Play with Purpose

Exploring digital games to encourage gender equity in STEM

By Patricia Zawada

Submitted to OCAD University in
partial fulfillment of the requirements
for the degree of Master of Design
in Strategic Foresight and Innovation
Toronto, Ontario, Canada, 2022

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Abstract

Playing digital games is one of the most popular activities amongst youth today. Research studies have connected young women who participate in digital games as three times more likely to pursue a career in Science, Technology, Engineering and Math (STEM) fields. Although STEM skills are considered essential for the future of an innovative society, there exists a gap of the women represented in these fields. Exploring digital games provides a potential solution to closing this gap, however the digital games environment is not as inclusive for women as it could be.

As a result, this research focuses on utilizing digital games to support STEM education for young women in Canada. The research begins with a literature review, anonymous survey, semi-structured interviews, and a co-creative workshop to understand the experiences of women in digital games and STEM in Canada today, and to structure these insights through a Deconstruction:Reconstruction process. Systems mapping and foresight tools were also used to generate a desired future and guide strategic recommendations.

Insights suggest a desire for education on digital etiquette and the development of a digital space where young women can practice building confidence while having their voices heard. Three opportunity spaces were identified as key leverage points to intervene within the digital game system, including opportunities between Educational, Recreational and Gaming Industry subsystems. These opportunity spaces were further established as two recommendations that provide strategic initiatives for educational institutions to engage with digital games, involving different stakeholders in the system. By changing the experiences women currently have while engaging in digital games, perhaps more women would be inclined to participate in play and therefore engage in STEM fields.

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This work is dedicated to the next generation of youth.

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Introduction

Project Context

The need for gender equality and inclusion has been long recognized as a challenge in Science, Technology, Engineering and Math (STEM) fields, in addition to the corporate world. In an article from *Forbes Magazine*, Elaine Montilla emphasized that the underrepresentation of women will become a fundamental economic challenge if left unaddressed (2020). With more jobs in computer science than available graduates, Montilla highlighted the need for women in tech for reasons including: innovation through diverse teams, unique perspectives for problem-solving, and creating more role models for younger generations.

As outlined by the Council of Canadian Academies, STEM skills and knowledge are essential to the progress of Canadian innovation (2015). Although there is uncertainty about the specific types of skills and jobs required to thrive in the economy of the future, the skills associated with STEM degrees are often put in the spotlight. In order to develop proactive long-term strategies to support the future of Canadian jobs and productivity, investing in STEM skills are encouraged to keep an open range of options (Council of Canadian Academies, 2015).

According to a 2016 Canadian Census, there was more than twice the number of male graduates with a bachelor's degree in STEM than women, and more than three times at the college level. Not only were women less likely to enter post-secondary STEM education, women were also found to be more likely to leave a STEM occupation in comparison to men (Frank, 2019). There are numerous explanations for why women are less likely to pursue or remain in STEM careers including: gender roles, cultural pressures, family expectations, social norms, lack of self-confidence, lack of mentorship opportunities, and pursuing other preferences or interests (Frank, 2019).

Although a number of solutions have been suggested to address the problem of gender equality in STEM, using video games to encourage girls' participation in STEM has become increasingly more recognized. Anesa Hosein, a researcher at the University of Surrey, conducted a statistical analysis to see if there was a link between the gaming behaviour of girls and their choice of undergraduate study (2019). The results support that girls aged 13-14, who were more heavily involved in gaming, were three times more likely to pursue a PSTEM field (**Physical Sciences**, Science, Technology, Engineering, Math).

There are many parallels women face across the STEM and gaming industries, however, with more prevalent research into digital games over the last few decades, the benefits of gaming are becoming more apparent. Dr. James Paul Gee, a psycholinguistic researcher from Arizona State University, writes that people learn new forms of literacy and skills through playing video games (2003). Engaging with gaming gives users the ability to explore new learning opportunities, as he identified 36 distinct learning principles from video games. Principles include empowered

learning, problem-based learning, and deep understanding. Gee highlights that games allow players to actively engage in their environments and therefore understand a multimodal combination of texts, symbols or images in order to achieve their goals.

Although gaming can aid in the development of STEM skills, the experiences players have within a gaming context can differ significantly from player to player. In an online survey from the game development company Electronic Arts (EA), over 2,000 US gamers between the ages of 13-54 identified inclusion as a key area for improvement in games. The survey suggests that players want greater customization in regard to gender, skin colour, body type, and features for individuals with unique needs. Furthermore, the survey dives deeper into gender issues women face as they game, in particular the toxicity of disruptive behaviour from other players (Sinclair, 2019).

Toxic behaviour is defined as any act committed by a player which has malicious intent, such as abusive or insulting language (Statt, 2021). In digital games, toxic behaviour typically occurs in an online setting where communication between players through text and voice chat is common (Statt, 2021). Research suggests toxicity may be a result of dissociative anonymity, which causes players to engage in threatening and bullying ways with no fear of repercussions. Dissociative anonymity enables players to separate their negative behaviour in-game from their real-life behaviour, and as a result, opens the door to misogyny and other forms of discrimination (Statt, 2021). As more women engage in digital games, toxicity becomes increasingly more apparent as a barrier that limits the representation of women in games. This represents an opportunity to explore the greater system of games and identify points of opportunity for women to better engage in games, and therefore gain STEM-related skills.

Overall, this Major Research Project (MRP) seeks to focus on the experiences of women in gaming and how it relates to STEM, in order to further identify barriers, benefits and opportunities for change. With the goal of increasing the representation of women in STEM fields in Canada, this MRP seeks to contribute an additional perspective on the existing conversation of gender equity in STEM. Specifically, this MRP explores how digital games can be utilized as a tool for learning and practicing skills to better prepare young women for professional careers in STEM industries.

This leads to the following research question:

How might we utilize digital games to support STEM education for young women in Canada?

Additionally, the following supportive questions are used to help guide the primary research:

- How might we improve young women's experiences surrounding digital games so that they can better engage with STEM?
- How can stakeholders support the experience of young women in STEM education through digital games?

Purpose and Audience

The purpose of this MRP is to provide the broader educational industry with recommendations as they navigate digital futures and incorporate games into extracurriculars and curriculum development. While not a replacement for traditional school structures, digital games can provide supplementary extracurricular learning in addition to enhancing current learning techniques. Although every woman who participates in gaming may not want to pursue a degree in STEM, this research seeks to explore how more women can be welcomed and encouraged to play, while still gaining STEM-related skills, whether they be fundamental, practical or advanced skills.

The succeeding Approach section will explain how different research methods were used to engage participants and stakeholders through the *Deconstruction: Reconstruction* framework. This design process was essential for organizing the research into four steps that broke down the current state, shifted perspectives, established wants and needs, and developing future recommendations. Additionally, while much research exists on the negative aspects of video games, such as addiction and lack of physical exercise, this research will focus primarily on the potential benefits of gaming, and encourage playing digital games in moderation to supplement learning.

Terminology

Digital Games is an umbrella term used to include all forms of video games, including mobile, computer, console, virtual reality and everything from earliest versions of experimental games to contemporary cutting edge games (Rutter & Bryce, 2006). There may be instances in the MRP in which the term video games is used, this will refer to citations from other authors or research.

Toxicity refers to negative behaviour and communication practices between individuals, which can occur both online and offline. As a relatively newer term, toxicity originated in masculinity theories and is used as a tool to explain social mechanisms supporting hegemonic masculinity (Deslauriers et al., 2020). In this MRP, toxicity will refer to behaviour between players inducing stress or trauma in one player or more.

Approach

Approach

As a research project rooted in gender equity, it was important to highlight the work and frameworks of prominent women in the design field. Much of the work done in this research project was influenced by Ayse Birsel, Elizabeth B.-N. Sanders, and Donella Meadows, which will be further explained throughout the paper.

The approach for this research was inspired by the process presented in Ayse Birsel's *Deconstruction:Reconstruction* Framework (2015). The process of deconstructing the current state into multiple parts is described as key to understanding the system, and guides the reconstruction of a future state that is greater than the sum of its parts (Birsel, 2015). In this research, the *Deconstruction:Reconstruction* Framework was applied to the current landscape of both women in STEM and gaming industries. Insights from the literature review were used to support primary research, which were then reconstructed and expressed as recommendations. The benefit of this framework is that it incorporates various concepts from design thinking and systems thinking. The following diagram illustrates the approach that was used to guide this research. The research question was deconstructed into parts, analyzed from alternate points of view, reconstructed and synthesized into metaphors and system leverage points, and lastly expressed and given form as recommendations.

