring all feel accepted. While a portion of these findings indicate that simply participating is correlated with increases in STEM efficacy and interest, positive experiences in geek pop culture led to more benefits. Women are not only spending their time enjoying these leisure activities but

could also prepare themselves for skills or social experiences that would likely occur in STEM careers. For instance, a woman who attends board game night and has a neutral experience with other community members still has the potential to walk away with benefits towards STEM efficacy and interest. It is possible that playing and learning a complicated board game helps one feel more confident towards learning new mathematic concepts. Now if she attends a board game night and receives welcoming comments and positive feedback from other community members, there is additional reassurance present. This additional reassurance could translate into higher confidence in both her technical abilities to learn new mathematic concepts, but also that other community members agree on her ability and that she belongs. This social implication is important because it means that women participating in the activities they enjoy, such as gaming live streams, board games, watching anime, or other geek pop culture activities, have the potential to gain benefits towards their ability to tackle something bigger than their hobbies: STEM careers.

Although it is encouraging that positive geek social experiences are associated with STEM-related efficacy, this might not be the status quo within women's geek experiences. A masculine, toxic culture is pervasive in many geek spaces (Fox & Yen Tang, 2017; Nic Giolla Easpaig & Humphrey, 2017; Salter & Blodgett, 2017) and this might discourage women from participating in these activities. Furthermore, women who do participate often disguising their gender identities as a method of protection from abuse, which results in an underrepresentation of femininity within these spaces (Nic Giolla Easpaig & Humphrey, 2017; Orme 2016). This, combined with the underrepresentation of geek femininity in media portrayals (Blodgett, 2015; Hamlen & Imbesi, 2020; Taber & Woloshyn, 2011), may give many women the impression that they should not participate in geek activities.

And yet, an unexpected finding from this thesis is that negative social experiences in geek culture (i.e., hostility and sexism) were unrelated to STEM-related efficacy and STEM career interest. Past research indicates that negative experiences such as the use of sexist or misogynist language can be fairly common in geek spaces, especially in the online atmosphere where toxic members can remain anonymous (Blodgett & Salter, 2018a; Byerly, 2020). Furthermore, benevolent sexism and sexual harassment have become common in geek spaces as well (Nic Giolla Easpaig, 2018; Salter & Blodgett, 2011; Rott, 2014). Encouragingly, however, this study's findings suggest that even if women have negative experiences and face resistance to their participation in geek-related activities, this does not necessarily have a negative impact on their efficacy or deter them from engaging with STEM. It is possible that the initial hypothesis of negative geek experiences decreasing STEM efficacy and STEM interest was not supported as it was based on past literature regarding gaming and STEM career interest (Fordham et al., 2020; Kaye & Pennington, 2016) as opposed to geek activities as a whole and STEM career interest. Fordham et al. (2020) found that negative stereotype threat during gaming was associated with less STEM career interest and the perception that women were less capable of STEM careers. Because this study was focused on a person's total geek engagement as opposed to specifically gaming, it is possible that receiving negative experiences and harassment in other social geeks areas (cosplaying, online forums, board game playing, etc.) do not have the same negative effect that Forham et al. (2020) found. One intriguing possibility for why negative experiences did not affect STEM-related efficacy is because the women reporting on these social experiences were somewhat inoculated to any ill-treatment they experienced (at least in terms of their efficacy). In the case of gaming, at least, research suggests that women often continue to engage in geek spaces despite sexist treatment (McLean & Griffiths, 2019), when employing various coping

strategies such as finding their safe communities to play with or disguising their gender identity, but still chatting virtually (McLean & Griffiths, 2019; Nic Giolla Easpaig & Humphrey, 2017). There is even research that suggests women will cope by adopting characteristics of toxic masculine members to better fit in with them, which becomes problematic when these women will then display hostility and harassment to other women in order to be remain accepted by the toxic members (Nic Giolla Easpaig & Humphrey, 2017). While this practice is not ideal as it continues to perpetuate harm to other women, it is still an important coping mechanism to analyze. By "practicing" ways to deal with the toxic geek masculinity they encounter, these women may be able to buffer against any negative effects that these experiences could have on their sense of efficacy.

Notably, however, because negative experiences were not positively correlated with efficacy, there is no evidence that these experiences empowered women and gave them greater confidence to engage in STEM. However, interestingly, these negative experiences were correlated with interest in STEM careers, suggesting that at the very least the women reporting greater negative experiences might be imbued with some sort of resistance to the negativity. It appears that women who have negative experiences in geek culture leave the situation with their STEM efficacy untouched but have a higher interest in STEM career fields. For better and worse, these experiences make women better equipped to shrug off hostility and criticism. This correlation is not affecting women's efficacy to succeed at STEM tasks but perhaps increases motivation to learn more about STEM career fields as they feel more tolerant of the hostility they have already encountered. Women may not necessarily feel more or less confident in their ability to succeed in STEM, but they may nonetheless be comfortable with their ability to exist in a toxic geek space to continue persisting in STEM career fields. To present a hypothetical: A