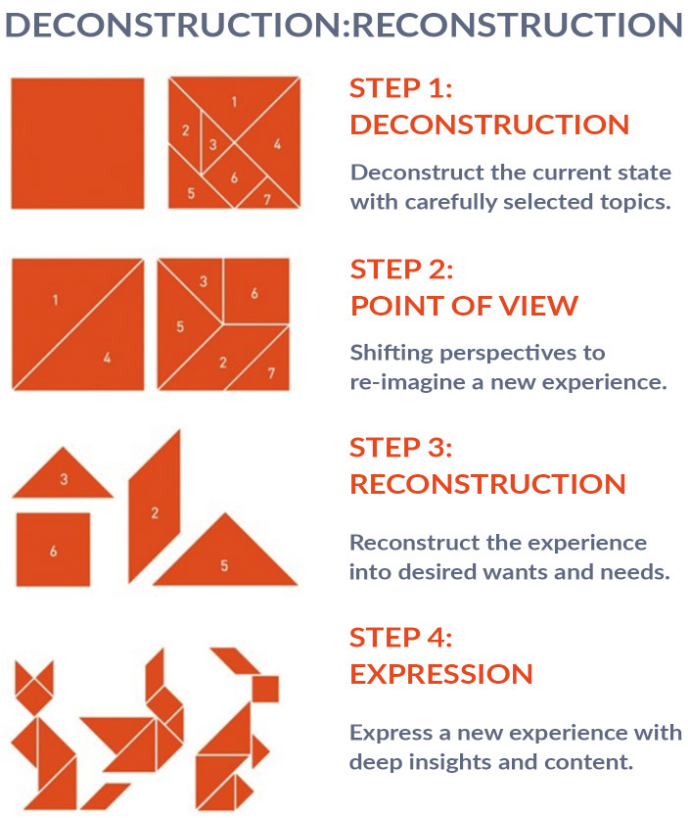


Figure 1: *Deconstruction: Reconstruction* framework by Ayse Birsel (Birsel, 2015)

The following outlines the steps of the Deconstruction: Reconstruction process:

Step 1: Deconstruction
The Deconstruction step involved breaking down the research question into smaller elements of the problem. For this project, this step consisted of a high-level literature review of women's experiences in STEM and gaming industries. By taking apart the research question through literature review, this step identified where to dive further in the point of view stage.

Step 2: Point of View
The Point of View (POV) step framed the current context identified in Deconstruction through alternative perspectives and filtered lenses. For this step, primary research was conducted in the form of a survey, interviews, and a co-creative workshop to gain insights on the system's main actor, the player. Key highlights found within primary research were identified utilizing clustering techniques, and will be brought together in the Reconstruction step.

Step 3: Reconstruction
The Reconstruction step consolidated the insights from Deconstruction and Point of View into a systems map to identify subsystems, opportunity spaces, and leverage points. In addition, a *Causal Layered Analysis* (CLA) was used to filter primary research insights to identify a desired future state expressed through metaphors. Both the systems map and CLA set the foundation for the recommendations in the Expression step.

Step 4: Expression
The goal of the Expression step was to develop recommendations and opportunity spaces based on the leverage points and desired futures from the previous steps. Here the goal was to reinforce and refine the recommendations according to the intended audience, purpose and research questions. For this project, recommendations were focused on improving women's experiences while playing digital games in order to better equip educational institutions with the knowledge needed to incorporate digital games into their curriculum.

Each step of the *Deconstruction:Reconstruction* process will further be explained throughout the rest of the paper. The methodology, tools, insights, and reflections are detailed in each step.

Step 1:

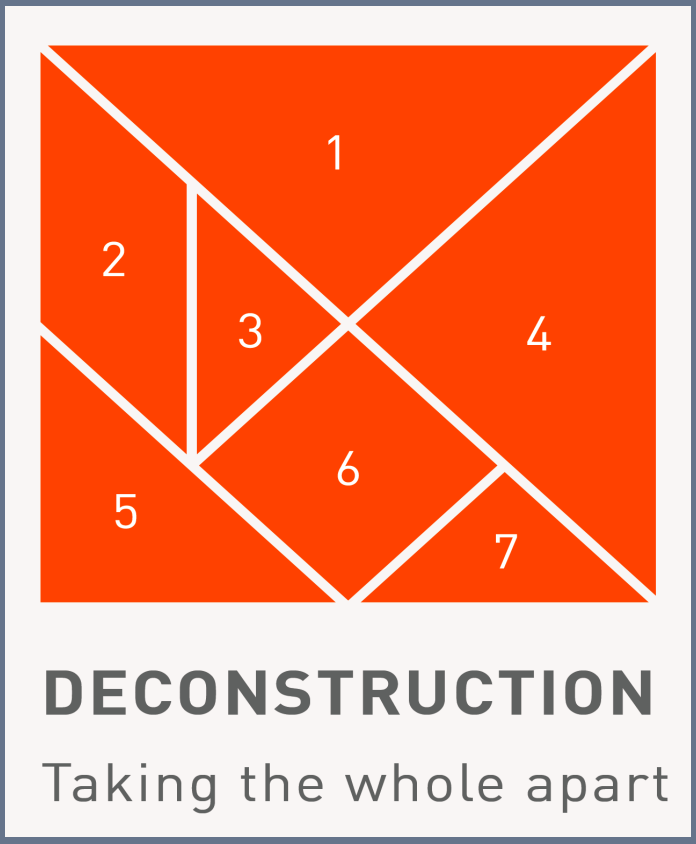


Image Source: Ayse Birsel, 2015

Step 1: Deconstruction

The goal of the Deconstruction step was to break down the current state of women's experiences in both STEM and digital games into its building blocks to understand what it is made up of in smaller, more manageable parts (Birsel, 2015). In this MRP, the step began with analyzing the research question and identifying topics for the literature review. Deconstruction of the research question "How might we utilize digital games to support STEM education for young women in Canada?" began by identifying skills and gender equity as areas to uncover within STEM and Digital Games, which will be explored further in the sections ahead. The step ends with a reflection in which key areas are identified, linked together, and explored further in Step 2: Point of View.

Skills

Skills in STEM

In a rapidly changing world, students will need to develop STEM skills in order to make decisions regarding the complex challenges of the future. As students engage in STEM, they develop transferable skills which contribute to basic skills in problem-solving, critical thinking, innovation, and design (Ontario, 2020a). According to the Council of Canadian Academies, STEM skills are broken down into the following three categories:

Fundamental STEM Skills
As a building block for more advanced STEM skills, fundamental STEM skills can be learned at an early age and applied to a variety of technology-rich environments. These skills include "reasoning mathematics, and computational facility (numeracy), as well as capacity for critical thinking and problem solving" (Council of Canadian Academies, 2015). Regardless of occupation, these skills are essential for all Canadians and can contribute to overall STEM literacy. Whether managing personal finances, taxes, schedules, or using technology products, basic STEM skills are an essential component for making informed decisions. Fundamental STEM skills act as a foundation for both practical and advanced STEM skills.

Practical STEM Skills
As the next level for STEM skills, practical skills are typically associated with "trades, apprenticeships, and education in a STEM field at the diploma or certificate levels (one-to three-year programs)" (Council of Canadian Academies, 2015). These skills focus on aspects such as algebra, solving complex calculations, and applying relationships based on physics, chemistry, and biology concepts. Computer programming and technical design may also be considered practical STEM skills as knowledge in these skills are required to modify existing technology.

Advanced STEM Skills
Often associated with education at the undergraduate level and above in STEM-related fields, advanced skills are important for developing innovative ideas that create jobs and support the economy (Council of Canadian Academies, 2015). With a focus on scientific methods, specialized STEM discipline training, and conceptual design, advanced skills support the research and development of new ideas and technologies.

Overall, STEM skills are essential to meet the needs of the 21st-century workforce (Sen et al., 2018). Educational institutions are constantly seeking new learning approaches and strategies to engage, motivate, and retain students in STEM education. This MRP suggests the introduction of digital games as a way to encourage the development of STEM skills, support current learning techniques, and engage students in play. The following section will detail the skills learned in digital games, and how they complement STEM skills.

Skills in Digital Games

Play is considered a leading factor in the mental development of a child and is responsible for creating a zone of proximal development (Hakkarainen & Bredikyte, 2019). Proximal development is defined as the difference between what a person can accomplish without support, in comparison to what they can accomplish with support and encouragement. In the context of learning, digital games that are not too difficult and not too easy, are within the player's zone of proximal development (Hakkarainen and Bredikyte, 2019).

With 89% of children and adolescents in Canada playing digital games, and a growing representation of female players, digital games are becoming increasingly more integrated into the lives of Canadian youth (Entertainment Software Association of Canada, 2020). Recognizing the skills learned through digital games is the first step in identifying how these games can support youth in STEM education. The following skills were discovered through the literature review as skills that can be developed while engaging in digital games:

Critical Thinking Skills
As an objective way to form a judgment, critical thinking is identified as one of the Four C's of 21st-century learning, which also includes communication, collaboration, and creativity (Kivunja, 2015). With processes of information analysis, integration, and evaluation, critical thinking skills are essential for problem-solving (Reichenbach, 2002). In the game *Portal*, players are trapped in a set of rooms, surrounded by a series of puzzles that can only be solved by teleporting the character and objects between different locations on the map. The player must understand the patterns and limitations of their environment in order to strategize a solution, progress to the next level, and ultimately escape (Ewalt, 2011).