woman who is harassed on an online discussion forum about her favorite fandom may not feel any more or less capable to do STEM tasks like calculating equations or designing lab experiments; however, she may feel able to persist the hostility in this discussion forum and translate that into the ability to do so in STEM fields. In fact, there is evidence, that in some cases stereotype threat can enhance individuals' performance in spite of the stereotype. For instance, one study found that that a math-related stereotype threat had no effect on participants taking a mathematic examination when it was presented as a challenge as opposed to a test (Atler, Aronson, Darley, Rodriguez, & Ruble, 2010). This suggests that individuals can be motivated to overcome a perceived self-stereotype if it's viewed as a challenge. Additionally, Deshayes, Zory, Seitchik, Chalabaev, and Clément-Guillotin (2020) found that, when women were presented with negative stereotype threat regarding a physical endurance task, they actually had improved performance compared to a nullified stereotype threat group and the control group. Similarly, Shih (2004) found that, amongst successful individuals who belonged to stigmatized groups, a commonality amongst successful individuals was gaining empowerment through stigma instead of coping behavior. Collectively these findings support the notion that, possibly, the women who received negative experiences in geek culture experienced no effect on their STEM technical efficacy, but resulted in higher interest rates in STEM due to resilience and gaining a sense of empowerment from the negative treatment of others. This does not, of course, imply that all women who endure toxic geek masculinity will have an increased interest in STEM. The sample of this study consisted of women who had social geek experiences—many of whom likely persisted despite their negative experiences. Women with less experience engaging in popular geek culture may be less tolerant. However, from this data it can be concluded that, at least among women with social experience in geek culture, not only do the negative, often sexist,

experiences they encounter within these domains not discourage them from STEM, it may build their level of tolerance—or perhaps even motivate them to challenge a negative stereotype, thereby reinforcing their interest.

At first glance, this finding is both encouraging and discouraging. The discouraging part is the possibility that these same negative experiences have already deterred some women from further participation in geek culture or that this coping strategy is necessary at all. The encouraging portion of this finding is that, even if women are faced with negative experiences in geek culture, it seems that members who engage often build a resilience to this treatment and further increases their interest in STEM options. Combined with the findings for positive experiences and STEM interest, this is positive news. Women who engage in STEM activities are bound to have a mixture of positive and negative experiences over time. The overall findings of this thesis indicate that positive experiences are going to increase their STEM efficacy and STEM interest, thus encouraging more women into the workforce and help close the gender gap. For women who engage and have negative experiences, they regrettably will miss the benefits associated with positive experiences; however, do not walk away with zero benefits. Women with negative geek experiences still walk away from the environment with greater interest in STEM career options. It is possible that, through these negative experiences, women develop coping strategies to navigate the hostile environment. Although the need to develop a "thick skin," so to speak not ideal, it is somewhat reassuring that women who have negative experiences during geek leisure activities may instead be taking something away from the experiences as opposed to negative effects on their STEM efficacy or interest. Both of these findings highlight once more that collecting data about positive and negative interactions help to understand a more realistic perspective of participant's experiences. Highly involved individuals

are likely to have more of both positive and negative experiences and these experiences are not isolated from one another, thus both should be included to understand the full picture of participants' experiences.

Limitations and Directions for Future Research

While this thesis provides valuable data about how positive experiences in geek-culture activities can positively influence STEM career interests, no research is without limitation or opportunity for future improvement. A substantial limitation of this study is its reliance on two convenience samples, one from Amazon's MTurk and another consisting of university students. Compared to the general population, both of these samples were highly educated, more technologically savvy, and possibly even more "geeky," with and a greater proclivity and greater access to resources needed to participate in STEM activities. Thus, the findings here may not generalize to younger women in the population at large, who, it stands to reason, may have more sociocultural or socioeconomic barriers to popular geek culture and STEM culture alike.

Relatedly, because this thesis was exploring questions about the summation of women's social experiences with geek culture activities, the sample was necessarily limited to participants who had these experiences. For this reason, the findings are also not generalizable to participants who have not had prior geek-related social experiences. It is currently unknown if women who are less active with geek-related activities would receive the same benefits from their positive experiences.

This thesis focused solely on the experiences of women within geek culture engagement and the sample collected was mostly white. The experiences of women of color were beyond the scope of the research, yet is an important direction for future research as their experiences are likely to be different due to the intersectionality of their race and gender. Research has found that

stereotypes of geeks being white men who are good at computers could serve as a stereotype threat related barrier towards Black and Hispanic participant's interest in computer-related careers (Kendall, 2011). Furthermore, research supports that stereotype threat associated with race and STEM activities positively relates to attrition rates and can serve as a general deterrent towards STEM careers (Beasley & Fischer, 2012). It is likely that women of color's experiences in geek culture are impacted both by their gender and race, which can further impact their STEM efficacy and STEM interest. Furthermore, an analysis of young viewers' reactions to *Black Panther* revealed that, despite having fewer representations of geek figures that share their race, this movie resulted in increases in well-being, empowerment, and identification with the protagonist for Black and African American children (González-Velázquez, Shackleford, Keller, Vinney, & Drake, 2020). This area of research deserves further exploring as people of color, specifically Blacks and Hispanics, remain underrepresented in geek culture, the STEM fields, and their experiences remain unexplored in comparison to academic literature about White people's experiences (Funk & Parker, 2018a, Kendall, 1999; Kendall, 2011; National Science Board, 2020; Salter & Blodgett, 2017). This proves problematic as a full understanding of how positive and negative experiences influence people of color and women of color's STEM efficacy and STEM interest is not understood and is not being utilized. Future direction could apply a similar methodology, of researching both positive and negative experiences in geek culture influencing STEM efficacy and STEM interest, to help understand how women of color's intersectionality creates a different experience than the findings of this thesis.