In Dr. Gee's first learning principle, 'Active, Critical Learning,' he states that digital game environments are designed to support active and critical learning, as opposed to passive learning situations, such as lectured formats. Critical thinking is further emphasized in his fifth principle which focuses on 'Meta-level thinking about Semiotic Domains'. In this principle, Gee outlines critical thinking as a key aspect of learning in digital games as it considers the relationships and comparisons of semiotic domains (Gee, 2003).

Semiotic domains incorporate fluency in signs, symbols, sounds, language, and speech between one or more possibility spaces to communicate distinctive types of messages (Gee, 2003). For example, music, science, and digital games all have their own distinct semiotic domains. Communication within a semiotic domain uses specific words, signs, and symbols to translate specialized messages within that domain (Gee, 2003). In digital games, semiotics occur through signs and symbols that give players clues and hints such as statistics, maps, and graphical or auditory prompts. Conversely, in STEM, semiotics exist through resources such as diagrams, mathematical symbols, graphs, spoken and written language, and laboratory apparatuses (Airey & Linder, 2017).

Exploring Failure and Resiliency

With growth mindsets cited as essential for career success, more organizations are encouraging failure as part of the process for innovation. 'Fail fast' is often a term used to describe the iterative and experimental process of tech-driven industries, especially in areas such as Silicon Valley (Markowitz, 2012). According to Gee, digital games encourage failure as "learners can take risks in a space where real-world consequences are lowered" (2003). The iterative nature of simulated games encourages players to try again with different techniques and roles to analyze and solve the issue at hand.

Gee's 'Probing' principle states that learning is a cycle of examining the world, reflecting on the actions taken, creating a hypothesis, and then re-examining to test the hypothesis. In digital games, such as *Super Mario*, probing is essential for overcoming many challenges (Gee, 2003). For example, trial-and-error describes a type of gameplay that is designed for the player to fail several times before succeeding. In *Super Mario*, trial and error occurs when the character is eliminated, or when the mission ends in failure. The player is then forced to restart that challenge from a check point, or from the beginning again (Gee, 2003).

This iterative process challenges the player to continuously attempt and troubleshoot possible solutions in order to achieve the desired outcome. This is an effective learning process in many STEM applications where the cost of failure is low, or when a product is in the early research phases. In software development, failure is encouraged as it promotes iteration and antifragility, which is the capacity to prosper despite mistakes or stressors (Danchin, 2011).

Systems Thinking Skills

Identified as a necessary 21st-century skill by systems scientist Peter Senge, systems thinking provides a language for describing and understanding relations that shape system behaviours (1994). With a focus on breaking down problems into parts, examining relationships, and understanding behaviour between the parts, individuals who use systems thinking can understand the big picture of complex problems and therefore make informed decisions or solutions. In the context of digital games, every game has a unique system in which a player must understand and navigate in order to solve challenges and make progress toward final objectives.

Games such as *Minecraft*, *Civilization*, and *SimCity*, have complex systems in which players can collect resources, manage economic growth and even balance character well-being. In order for a player to be successful in a game, they have to understand the relationships and interactions between their character, other in-game objects, and the rules that govern the in-game system. This is expanded on in Gee's "Semiotic" principle, in which he explains learning about interrelations across and within complex semiotic domains as a core learning experience (2003).

Systems thinking is also vital in STEM education, as it acknowledges complex relationships between the components of a system and the environment within which a system is contained (Ndaruhutse, 2019). This is particularly evident in STEM areas such as biology, ecology or circuitry in which systems concepts are fundamental. For example, the circulatory system consists of the heart (component) which pumps blood through vessels circulated throughout the body. These vessels create pathways (or relationships) to other organs and tissues in the body, distributing blood and nutrients. The blood interacts with many other systems in the body (digestive, nervous, endocrine systems, etc.), is returned to the heart through veins, and the cyclical process continues (Cleveland Clinic, 2021).

Overall, digital games can support STEM skills through critical thinking, resiliency, failure, and systems thinking. The ability to take risks, fail, persevere, iterate, and grow, can all contribute to the future skills required in STEM. Although playing digital games can provide added educational benefits, multiple reasons exist as to why women may not pursue or choose to discontinue pursuing gaming as a hobby. Such reasons for a lack of representation include misrepresentation, misogyny, and toxicity (Smith, 2019). This finding guided the literature review towards analyzing the experiences of women in both STEM and digital games and comparing the similarities between them.

Gender Equity

Gender Equity in STEM

In 2016, women aged 25-64 only made up 23% of the Canadian workforce in science and technology (Wall, 2019). Currently, women only make up 25% of the STEM workforce worldwide (Tsusaka, 2020). These statistics highlight an ongoing shortage of women in the STEM workplace, identifying a gap in female representation in STEM. This gap in female representation can also lead to unintended challenges, and biases. As a result, the following biases in STEM were discovered through the literature review:

Gender Bias in Physical Technology

Bias in technology occurs when personal beliefs, attitudes, and behaviours have an impact on the overall design of the technology being developed (Elsbach et al., 2019). For example, some virtual reality (VR) headsets have caused more women to experience nausea in comparison to men. In a study conducted by Stanney, Fidopiastis and Foster, researchers measured how men and women were able to tolerate VR exposure and cybersickness (2020). Hypothesizing that women would experience more nausea (based on prior studies) in comparison to men, the researchers wanted to identify driving factors for this phenomenon. Ultimately it was identified that the distance between the pupils (Interpupillary Distance or IPD) was a primary driver of sickness for women, as the VR headsets were not adequately fit for them. This experiment is one example of many which suggest including women, and other STEM minority groups, within manufacturing and design processes to reduce these biases (Stanney et al., 2020).

Everyday items such as smartphones further highlight gender bias in technology, as outlined by Caroline Criado Perez in her book *Invisible Women*. With the average size of a smartphone being 5.5 inches, the average man can hold and comfortably use the device in one hand, whereas “the average woman’s hand is not much bigger than the handset itself” (Criado Perez, 2019). Due to the use of technology such as smartphones, studies have linked women to higher musculoskeletal symptoms and disorders in comparison to their male counterparts (Eitivipart et al., 2018). Criado Perez also stated that women are often underrepresented in research studies related to ergonomics and data, and suggested proper representation as an important step in overcoming technology bias (2019).

Gender Bias in Software

Beyond the physical hardware, biases also appeared in software development. For example, biases have been discovered in software that uses recruitment algorithms to rank candidate resumes on qualifications and experience. In a study conducted by the University of Melbourne, AI-assessed resumes rated male candidates higher than female candidates based on historic hiring patterns (Krishna, 2020). In 2015, the algorithmic systems at Amazon were trained to select candidates by observing patterns of resume submission over the previous

10 years (Dastin, 2018). As the majority of previous hires were men, when the algorithm encountered words on a resume such as 'women's chess club captain' or 'all-women's colleges,' the applicant was rated lower in comparison to other resumes (Dastin, 2018). This highlights the importance of identifying and correcting biases in software development as future technologies will likely have biases as well.

Gender Bias in the Workplace

According to a study conducted in 2017, 50% of women working in STEM careers stated they had experienced workplace discrimination due to their gender, in comparison to only 19% of men (Funk & Parker, 2018). Women stated the most common forms of gender discrimination experienced in STEM jobs included:

- Earning less than a man doing the same job (29%)
- Having someone treat them as if they were not competent (29%)
- Experiencing repeated, small slights in their workplace (20%)
- Receiving less support from senior leaders in comparison to a male colleague at the same job (18%) (Funk & Parker, 2018)

These statistics highlight the ongoing gender bias in STEM, and how it impacts the identity, confidence, and morale of the women in these fields.

Overall, women working in STEM careers have often expressed working in inequitable environments, in comparison to their male coworkers (Funk & Parker, 2018).
The bias and underrepresentation that exist in male dominated STEM fields also echoes the experiences of women in games, as women in games also report being underrepresented in their industry. Accurate representation is one of the first steps in supporting women in both STEM and digital games, and leads the MRP to explore gender equity in games.

Gender Equity in Digital Games

Digital games account for the largest sector in Canada's entertainment industry (Globe and Mail, 2021). In 2021, the digital game industry was responsible for contributing $5.5 billion to the Canadian economy and over 55,000 jobs (Osborne and Tinajero, 2022). However, only 23% of Ontario digital game employees in 2021 were women (Entertainment Software Association of Canada, 2021). As the gaming industry continues to encourage more women to pursue a career in game design, deep-rooted systemic issues need to be resolved before more women gain significant involvement in digital games.

Historically, the depiction of women in early digital games has often been sexualized and derogatory. As a result, the trope of the 'damsel in distress' or the 'overly-sexualized' woman perpetuated unfavourable narratives and stereotypes that may have created a training ground for privilege and hegemony (Gray et al., 2018). The examples below will further describe gender bias encountered through voice, in digital gaming industries, and through underrepresentation:

Bias of Women's Voices in Games

In the 1920s to the 1940s, the voices of women on the radio were considered unsuitable for being "too shrill and noisy for the airwaves while also too emotionally unbridled, 'cackling', and informal to be taken seriously" (Gray et al., 2018). This cultural construct of women's voices as being 'unprofessional' translated to contemporary media by assigning roles of hypersexualized female characters with a voice that utilized vocal fry or upspeak to covey female battle cries in role-playing games (Gray et al., 2018).

Vocal fry is a speech effect caused by intermittent irregular vibrations of the vocal folds resulting in a lowered pitch and creaky sounding voice. According to a research study done by a research team at Duke University, a vocal fry is perceived negatively, especially for younger women (Anderson et al., 2014). Young adult female voices exhibiting vocal fry are perceived as less competent, less educated, less trustworthy, and less hireable (Anderson et al., 2014).

Another common vocal trait primarily associated with female voices is upspeak. Upspeak is the rising of intonation at the end of sentences that make statements sound like a question. This trait is perceived as lacking assertiveness and conviction and is considered unprofessional (Lyon, 2017). These associations with women's voices can contribute to hostile environments that affect the decision to participate in digital games for fear of being ridiculed or criticized for one's voice (Funk & Parker, 2018).

Biased Representation

As part of the larger technology and computing industry, the game industry has encountered problems in the diversity of its workforce and community. Underrepresented minority groups, such as LGBTQ, has been a problem in the gaming industry for many years, there is an even larger gap of underrepresentation for women within minority groups (Smith & Decker, 2016). In a research study done by the School of Interactive Games and Media at Rochester Institute of Technology, a survey conducted on a cross-sectional group of underrepresented minorities highlighted how a majority of survey participants felt misrepresented and invisible in the games they played. These feelings resonate with the feelings of women in STEM and games, as invalidation and invisibility may contribute to feelings of alienation and losing interest in the field (Smith & Decker, 2016).

Gender Bias in the Digital Games Industry

Women often face misogyny while participating in online games, which can lead to masking their own identities to avoid toxicity and poor behaviour from other players (Sinclair, 2021). Misogyny is a frequent aspect of gaming culture and can take place in a variety of ways, whether it be through politics in representation, graphics, or through the female voice itself. Women who actively partake in competitive gaming culture are occasionally stereotyped as 'gamer girls' that participate in the industry for attention rather than for their skill or talent (Gray et al, 2018).

In 2014, the Gamergate controversy occurred when thousands of people in the gaming community began to harass, target, and threaten women in the gaming industry on issues centered around sexism and anti-progressivism (Romano, 2021). Through the social media hashtag *#Gamergate*, the campaign escalated to the degree where some women received death threats and threats of rape (Dockterman, 2014). This controversy uncovered significant underlying issues in gaming culture and brought to light the difficulties women face as a result of bias in the industry. The battle for inclusion and diversity is deeply rooted in male-dominated industries where sexism and inappropriate behaviour towards women are more common.

Overall, women participating in digital games often experience criticism and harassment due to deep-rooted systemic biases through their voices, within the industry itself, and through underrepresentation. While better representation in digital games can help support more young women to feel comfortable participating in play, the deeper systemic biases will also need to be addressed.

Reflection

Through the Deconstruction step, the literature review identified skills aquired in digital games as relevant to the skills required for STEM. After breaking down the aspects of skills within STEM and digital games, the most prominent findings stood out as the following:

- STEM Skills - A variety of skills are associated with STEM, the three levels include Fundamental, Practical, and Advanced.

- Digital Games Skills - James Paul Gee identified 36 principles that support learning through digital games. Three of the skills learned include: critical thinking, failure and resiliency, in addition to systems thinking. These skills can be applied to any industry, but are especially relevant in STEM fields.

Overall, STEM skills are important to develop regardless of the career a person may enter. Figure 2 summarizes the relationship between skills required in STEM and the skills gained through digital games, validating the connection between the two.

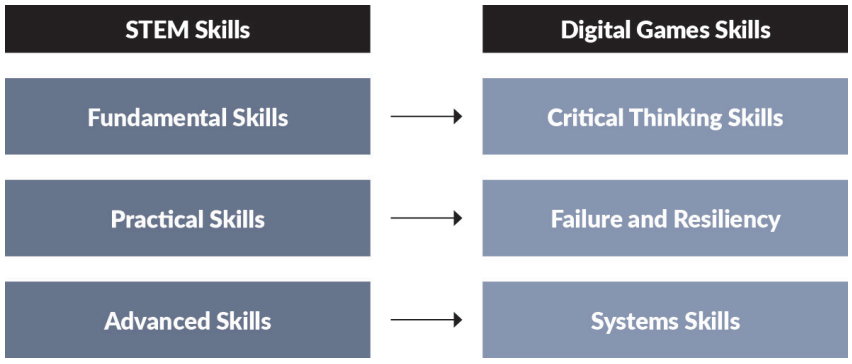


Figure 2: Skills summary between STEM and digital games

In addition, the literature review identified similar biases women experience in both STEM and digital games. After breaking down the aspects of gender equity within STEM and digital games, the most prominent findings stood out as the following:

- Gender Equity in STEM - Women in STEM experience bias whether it be through physical products, algorithmic codes, or within the industry itself.

- Gender Equity in Digital Games - There is a major lack of representation and character diversity in digital games. The stereotypical use of women's voices and the over-sexualization of female characters throughout history reflects the patriarchial hegemony occurring at the time.

Overall, lack of gender equity is a complex problem that exists in male-dominated technology industries. A contributing factor to this lack of representation is systemic gender biases. Figure 3 summarizes some of the biases encountered in STEM and in digital games.

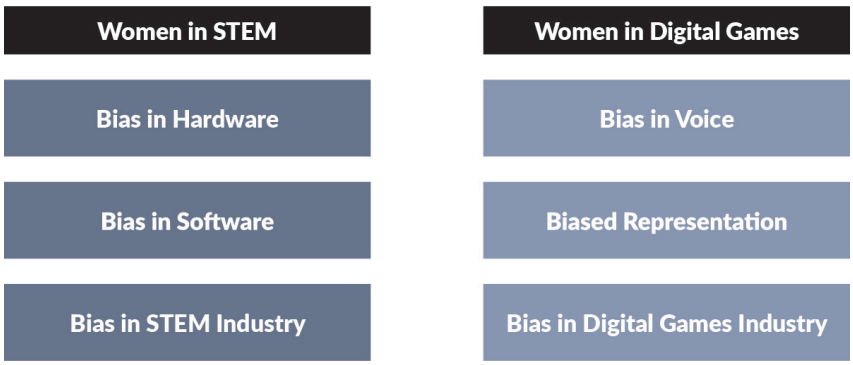
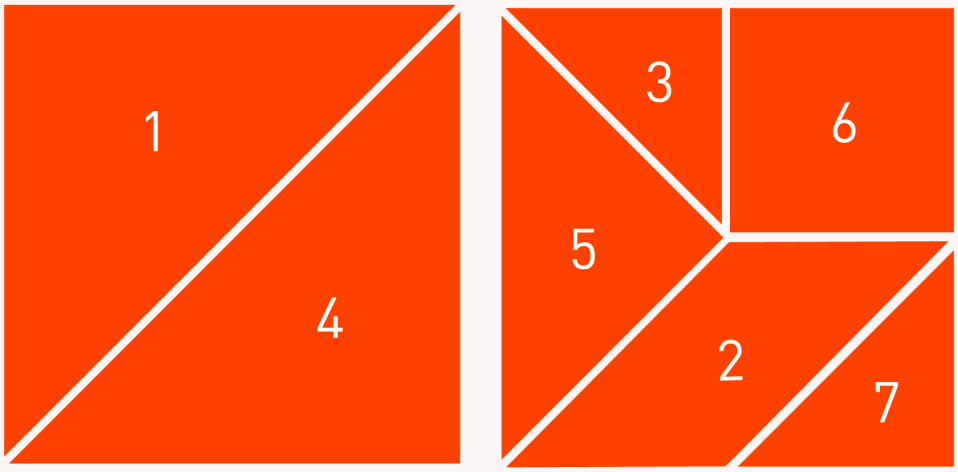


Figure 3: Gender equity summary of STEM and digital games

As a result, these insights on gender bias guided the MRP to further explore the experiences surrounding women in both digital games and STEM, particularly experiences that address voice and inclusion. Primary research will be guided by the following supportive research questions, which will be explored further in the next step: Point of View.

- How might we improve young women's experiences surrounding digital games so that they can better engage with STEM?
- How can stakeholders support the experience of young women in STEM education through digital games?