Because this thesis was exploring geek pop culture engagement as a general cultural concept, one limitation of this study is it cannot speak to the type of geek activities or the types of positive experiences that are most conducive to raising interest in STEM through STEM-

related efficacy. The measures used for engagement and experience positivity were selected to cover the broad range of geek engagement topics and potential experiences that participants had, both positive and negative. It is possible that certain geek activities help women feel more prepared and efficacious than others, but the scales used in this thesis could not distinguish between different geek engagement activities. The Geek Culture Engagement Scale (McCain, Gentile & Campbell, 2015) provides a comprehensive list of geek-related activities, including watching anime, interest in making or using robots, or attending renaissance fairs, but can complicate findings as there is no delineation between the different types of activities or frequency of participation. Thus, the correlations of this thesis were between total engagement in all activities and the participant's overall experience positivity. In other words, it was not activity-specific. Future research should further investigate the different activities listed with this measure and how they correlate with STEM efficacy and interest. It is very possible that the activities listed vary in their association with STEM efficacy and interest, in that some activities are bound to result in higher STEM efficacy. For instance, women who attend a welcoming after-school robotics club could report higher STEM efficacy compared to data collected from an equally welcoming sci-fi book club. In this hypothetical, both clubs are supporting geek leisure activities, providing social experiences in geek areas, and could lead to higher interest in STEM careers, but a robotics club is likely to include more technical skills that could further increase STEM efficacy more so than sci-fi reading. Future research is recommended to explore these different geek-related activity types to see the unique contributions each one could make towards closing the STEM gender gap.

Similar to the geek engagement measure, the experience measure is limited in its ability to provide insight into the influence of specific types of experiences. The items used to measure

a participant's positive or negative interactions within geek culture included items gauging their positive experiences such as "felt welcome" to "received compliments" and negative experiences such as "felt sexually harassed" to "made to feel excluded". While these options are representative of both positive and negative experiences that could occur for participants, the differences between being sexually harassed and feeling excluded are, needless to say, dramatically different and could have varying effects on women's attitudes about engaging in STEM. For instance, women participating in a mathematics team in college that receive positive comments about their ability to calculate equations would, hypothetically, have high STEM efficacy and interest as they are receiving feedback on their good performance; however, women participating in the same team who feel respected by the team but are not receiving that feedback may warrant a different efficacy rating. Similarly, women who receive negative comments about their cosplay may be able to "brush off" the negative experience; however, women who report sexual harassment from others may find a more difficult time coping. This research was intended to gather preliminary data into the broad relationship between the positivity of geek culture activities and STEM career interests, and these broad measures helped accomplish this purpose. However, a direction that future research should consider is to look closer at specific types of positive or negative experiences to see if the same relationship between experience and STEM efficacy occurs. Targeting specific geek activity groups to learn more about women's experiences in said groups could be a helpful means towards this end.

Because this study employed a cross-sectional survey casual relationships between the variables cannot be inferred. This thesis theorizes that young women's recreational pursuits with geek pop culture can enhance their STEM-related efficacy and career interest, provided that they have positive experiences. However, it is perhaps equally likely that the time-order of these

relationships is reversed, and women's efficacy and interest in STEM motivates them to engage in geek pop culture activities. In future studies, longitudinal methods such as a series of surveys administered over time could help to establish the directionality of these relationships, by determining if, for instance, if *after* participating in certain geek activities, STEM-related efficacy and interest increases. The use of experimental methods could also aid efforts to establish a causal link between women's experiences in popular geek culture and perceptions of their ability and desire to succeed in STEM. For instance, future experiments could start with participants who are randomly assigned to describe either a positive or negative experience they have encountered within geek culture spaces or a control group where no description is necessary. This would allow for three separate conditions (positive description, negative description, control) to be analyzed and learn more about how their recollections of the experiences could influence their perceptions of their own ability and desire to pursue STEM fields.

Research on the negative experiences that women in geek culture have often paints a grim picture for the women who may want to engage in geek activities; however, hope is not lost. From the lens of Social Identity Theory (SIT; Tajfel & Turner, 1979), toxic geek men represent the dominant social group within geek culture: white men. This group holds the top of the social hierarchy and receives benefits like more resources, media representation, and feeling positive about one's social identity. Since femininity and women joining geek activities presents a threat to the current status quo of geek men being at the top of the hierarchy, there are active efforts to try and exclude and harass women out of the space altogether. SIT presents two actions that lower social groups, in this instance geeky women, can attempt better their situations: social creativity and social competition. The method of social creativity allows lower social groups to

redefine aspects of their group that were once prescribed to be negative (Tajfel & Turner, 1979). Social competition involves actively working to ensure that the lower social group will receive similar resources, finances, and media representation as the top social group. For example, cosplay (a.k.a. costume play) is considered a geek activity in which members create and wear intricate costumes of their favorite media characters, primarily attending conventions to meet other cosplayers and media fans. Hills (2017) explains that, while toxicity could still exist at these conventions, cosplay allowed for the flexibility for women to redefine characters to add femininity or fashion a feminine costume of masculine heroes that dominate the geek sphere. Furthermore, when issues arose of cosplayers being sexually harassed or touched in their costumes, many cosplayers banded together to start the "Cosplay is NOT consent" movement to empower others to speak against and even change convention rules and regulations to ban sexual harassment or racist behaviors. Although there are still reports of toxic behavior and sexual harassment towards cosplayers, it stands to reason that these actions of social creative by changing beloved masculine characters to embrace femininity or redefining the term "Girl geek" to a positive spin can assist this social group. Furthermore, socially competing for more media representation of women in geek roles, new rules and regulations at conventions to prevent sexual harassment, and overall banding together with other geeky women might help claim a stake in geeky environments. These are encouraging possibilities that also stand to be investigated by future research.