Step 2:



POINT OF VIEW

Forming a new POV

Image Source: Ayse Birsel, 2015

Step 2: Point of View

The goal of the Point of View (POV) step was to look at the current state through different perspectives in order to identify where to go deeper with insights from the literature review. In this step, primary research was conducted in three phases: in the form of an anonymous survey (Phase A), semi-structured interviews (Phase B), and a co-creative workshop (Phase C) illustrated in Figure 4. This primary research was inspired by a mixed-methods approach in which both quantitative and qualitative data were collected. The benefit of this approach was the ability for qualitative data (interviews and workshop) to provide explanations for the quantitative data (survey) (Creswell & Crewswell, 2018).

Primary research began with an anonymous survey aimed at women in digital games in order to acquire quantitative data sets on the following three sections: STEM Outlooks and Skills, General Gaming, and Online Gaming. These sections asked participants broad questions relating to their views on STEM in addition to their gaming background, interests, and habits. The survey data acted as a statistical reference point when comparing data discovered in other parts of primary research.

After the survey was completed, semi-structured interviews were conducted with women in digital games and STEM, focusing on qualitative, open-ended questions that collected detailed views from participants. The interview process was useful for uncovering explicit knowledge of participant behavior during digital play that was challenging to identify in the survey, such as complex information about a participant's thoughts, emotions, and beliefs. By providing a space for participants to share their experiences in either digital games or STEM, participants were able to share their experiences in a way that encouraged their voices to be heard.

After semi-structured interviews, a co-creative workshop was conducted and preliminary findings were presented to participants. The goal of the workshop was to invite stakeholders to come together and conceptualize criteria and actionable steps for improving women's experiences playing digital games. It was important to include a range of stakeholders from different industries within STEM, digital games, and education in order to bring a diverse range of perspectives and insights.

Participants in this study were notified of the research through a Research Ethics Board (REB) approved post that was shared on social media through the researcher's personal network. A description with links to the online survey, interview and workshop content forms were distributed amongst the Ontario eSports League and Uniting Gamers communities; as these organizations offered to share the recruitment forms among their gaming community members.

The following figure depicts the three phases of primary research, along with the participants involved, and the supporting research questions explored in each phase. The step ends with a reflection in which key insights are discovered and explored further in Step 3: Reconstruction.

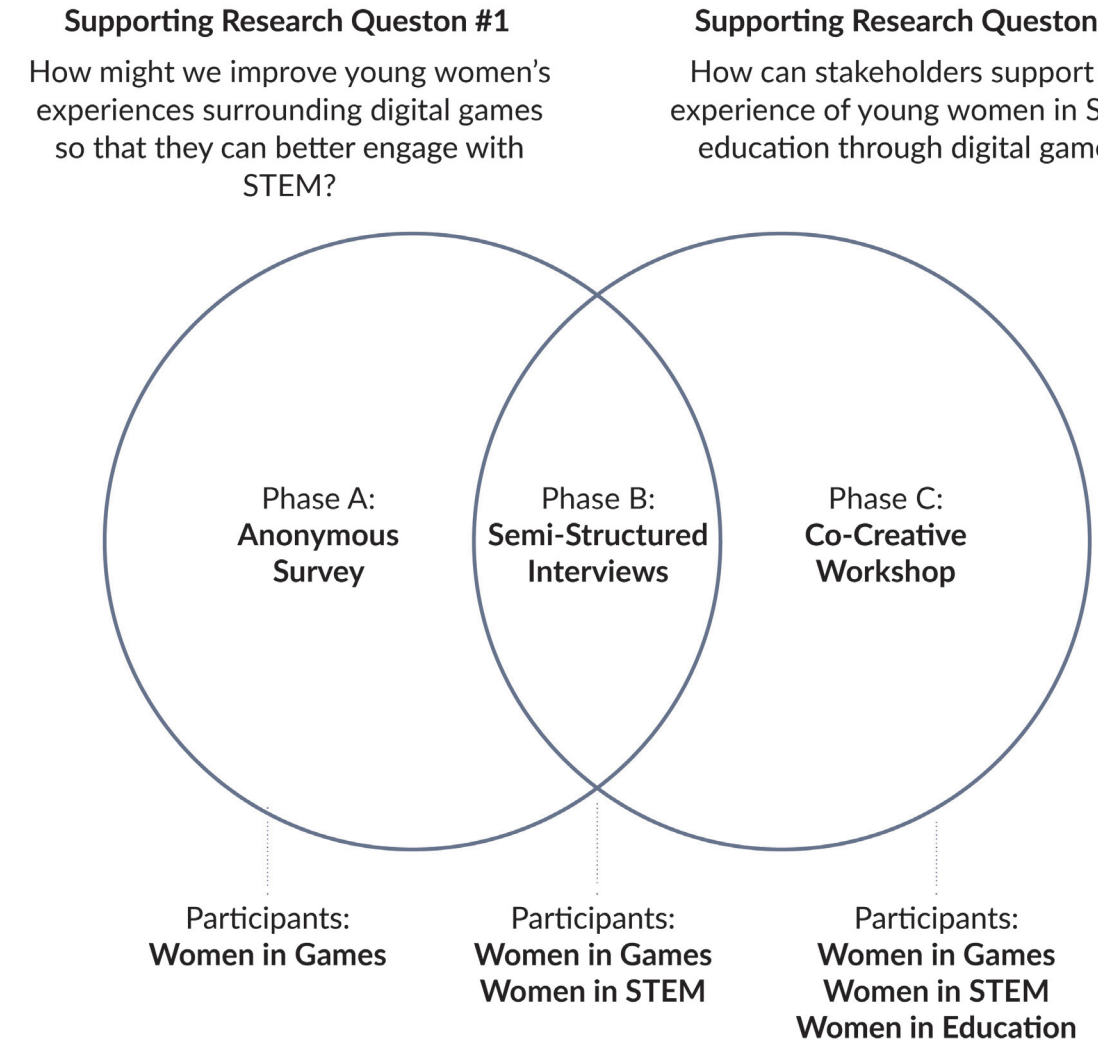


Figure 4: Venn diagram of primary research phases

Phase A: Anonymous Survey

Survey Methodology

Primary research began by conducting an anonymous survey aimed at women in Canada who play digital games in their spare time, in order to identify participants' values and perspectives. The main criteria to participate in the survey consisted of the following: women aged 18 or older, who reside in Canada and play digital games leisurely. Although the survey was anonymous and did not collect any contact information, it did ask participants their age range.

The 25-question survey was split into three main sections:

STEM Outlooks and Skills
This section asked participants to rate their interest in a variety of STEM fields and what skills they believe to have gained through gaming. The goal of this section was to obtain direct feedback from participants on what skills they believed to have learned while playing digital games. Additionally, this section explored how many participants were involved in both STEM and gaming fields.

General Gaming
The General Gaming section identified popular titles and genres the participants preferred to play, in addition to the duration and frequency of play throughout a week. Furthermore, this section uncovered who the participants preferred to play with, the age they started playing games, and if they felt represented by the characters in-game (either by gender, ethnicity, sexual orientation, etc.).

Online Gaming
The Online Gaming section dove further into the experiences of participants who interact with other players online. This section asked participants questions about voice communication, experience playing with strangers, and if they have felt any forms of toxicity while playing. If participants only played digital games independently and not online then they were still invited to select their preferences or to skip this section. The purpose of this section was to learn about women's experiences while participating in online games, and how these experiences compared to literature findings.

Overall, 31 participants were surveyed, with 30 meeting the eligible criteria. The respondents represented two primary demographic groups: Generation Z (aged 18-24) and Millennials (aged 25-39). Of the 30 participants involved in the survey, 50% of participants were between the ages of 18-24, and 50% were between the ages of 25-39, all of whom identified as women. The survey was conducted over a period of eight weeks and included a prerequisite consent form in order for participants to access the survey. Sampling women in the gaming population provided a quantitative analysis of potential trends, attitudes, or opinions about their experiences playing digital games.

Survey Findings

After analyzing the responses from survey participants, the following findings emerged:

STEM Outlooks and Skills Summary

- 70% of participants answered “Yes” when asked if they had ever considered pursuing a career in STEM
- 37% of participants answered “Yes” when asked if they were currently pursuing a career in STEM
- 44% of participants answered “Yes” when asked if they thought digital games supported their interest in pursuing a STEM field
- 72% of participants answered “Arts”, and 47% stated “Humanities” when asked what other fields they were interested in growing up
- 97% of participants answered “Strategy” when asked what skills they had gained from playing digital games
    * 93% of participants equally stated “Critical Thinking” and “Problem Solving”
- When asked how interested participants were on a scale of one-to-five in various STEM fields growing up, the top answers consisted of: “Biology”, “Virtual Reality/Augmented Reality”, and “Astronomy”

General Gaming Summary

- 87% of participants responded that they were under the age of 12 when they started to play digital games
- 80% of participants stated that they played with a sibling growing up
- 37% of participants stated “I am often not represented” or “I am never represented” by the characters they play in games
- 26% of participants stated their parent’s/guardian’s outlooks on gaming were “Passively Encouraging” while growing up
- 23% of participants stated their parent’s/guardian’s outlooks on gaming were “Passively Discouraging” while growing up

Online Gaming Summary

- 36% of participants felt as though their gaming experiences online were 50/50 split between positive and negative
    * 33% of participants stated mostly positive, 23% stated mostly negative
- 30% of participants stated they avoid playing online with strangers
- 64% of participants answered “Sometimes” and only 16% answered “Always” when questioned whether they played games with audio/voice communication
- 43% of participants responded that they “Sometimes” mute another player due to toxic behaviour, whereas 27% of participants stated they “Always” mute another player due to toxic behaviour
- 76% of participants responded that they “Report toxic players” when asked what they do if they experience a toxic player online
    * 50% of participants stated “Mute the microphone”
- 83% of participants stated “Yes” when asked if they had witnessed discrimination of any other players online

Survey Insights

From the STEM skills section, participants ranked strategy, critical thinking and problem solving as the top skills they learned from gaming. This supported the literature findings in the Deconstruction step and reinforced the STEM skills needed to be successful in STEM industries. From there the next steps were to explore these findings in the semi-structured interviews, asking interviewees more questions about their current context in relation to STEM or professional careers.

From the General Gaming section, an interesting insight was the age at which participants began playing, with the majority under the age of 12. This insight highlights the importance for young players to have responsible mentors that introduce them to digital spaces. These mentors can support young players by establishing ground rules and proper etiquette in games. In addition, the majority of participants stated they had a sibling that also enjoyed gaming growing up. This insight will be further explored in the interview phase, by asking interview participants about their past experiences and family dynamics with games. Exploring participants' past in games gives insight into understanding the systems and structures that encouraged them to participate, who introduced them, and how.

From the Online Gaming section, a majority of women stated they had personally encountered toxicity from another player or witnessed discrimination of other players. This validated the secondary research finding which stated that negative experiences in gaming were a key factor deterring women from participating in digital games. This finding also highlighted the importance of developing solutions that improve the experiences women have surrounding digital games, in order to build a more inclusive gaming culture. In the following interview phase, this finding was explored further with participants by asking them to envision their ideal experience while participating online in digital games.

Although the sample size for the survey was based on a fraction of the population available, it was intended to support and find areas of deeper analysis for the next part of the research: interviews. In the following section, an emphasis was placed on women in games to further explore their current context, past memories, and future dreams. In addition, women in STEM were introduced in the interview section. Figure 5 shows how the survey sections and insights supported and framed the structure of the interviews.

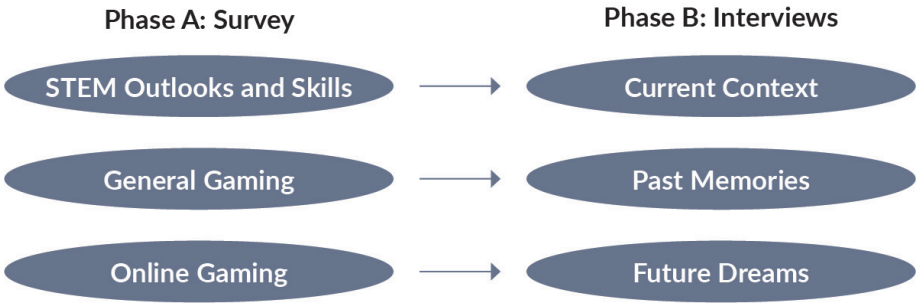


Figure 5: Survey insights translating into interview questions

Phase B: Semi-Structured Interviews

Interview Methodology

The next phase of primary research consisted of semi-structured interviews with Canadian women involved professionally in either digital games or STEM, or both. The goal of these semi-structured interviews was to capture issues and challenges interviewees may have encountered during gameplay or in their professional careers. Interviews were conducted following the surveys, in which the quantitative data from the surveys grounded the interview questions by providing context for digital games and players' experiences. Additionally, interviews explored in what capacity digital games may or may not have had supporting the careers of interviewees. Conducting semi-structured interviews provided space for in-depth exploration of stakeholder perspectives by diving into lived experiences and personal opinions.

Interview sessions were based on Elizabeth B.-N. Sanders' *Path of Expression*, which is a process of guiding interview participants to a deeper understanding of their needs, wants, hopes, and dreams in order to identify future opportunities (Sanders & Stappers, 2014). As seen in Figure 6, the *Path of Expression* is divided into four parts. The first starts by asking interviewees questions about their current state, the second part recalls interviewees past experiences, the third part reflects on those experiences to uncover underlying values, and the final fourth part uses those values to guide the thinking of desirable futures (Sanders & Stappers, 2014).

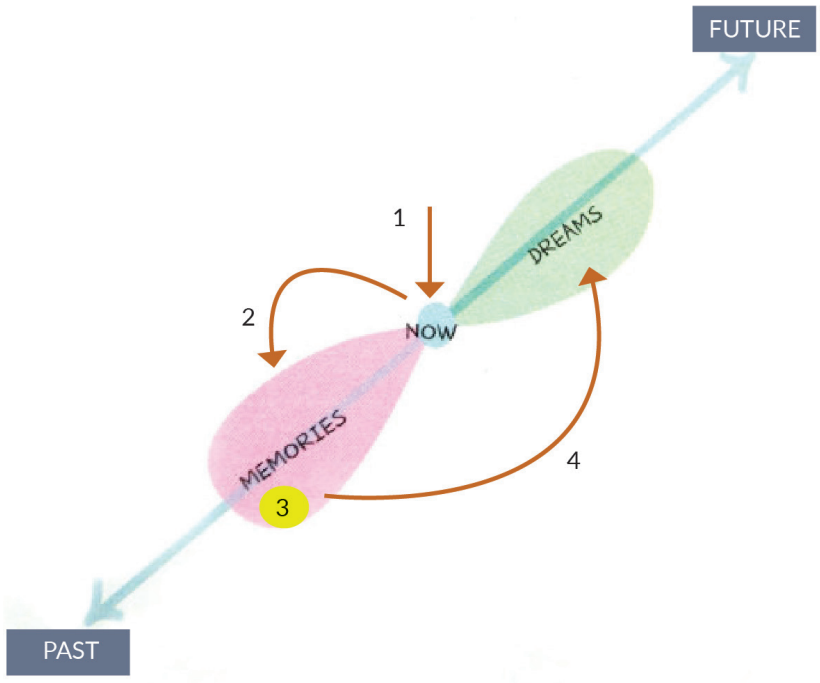


Figure 6: *Path of Expression* by Elizabeth B.-N. Sanders and Pieter Jan Stappers (Sanders & Stappers, 2014)

The interviews were aimed at female professionals over the age of 18 in either STEM fields, or digital game industries, with at least one or more years of experience in the field. While having a gaming background was not required, if the interviewee had a background in digital games, they were guided towards a set of questions that explored family views, stereotypes, gender bias, STEM, and what skills they acquired through playing. If the interviewee had a background in STEM, they were guided towards a set of questions that explored their current career state, the role STEM played in their career, if they had a mentor or champion, and any gender biases they may have encountered in the workforce. Interviewees who had experience in both digital games and STEM were guided through a set of questions regarding what skills they believed were most important in their current career and if games contributed to developing those skills.

Overall, 12 participants were interviewed, three with STEM backgrounds, two with mixed backgrounds in STEM and gaming, and seven with gaming backgrounds. Interviewees ranged from 18 to 40 years of age, with one to nine years of professional work experience. Interviews were conducted one-on-one over a three-week period and lasted approximately 30 to 60 minutes. Each interview was recorded, transcribed, analyzed, grouped into findings, and compared with survey findings in order to identify patterns, and themes.

Interview Findings

Following the *Path of Expression* process, interviews with gamers began by questioning interview participants on their current views of digital games and what their gaming tendencies were. Interviewees were then asked to reflect on past experiences, such as when they were introduced to digital games, and if having a mentor had a positive effect on their perspectives of games. Lastly, interview participants were asked to identify what changes they wished to see in gaming culture in order to build a desired future.

After analyzing the responses from women about their experiences while gaming, the following findings emerged:

Current Context - Women in Digital Games

- Some interviewees stated they were often overlooked and dismissed as valuable team members due to their gender and not their skill in-game.
- Interviewees expressed that they had to win in order to prove themselves. They felt pressure to represent female players, especially as some male players would leave a game automatically if they saw anything related to “girl” in their gamertag or profile.
- Some interviewees expressed that as their in-game rank and skill level increased, so did the nuanced levels of toxicity they experienced while gaming online.
- Interviewees expressed there is a common assumption that all gamers who play First Person Shooter (FPS) games are men, and the women who play FPS games are not as skilled as men.