Finally, the results of this study pave the way for some interesting lines of future research inquiry. For instance, the finding that negative experiences in popular geek culture were unrelated to STEM-related efficacy but positively related to STEM-career interest suggests that these experiences could potentially influence women's motivations to pursue STEM through

some other variable not examined in this research. Future research should further explore these phenomena since it could help to better understand how these negative experiences may build resilience within women and almost reaffirm that their motivations. It is possible that, for women who have a lot of experience in geek culture, the negative treatment from toxic members does not affect them anymore. If the harassment and negative treatment are common, highly involved women may be better able to brush off the harassment in a manner that does not influence their STEM efficacy. In fact, it may even reinforce their identity as a "geeky girl," further confirming to them that they fit STEM career paths. If the harassment and negative treatment are normative in geek culture and STEM workplaces, then it is possible that highly involved women in geek spaces recognize the mistreatment in one space and feel a motivation to go succeed and prove toxic men wrong in STEM workplaces too. Additionally, even if women are receiving negative treatment from others during their geek culture engagement, those women are still receiving the benefits of their leisurely pursuit. Hypothetically, if someone enjoys coding and receives negative treatment from the geek community about it, the findings support the notion that she will still enjoy her leisure pursuit of coding and be interested in pursuing it as a career. Future research should further explore this seemingly contradicting relationship to find out why women who receive negative treatment display higher interests in STEM. A future study could implement measures on perceptions of social identity groups (for geeks and STEM fields) or competitiveness. If participants are highly competitive and are confronted with negative treatment within geek spaces, it is possible that competitiveness would drive a higher interest in STEM for women who already felt efficacious enough to handle STEM tasks. Furthermore, if a participant views geek culture identity groups and STEM identity groups similarly and receives

harassment in one, they may feel interest in STEM fields since they have previously survived and succeeded in geek spaces.

Conclusion

This thesis is representative of the complex problem of women being underrepresented within STEM career fields. In 2017, women consist of over half of the educated workforce, yet less than 30% of the total science and engineering workforce were women workers (National Science Board, 2020). This dilemma has multiple factors influencing women's decision to pursue the STEM fields, including the perception that STEM is incompatible with femininity (Simon et al., 2016; Banchefsky et al., 2016), the fear of ridicule, or outright harassment (Mozahem et al., 2019; Leaper & Starr, 2019). Not only are women deterred from a career in which they could enjoy, but it represents a larger concern where this gender gap results in STEM fields losing women's perspective and idea generation which contributes to an existing gender bias found in STEM research, where participants and products tend to be designed for men (Bert, 2018).

As organizations and researchers attempt to find ways to increase young women's interest in STEM careers, a special emphasis should be made on supporting and creating opportunities for women to participate and join geek-related activities. The findings of this thesis indicate that there is a relationship between spending time on geek culture activities and interest in STEM careers. Even if women's geek experiences are negative, it appears that they can nonetheless cultivate their STEM career interest. More importantly, when these experiences are positive and welcoming, women receive the most benefits towards their STEM efficacy and STEM interest. These pop culture experiences could be advantageous in helping close the gender

gap, especially if there are efforts to ensure that women truly feel accepted and welcome in these spaces.

Notably, when trying to understand the experiences of underrepresented social groups, academic literature tends to focus on collecting data regarding their negative experiences and how it can impact participant's attrition rates, motivation, or interest (Beasley & Fischer, 2012; Makarova et al., 2019); however the findings of this thesis emphasize the importance of measuring both the positive and negative experiences. These findings imply that highly involved women are likely to face more negative and positive experiences, which would make theoretical sense as they are exposed to more geek culture than others. If this research were to narrow on only the influences of participants' negative experiences, our findings regarding the benefits associated with positive, welcoming experiences would be lost. Thus, an important finding that contributes to helping close the STEM gender gap would remain undiscovered and unutilized. One takeaway from these findings is incorporating both the positive and negative experiences of underprivileged groups in order to gain a broader picture of their total experience.

This has important implications for understanding both the importance of pop culture and potential solutions to the STEM gender gap. These findings can help researchers understand ways that geeky leisure activities are related to STEM careers and could be useful in helping to close the STEM gender gap. Additionally, geek leisure activities have the potential to influence women's STEM efficacy and interest, thus, these are activities that can be easily implemented during grade school and college years to help bolster confidence and interest while women start to determine future career paths, similar to Ball et al.'s findings (2020) where they found that implementing a "tech week" of computer activities and coding assignments in a fifth grade classroom helped to increase self-efficacy with computer and increase attitudes towards the

STEM fields. Similarly, Spieler et al. (2019) found similar results with a women-only "coding week" for teenagers, which resulted in higher reports of self-efficacy and more interest in the coding process. The experiences that women have while participating in geek leisure activities have implications beyond their leisure pursuits, in that they have the potential to help close the gender gap in STEM fields by increasing efficacy and interest.