- Interviewees stated that respect and praise were often reserved for characters that had stereotypical masculine skills, such as accuracy while aiming or strength. Conversely, characters with stereotypical feminine skills, such as healing, were viewed as 'easier to play' and therefore garnered less respect.
- Some interviewees expressed their preference for playing games offline to avoid unwanted interactions with toxic players.
- A common theme expressed amongst many interviewees was that they felt there was a lack of patience, grace, or empathy in the online space.
- Some interviewees expressed that when they did not hide their identity or choose a gender-neutral gamertag, male players made negative assumptions about their abilities.
- Some interviewees stated they would not speak online unless they heard another woman's voice first.
- Interviewees stated that there is currently little accountability and policing for poor behaviour in digital games.
- Interviewees expressed that little to no programs exist in educational settings that teach players digital etiquette and responsible communication in digital game environments.
- Some interviewees expressed that learning how to gamify, set, and achieve mini-goals in digital games translated to how they approached growth and success in their careers.

Past Memories - Women in Digital Games

- The majority of participants mentioned playing games at a younger age, starting by either watching a sibling, parent, or family member play.
- For participants who immigrated into the country, games were used to meet new people and as a tool to learn English.
- Many interviewees expressed that while growing up, their parents were neutral or supportive of digital games, as they saw the social benefit of children coming together to play with each other in person.

Future Dreams - Women in Digital Games

- Interviewees expressed their hopes of using digital games to develop skills such as leadership, exploration, adaptability, critical thinking, and problem-solving.
- Interviewees stated their hopes of digital games being more acceptable in the future, and not stigmatized.
- Interviewees hoped society would become accepting of the social benefits of digital games including: relationship building, community development, and the ability to shape culture.
- Interviewees expressed that playing digital games could be used as a therapeutic way to relax, decompress, and support mental health in the future.
- Some interviewees desired government involvement on a federal and provincial level to add legislation that governs digital games.
- Some interviewees hoped extreme negative behaviour in digital games (such as threats and sexual harassment) would have more real-world accountability.

Interviews with women in STEM industries began by questioning interviewees about their career path, experiences with gender bias in the industry, and if they had a mentor in the field. Questions were also asked about what their views on gaming were and how digital games could relate to their industry. Lastly, interviewees were asked to identify what changes they were seeing or wished to see in STEM in order to understand their future desires.

Although the sample size was small for women in STEM, and the data is not large enough to be fully representative, the following directional findings still emerged:

Current Context - Women in STEM

- Interviewees stated that they have experienced misogyny in the form of microaggressions in the workplace.
- Some Interviewees felt that their male colleagues garnered more respect.

Past Memories - Women in STEM

- Interviewees expressed the need for mentors in the field in past educational experiences.

Future Dreams - Women in STEM

- Some interviewees said they were moving towards gamification in their industries (ex. Using gamification for user training and research).
- Interviewees expressed the importance of having diverse representation in STEM to design better products and solutions.
- Some interviewees stated that understanding game mechanics is an important skill of the future.

Interview Insights

Qualitative data from the semi-structured interviews were gathered into a spreadsheet and grouped into clusters to uncover valuable findings. These interview findings were then compared to the literature review and survey findings in order to develop relevant insights.

From the Current Context section, the interview findings further validated the negative gaming experiences of women and identified common themes such as women are harassed online by male players, and many women hide their identity online due to toxicity. These negative experiences have deterred women from playing and one interviewee expressed the toxicity was so severe that they had to stop playing digital games altogether.

Another interesting insight shared by interviewees was that there is currently little governance in the online space that holds players accountable for their toxic behaviour. Since digital games are a form of interactive entertainment that require two-way participation between the players and the game, regulating experiences is difficult due to the fact that content is created in real-time. In online settings, it

is unpredictable to know what another player might do or say, which could allow a participant to experience negative behaviour unintentionally. This unpredictability is more challenging to control in online spaces than in other passive forms of entertainment, such as television and film.

In the Past Memories section, interviewees were asked to share the age at which they began playing digital games and who introduced them when they were younger. Many participants began playing before the age of 12 and were introduced by a sibling, which aligned with the findings in the anonymous survey. Another participant was dedicated to minimizing the stigma of female gamers and advocated for the social benefits of digital games as a community-building tool that also shapes culture. Interviewees also stated that games were used as a way to unwind and de-stress, supporting their mental health and personal wellbeing.

Lastly, in the Future Dreams section, an interviewee stated that greater regulation of virtual spaces was desired in hopes of creating a more safe and inclusive environment. One participant expressed the need for a new government initiative that focuses on gaming regulation separately from other forms of entertainment, considering the experience of playing digital games online is unique compared to film or television.

In summary, the interviews validated the assumption that female gamers are currently exposed to a high volume of negative and toxic experiences. Interviewees also highlighted digital games as a tool for skill-building, not only in STEM but in other fields as well. By establishing the Current Context, Past Memories, and Future Dreams sections of the interviews, findings were incorporated into a *Causal Layered Analysis* in Step 3: Reconstruction.

The following Figure 7 depicts how the insights discovered in the survey and interview phases were used to frame the problem for participants in the co-creative workshop.

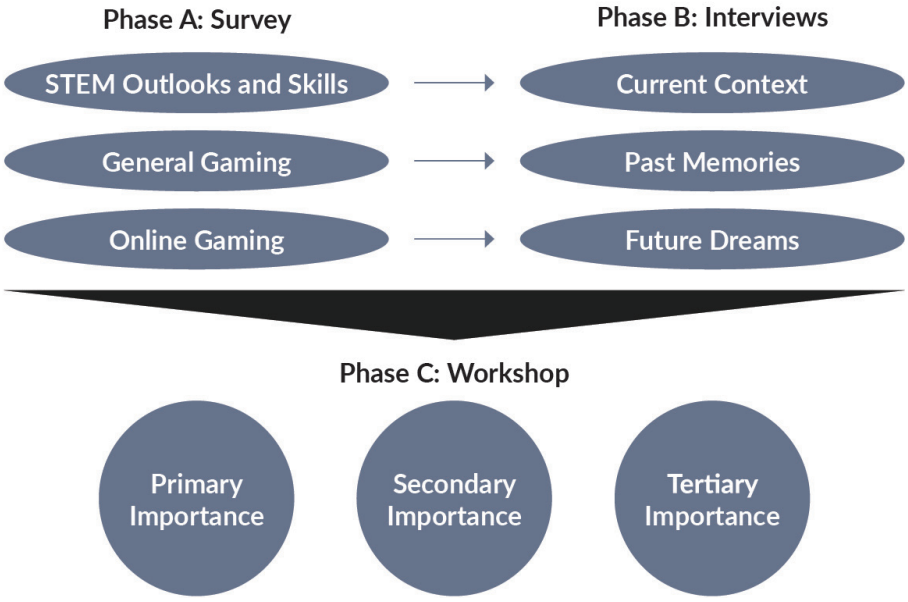


Figure 7: Phase A and B primary research insights funneling into Phase C

Phase C: Co-Creative Workshop

Workshop Methodology

In the last phase of primary research, a co-creative workshop invited a range of stakeholder groups, including Educators/Teachers, Gamers/League Organizers, STEM Camp Counselors, or Directors. Each stakeholder group was selected based on their involvement with either STEM education or their understanding of game development/experience. The goal of the workshop was to identify different stakeholder group priorities, and design recommendations in Step 4: Expression that aligned with workshop participant's feedback.

The co-creative workshop structure was inspired by Sander's approach to generative research through *Make*, *Tell*, *Enact*, a framework in which research is rooted in discovery and exploration in order to find opportunities for solutions and innovation (Sanders & Stappers, 2014). The *Make*, *Tell*, *Enact* framework was used in order to identify the opinions, knowledge, and experiences of each workshop participant involved in the participatory session (Sanders & Stappers, 2012). The workshop focused on the experiences of women in digital games and STEM in order to generate and develop ideas, concepts, and solutions for the future (Sanders & Stappers, 2012).

The workshop began with an introduction where examples of each activity were presented to workshop participants, detailing the workshop structure and objectives. At the half way point of the workshop, participants were also presented with a high-level summary of the primary research findings. This high-level summary was intended to provide foundational knowledge and key insights learned in the overall research study at that point.

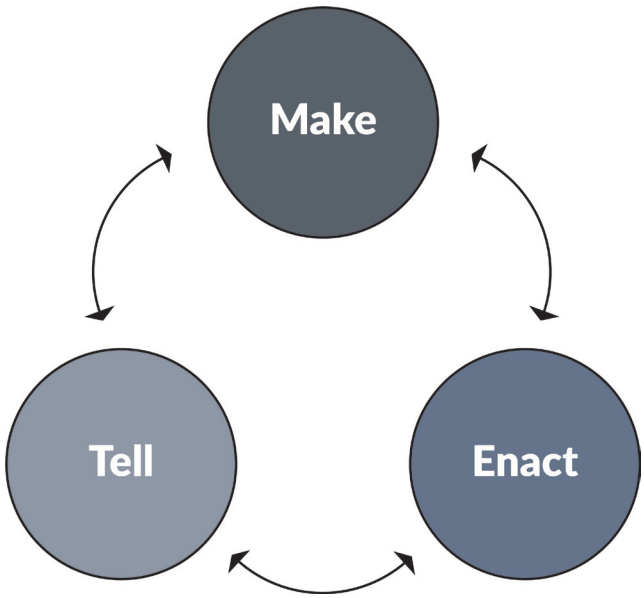


Figure 8: *Make*, *Tell*, *Enact* by Elizabeth B.-N. Sanders and Pieter Jan Stappers (Sanders and Stappers, 2014)

Beginning with the "Make" section, participants were invited to collaborate on an online whiteboard in order to create a three-by-six matrix, in which *Rose*, *Thorn*, *Bud* were labeled across the x-axis, and *STEEPV* (Societal, Technological, Ecological, Environmental, Policy and Values) was labeled down the y-axis. Workshop participants were asked to generate ideas on virtual sticky notes relating to each STEEPV category. Figure 9 illustrates the matrix laid out for workshop participants.