And the good news is that popular geek culture activities have a unique advantage compared to increasing efficacy with additional workplace training or ensuring teachers are supporting women in STEM. Pop culture activities are simply enjoyable. These are, by definition, leisure activities that people choose to spend their time doing and can have positive influences on STEM efficacy and interest. Geek pop culture activities provide a way to help increase STEM interest without directly targeting STEM topics or individuals who are already involved in STEM. Additionally, with the large range of different geek-related activities, there are multiple ones to choose from and could easily be integrated into grade school and college environments when women are still deciding on future career paths. Increasing exposure and providing welcoming opportunities by activities like women's sci-fi book clubs, grade school beginner robotics courses, implementing positive geek women representation into literature, or encouraging existing organizations or clubs to implement STEM activities could all be ways to increase positive experiences and begin exposure to geeky pop culture. This could open the door to geek culture engagement and lead to increased participation in geek activities and, by extension, STEM career interest.

There is still much to learn about the specific nature of how different geek-related activities could influence STEM fields or what kinds of experiences are influential for young women, but these findings create a beginning step to an overarching conversation about how

leisure activities that people are choosing to participate in are positively influencing the concerning STEM gender gap. Given that geek-related hobbies and themes are becoming increasingly popular in mainstream society, this conversation has extended beyond what geeks are or why they spend time discussing their favorite Star Wars film or comic book story arcs, but instead how these hobbies to relate a person's sense of career choice and what they are capable of achieving. This makes the conversation more interesting and more important than before. With the mainstreaming of geek activities, current understanding that it is commonly a toxic environment for women (Salter & Blodgett, 2017), and that it has real-world implications on women's sense of efficacy and interest in STEM, it is important to learn more about how the current geek culture environment is affecting the victims of this toxicity and ways to make productive change. While this conversation is relatively understudied compared to other topics, it is surely an exciting and optimistic one for the future to explore.

Appendix A

Consent Form

Principal Investigator (PI) | Elizabeth L. Cohen
Department | Communication Studies
WVU IRB Protocol # | **2103269379**
Study Title | Women's Interest in Geek Culture and STEM

Why is this research being done and what is involved?

The purpose of this study is to learn more about peoples' leisure and career. If you decide to participate, you will be asked to complete an online survey about your opinions about your current career and/or career goals and your leisure activities, interests, and experiences with different recreational groups. From start to finish the online study should take you approximately 15 minutes to complete.

Do I have to participate and what are the risks?

Risks from participation in this study include discomfort from some questions in the survey asking about personal experience with opinions about your current career and/or career goals and your leisure activities, interests, and experiences with different recreational groups. Should you become uncomfortable or upset at any time, or if you simply no longer wish to continue your participation after you start for any reason, you may skip the questions or stop participating. Your participation in this research study is completely voluntary and you are free to withdraw from the research at any time.

There are no known benefits of this research.

Will I be compensated for my participation?

You will be paid $0.80 in your Mechanical Turk account for completing at least 90% of the survey. The funds will be deposited within 3 days of completion. If you withdraw before completing 90% of the survey you will not be compensated.

What will happen to my research information and data?

Any information about you that is obtained as a result of your participation in this research will be kept as confidential as legally possible. Your research records, just like hospital records, may be subpoenaed by court order or may be inspected by the study sponsor or federal regulatory authorities, including the Food and Drug Administration (FDA), without your additional consent. In addition, there are certain instances where the researcher is legally required to give information to the appropriate authorities. These would include mandatory reporting of infectious diseases, mandatory reporting of information about behavior that is imminently dangerous to you or to others, such as suicide, child abuse, etc.

Your participation in this research is anonymous. The researchers will have no way to link your responses to your identity. In any publications that result from this research, neither your name nor any information from which you might be identified will be published.

Who can I talk to if I have questions or concerns?

If you have any questions or concerns about this research, you can contact Dr. Elizabeth L. Cohen, Ph.D. at Elizabeth.Cohen@mail.wvu.edu or Madeleine D. Butcher at mdb00016@mix.wvu.edu from the Department of Communication Studies at West Virginia University.

For information regarding your rights as a participant in research or to talk about the research, contact the WVU Office of Human Research Protection (OHRP) at (304) 293-7073 or by email at IRB@mail.wvu.edu.

I willingly agree to be in the study.

○ Yes ○ No

Appendix B

Amazon Mechanical Turk Survey Advertisement

Researchers at West Virginia University are conducting a research study about people's involvement in different leisure and career activities.

If you would like to participate, you will be asked to tell us your leisure activity and career preferences by answering survey questions.

You must be at least 18 years old to complete this study. The study takes about 15 minutes to complete. There are no known benefits of participating in this research. IRB acknowledgment is on file for this study (protocol #).

Select the link below to complete the survey. When you have finished the survey, please enter your MTurk user ID at both the end of the survey and in the box below to receive 80 cents payment. After it's confirmed that you participated in the survey, your payment will be transferred to your MTurk account within 3 days.

Thank you for your help!

Madeleine D. Butcher
mdb00016@mix.wvu.edu

Elizabeth Cohen, PhD
elizabeth.cohen@mail.wvu.edu

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Department of Communication Studies PO BOX 6293
Morgantown, WV 26505-6293

304-293-3905

Please Use the Following Link to Access the Survey: https://wvu.qualtrics.com/jfe/form/SV_cPeQ2J9dT9DlyXH

Provide your Mechanical Turk ID (that SAME ID you input at the end of the survey) here:

Appendix C

Research Cover Letter

Dear Participant,

This letter is a request for you to take part in a research project about people's involvement in different leisure and career activities. This project is being conducted by Madeleine D. Butcher in the Department of Communication Studies at WVU under the supervision of Dr. Elizabeth Cohen an associate professor in the Department of Communication Studies to fulfill requirements for a Master's Degree in Research.

If you decide to participate, you will be asked to complete an online survey with questions pertaining to your leisure and career activities, career goals, and demographics Your participation in this project will take approximately 15 minutes. You must be 18 years of age or older to participate. You will receive 0.80 cents of payment in your MTurk account for completing at least 90% of the survey. The funds will be deposited within 3 days upon completion. If you withdraw before completing 90% of the survey you will not be compensated.

Your involvement in this project will be kept as confidential as legally possible. All data will be reported in the aggregate. You will not be asked any questions that could lead back to your identity as a participant. Your participation is completely voluntary. You may skip any question that you do not wish to answer and you may discontinue at any time. West Virginia University's Institutional Review Board acknowledgment or approval of this project is on file.

If you have any questions about this research project, please feel free to contact me, Madeleine D. Butcher, by e-mail at mdb00016@mix.wvu.edu or research supervisor, Dr. Elizabeth Cohen, at elcohen@mail.wvu.edu. If you have any questions about your rights as a research participant, please contact the WVU Office of Human Research Protection by phone at 304-293-7073 or by email at IRB@mail.wvu.edu.

I hope that you will participate in this research project, as it could help us better understand people's involvement in different leisure and career activities. Thank you for your time and consideration.

Sincerely,

Madeleine D. Butcher

& Elizabeth Cohen, Ph.D.

Appendix D

Survey Instrumentation

I. Geek Identity

To start off, we would like you to think about how much you consider yourself to be a nerd or a geek. On a scale from 1 (Strongly Disagree) to 7 (Strongly Agree), please indicate your agreement to the following statements:

Geek Id Scale (GIS; McCain, Gentile & Campbell, 2015)

- I consider myself to be a geek.
- Being a geek is central to my identity.
- Being a geek is important to me in my life.
- Being a geek is a major part of who I am.
- I would describe myself to others as being a geek.
- I am proud of being a geek.
- If I stopped participating in geek activities, I just wouldn't be the same person.
- I can't imagine life without my geek interests and activities.
- I consider myself to be part of the geek culture.
- I value being a geek.

II. Geek Engagement

Now we'd like to know about your experiences participating in different "geeky" hobbies, interests, and activities. Please indicate the extent that you currently engage in or consume (or have engaged in or consumed in the past) the following activities, on a scale from 1 (Not at All) to 7 (Frequently)

Geek Culture Engagement Scale Short Form (GCES-S; McCain, Gentile & Campbell, 2015)

- LARPing (Live Action Role Playing Games)
- Table Top Roleplaying Games (e.g., Dungeons and Dragons, World of Darkness, GURPS)
- Attending Renaissance Fairs
- The Society for Creative Anachronism (SCA) and other historical reenactments
- Puppetry (making and performing with puppets, muppets, etc.)
- Robots (making, using, learning about robots)
- Theater (acting, costuming, building sets, etc.)
- Fantasy Fiction (e.g., Lord of the Rings, Harry Potter)
- Sci-Fi (e.g., Star Trek, Star Wars, Stargate, Babylon 5)
- Anime (Japanese cartoons, e.g., Pokemon, Full Metal Alchemist)
- Manga (Japanese comic books, e.g., Nana, Fruits Basket)
- Broadway/Theater/Musicals (e.g., Phantom of the Opera, Rent)

- Lolita
- Furry (anthro, etc.)

Additional Geek Culture Activities

- Attending conventions (e.g., Dragon Con, Comic Con, Gen Con, etc.)
- Reading comic books (physical or online)
- Computer gaming
- Console gaming (e.g. PlayStation, Xbox, Nintendo Switch, etc.)
- Mobile phone gaming
- Watching Twitch Livestreams or other gaming livestreams
- Watching e-sports (e.g. League of Legends Championship, World of Warcraft Arena World Championship)
- Computer coding and programming for fun
- 3D printing and 3D modeling for fun
- Trading Card Gaming (e.g. Magic the Gathering, Pokémon, Yu-Gi-Oh, etc.)
- Painting and crafting table-top miniatures and props
- Costume play (aka. Cosplay)
- Reading or writing fan-made fiction
- Party-based card and/or board games (e.g. Card Against Humanity, What do you Meme?, Taboo, Pictionary)
- Strategy-based board games (e.g. RISK, Settlers of Catan, Warhammer 40k, etc.)
- Owning merchandise related to any of the above topics (e.g. posters, figurines, clothing, etc.)
- Participating in forum discussions/online chat rooms about any of the above topics
- Participating in in-person discussions with others about any of the above topics

Sociality of Geek Experiences

Some of the activities listed above are fairly solitary (e.g., reading comic books), but many of the other activities mentioned are highly social (e.g., role-playing games, online chats, attending Cons).

Considering all the geek activities that you've participated in, please indicate how social your experiences have been on the whole on a scale from 1 (Not at All Social) to 7 (Extremely Social).

[PAGE]

III. <u>Positivity and Negativity of Geek Experiences</u>

Now, we are interested in learning more about the geeky experiences that you've had with other people. For these next items, please continue thinking about the geek experiences you've shared with other people, and use the scales below to indicate how you would characterize these experiences on the whole.

Scale of Positive and Negative Experience (SPANE; Diener et al., 2010)

Using the accompanying scale of 1 (Very Rarely or Never) to 5 (Very often or Always), please indicate the extent would you characterize your social experiences with these geek cultural activities using the following adjectives

- Positive
- Negative
- Good
- Bad
- Pleasant
- Unpleasant
- Happy
- Sad
- Afraid
- Joyful
- Angry
- Contented

Added items:

- Fun
- Uncivil
- Disappointing
- Fulfilling
- Violent
- Uncomfortable
- Rewarding

Next, continuing to think about the social experiences you've had engaging in geek activities (e.g., playing video games, attending cons, etc.) please indicate how often you've had the following experiences on a scale on a scale from 1 (Not at All) to 7 (Frequently).

How frequently have you …

- … been harassed verbally
- … felt socially accepted
- … been harassed sexually
- … felt like you can be yourself
- … felt like you needed to hide your true identity
- … been discriminated against
- … felt respected
- … had your skills insulted
- … been mistreated
- … been laughed at or made fun of
- … felt threatened

- … had positive remarks made about your physical appearance
- … had negative remarks made about your physical appearance
- … been made to feel like you don't belong
- … felt belittled
- … been made to socially excluded
- … been complimented on your abilities
- … been made to feel like you belong
- … been complimented on your skills
- … felt welcome
- … received positive feedback on your talent

[PAGE BREAK]

Open-Ended Best and Worst Experience

As you can probably tell from this line of questioning, we are interested in learning more about the positive and negative experiences you've had participating in what would be considered "geek culture" activities. To shed more light on this topic, we would appreciate learning more about your experiences. In the boxes below, please describe both the best social experience and worst social experience you that can recall while participating in some geeky activity (e.g., playing or livestreaming online games, attending cons, etc.). Any information you can provide is appreciated!

What was the best "geeky" social experience you had? Please indicate what the activity was and describe the experience. [text box]

What was the worst "geeky" social experience you had? Please indicate what the activity was and describe the experience. [text box]

(participants will be required to spend 2 minutes on this page before proceeding)
[PAGE BREAK]

IV. Demographics

Thank you. Now, we would like to ask some questions about who you are, demographically speaking. If you feel uncomfortable answering any question below, please leave the response box for that question blank.

Age

How many years old are you today?

State

In what U.S. State do you currently reside? [Qualtrics drop-down options]

Biological Sex

What was your biological sex at birth?
1. Male
2. Female

3. Intersex

Gender

With which gender do you most closely identify?
1. Man
2. Woman
3. Transgender Male/Trans Man/Female to Male (FTM)
4. Transgender Female/Trans Woman/Male-to-Female (MTF)
5. Gender Variant/Non-conforming
6. Not Listed [Please specify]: _____

Sexual Orientation

What is your sexual orientation?
1. Asexual
2. Bisexual
3. Gay
4. Heterosexual or straight
5. Lesbian
6. Pansexual
7. Queer
8. Not Listed [Please specify]: _____

Race/Ethnicity

With which race/ethnicity do you most closely identify?
1. White/Caucasian
2. Hispanic/Latino(a)
3. Black/African American
4. Native American/American Indian
5. East Asian/Pacific Islander
6. Middle Eastern/West Asian
7. Central Asian (e.g., Indian, Pakistani, Nepalese)
8. Other _____

Education

What is the highest level of education you have obtained?
1. Some High School
2. High School Diploma/GED
3. Some College
4. Associate's Degree
5. Bachelor's Degree
6. Master's Degree
7. Doctoral-level Degree (e.g., Ph.D., J.D., Pharm.D., M.D.)
8. Professional Degree
9. Other _____

What is the highest level of education you plan to complete in the future?

1. Some High School
2. High School Diploma/GED
3. Some College
4. Associate's Degree
5. Bachelor's Degree
6. Master's Degree
7. Doctoral-level Degree (e.g., Ph.D., J.D., Pharm.D., M.D.)
8. Professional Degree
9. Other _____

[Page Break]

If answered at least "some college" or above: What is or was your major in the highest level of school you have completed (or if you have not declared a college major, what would you like it to be?)

[PAGE BREAK]

Employment

Are you currently employed? Yes/No

If yes: Which of the following areas best describes your current field of employment.

Which of the following areas best describes your DESIRED field of employment—the type of job you would like to have at some point in the future? (this may or may not be the same as your current job) [Qualtrics Dropdown Options]

[PAGE BREAK]

Now please consider the following statements and indicate how much you agree with them.

I am interested in having a career that is rooted in natural science, technology, engineering, or mathematics now or in the future? (1 = disagree strongly; 7 = agree strongly)

It is likely that I will pursue an educational degree or a career rooted in natural science, technology, engineering or mathematics now or in the future? (1 = disagree strongly; 7 = agree strongly)

I enjoy working in natural science, technology, engineering or mathematics now or in the future? (1 = disagree strongly; 7 = agree strongly)

V. Interest in Other Activities (including STEM)

For this final collection of questions, we are interested in learning about your other interests,

outside of geek culture.

Please indicate the extent that you currently engage in or consume (or have engaged in or consumed in the past) the following recreational activities, on a scale from 1 (Not at All) to 7 (Frequently)

Non-Geek Activities
Watching Team Sports (e.g., Football, Baseball, Hockey Soccer, etc.)
Playing Team Sports (e.g., Football, Baseball, Hockey, Soccer, etc.)
Weight Lifting
Running, jogging, or hiking
Hunting
Dance or Aerobics
Outdoor and Adventure Sports (e.g., kayaking, skiing, mountain biking, gardening)
Automotive hobbies (e.g., racing, motorcycling, car repair, or restoration)
Arts or crafts (e.g., painting, photography, scrapbooking, knitting)
Reading (e.g. popular authors, romance, mystery, non-fiction)
Cooking or baking for fun
Listening to or creating music

[PAGE BREAK]
Gamer Identity **(adapted from the Geek Id Scale, McCain, Gentile & Campbell, 2015)**
Now we would like to think about how much you consider yourself to be a video gamer. On a scale from 1 (Strongly Disagree) to 7 (Strongly Agree), please indicate your agreement to the following statements:

- I consider myself to be a video gamer.
- Being a video gamer is central to my identity.
- Being a video gamer is important to me in my life.
- Being a video gamer is a major part of who I am.
- I would describe myself to others as being a gamer.
- I am proud of being a gamer.
- If I stopped participating in gaming activities, I just wouldn't be the same person.
- I can't imagine life without my gaming interests and activities.
- I consider myself to be part of the gaming culture.
- I value being a gamer.

For these next questions we want you to think about your experiences and interest in the fields of science, technology, engineering, and mathematics (STEM).

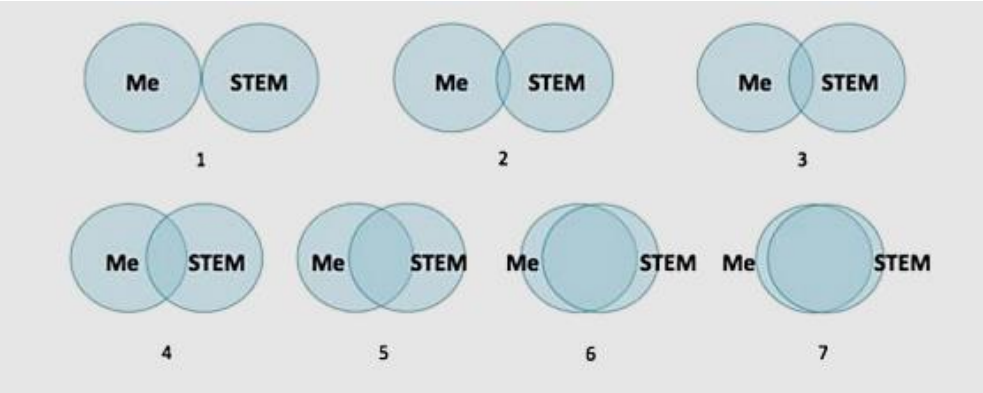
First, please indicate how much of an educational background you have in these areas. Please consider how many classes or formal opportunities of instruction you've had in high school, college, or graduate school. On a scale from 1 (No education or hardly any) to 5 (A great deal of education), please indicate how much education you've had in each of the following fields.

Natural Science (e.g., physics, biological sciences, chemistry, astronomy, geology)
Mathematics (e.g., algebra, geometry, numbers theory, statistics)
Technology (e.g., computer science, software engineering, data science)
Engineering (e.g., mechanical engineering, electrical engineering)

[PAGE BREAK]

Self-STEM compatibility **(adapted from Shin et al., 2016)**

Now, please examine the different pictures below, and using the scale below ranging from 1 to 7, please indicate which of the pictures best reflects how compatible you and STEM are.



[PAGE BREAK]

STEM Belonging **(Shin, Levy, and London 2016 – adapted from Aaron et al.'s IOS, 1992)**
Now, please thinking about how you feel when you are in STEM settings (e.g., such as science or math classes or laboratories) and indicate how much you agree with the following statements on a scale of 1 (Disagree Strongly) to 7 (Agree).

I feel like I belong in a STEM setting
I feel accepted in STEM settings
I feel comfortable in STEM settings
I trust others in the STEM settings to help me learn
When I am in a STEM setting I wish I could fade into the background and not be noticed (reverse coded)

STEM success self-efficacy

I believe in my ability to succeed in STEM-related activities.
I feel generally confident in STEM-related settings.
Even if STEM-related theories and concepts are difficult to understand, I am capable of learning them.

If given appropriate training, I feel secure about my ability to understand STEM-related theories and concepts.
If I set my mind to it, I can perform well on STEM-related tasks.
I know that can succeed in a STEM-related culture.
I am confident that I can work with other people in STEM-related fields well.

VI. Effort

Finally, we know that you are completing a lot of tasks and it's not always possible to pay close attention to surveys like these.

Your answer to this question will NOT affect any compensation or benefits that you were entitled to. Please answer based on the scale 0 = No Effort At All, 4 = A Great Deal of Effort.

In your honest opinion, how much effort and attention did you put into this study?

[PAGE BREAK]

Thank you so much for your time! Your participation on this survey is invaluable and we are grateful for your contribution!

Please input your Mechanical Turk User ID into MTurk and the box below. It is a long string of letters and numbers that MTurk associates with your account. You can find it in the top right of your Mechanical Turk dashboard.

As soon as your survey has been checked for completeness, your account will be credited with 0.80

Enter your MTurk User ID here (also put your ID in the MTurk box for this survey):

_____

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