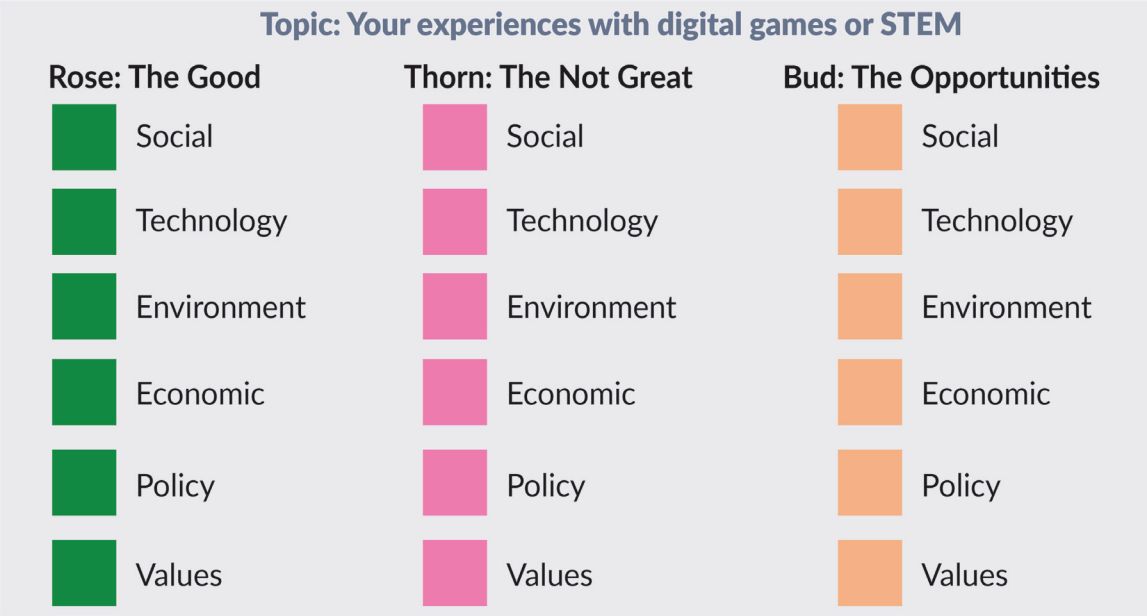


Figure 9: *Rose*, *Thorn*, *Bud* and *STEEPV* matrix

Rose, *Thorn*, *Bud*, was a helpful way for participants to structure their thinking on the positive, negative, and opportunity spaces in either gaming or STEM. Rose symbolized positive elements and possible beneficial outcomes of participating in digital games or STEM. Thorn symbolized negative elements that need to be redesigned or removed altogether from digital games or STEM. Bud symbolized opportunities for potential growth or change within digital games or STEM (Martin & Hanington, 2019)

Next, in the "Tell" section, participants each created their own *Bull's-Eye Diagram* utilizing insights from the previous activity. Topics were arranged into areas of primary, secondary, and tertiary importance according to the participants (Martin & Hanington, 2019). This is where participants were encouraged to explain their reasoning as to why certain stickies belonged in different areas of importance.

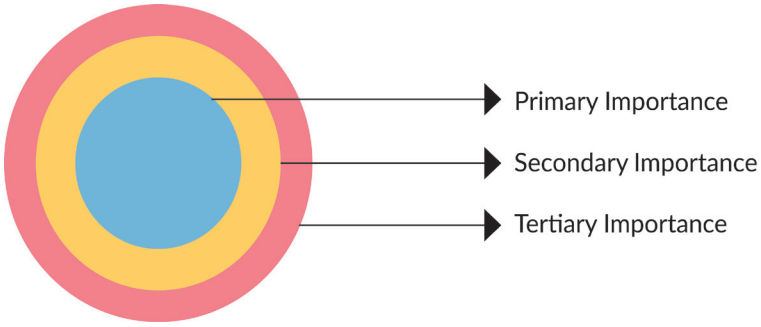


Figure 10: *Bull's-Eye Diagram* prioritization of importance (Martin & Hanington, 2019)

Finally, in the “Enact” section, the goal was for participants to engage in a virtual room on Mozilla hubs, an online 3d collaboration platform where players control an avatar in a shared virtual space. The purpose of utilizing this environment was to express ideas of future experiences and to reflect on the workshop process. The use of this virtual world was intended for participants to explore and discuss what the future scenario developed in the previous sections would look like. However, due to time limitations, the “Enact” section was not attempted by workshop participants.

Overall, the workshop consisted of three participants from stakeholder groups ranging from Primary School Teacher, Camp Director, and a Gaming Community Organizer. The workshop was conducted virtually over a single 90-minute session and participants were sent a link to an online whiteboard that was used throughout the workshop session.

Workshop Findings

In the “Tell” section of the workshop, participants were encouraged to describe their *Bull’s-Eye Diagrams* in order to explain their reasoning behind the prioritization of different aspects in STEM or gaming.

Participant 1: Primary School Teacher
This participant acknowledged that they were not as familiar with technology and online gaming, but if it was more accessible in a social and emotional way then they might feel more inclined to participate. This participant prioritized different ways to empower young students as capable math learners, such as teaching math in tandem with physical games.

Participant 2: Camp Director
This participant prioritized their diagram with a lens on levels of accessibility for youth to engage in educational activities. This participant acknowledged how games can create deeper friendships and communications between peers. However, they also acknowledged financial barriers and lack of internet access as limitations, impacting students when accessing and using technology for digital games.

Participant 3: Gaming Community Organizer
When reflecting on their own choices within the *Bull’s-Eye Diagram*, this participant noted that they grouped their top priorities around diversity in the digital games industry. Primary importance was focused on encouraging diversity within game development and establishing systems that shut down toxic behaviours in games. Furthermore, secondary priorities were areas relating to accessibility and inclusion.

Workshop Insights

In order to analyze workshop findings, a qualitative and quantitative approach was used to categorize, compare, and weigh the results. The analysis consisted of three stages:

Stage 1: Each individual *Bull's-Eye Diagram* was inputted into datasets on a spreadsheet.
Stage 2: Each *Bull's-Eye Diagram* was then compared and weighed based on levels of importance.
Stage 3: Alignments between each diagram were developed into findings.

The cross-reference of the workshop summaries resulted in the following findings:

Primary Level of Importance - Points that appear to have the biggest impact

- Participants expressed concern that there are potential barriers for those with learning needs/special education needs as well as financial barriers.
- Participants felt that having a greater diversity of game developers leads to greater representation and diversity of in-game characters.

Secondary Level of Importance - Points that appear to have mid-level impact

- Participants felt that the ability to connect with other players from around the world was a beneficial learning experience.
- Digital games and technology can be difficult to navigate for those who are not familiar with online gaming.

Tertiary Level of Importance - Points that appear to have a lower impact

- Digital games have highly realistic environments and characters which are appealing and may lead to addiction.
- Participants expressed their concern with governments and corporations' ability to use data in an uncontrolled or unethical way.

Reflection

Step 2 of the research explored the points of view of stakeholders through various forms of primary research. Surveys and interviews allowed participants to share their real-life experiences and provided their personal opinions on both STEM and digital games. A workshop was used to identify key points of impact and categorized them based on levels of importance.

When revisiting the primary research, it was evident that the challenges female players currently face are largely based on assumptions made by society that are common outside of digital games. In many cases, the participation of women has been overlooked in both the playing and developing of digital games. A lack of women in game development and STEM industries may lead to the development of games and technology with a bias in favour of those designing the experience.

Furthermore, the experiences of women playing games varied depending on which role or character they played. For instance, characters with traditionally masculine traits were more respected or praised. As a result of these biases, some participants made a conscious effort to play games offline or with gender-neutral gamertags to avoid unwarranted toxicity and attention from male players. The social misconception that males are superior to females transcends into the digital world as many female characters in digital games are misrepresented.

Findings from the workshop were further expressed as six keywords which established the following key pillars: Accessibility, Diversity, Connection, Education, Engagement and Trust. Figure 11 illustrates the six keywords that were generated from the alignment of workshop participants.

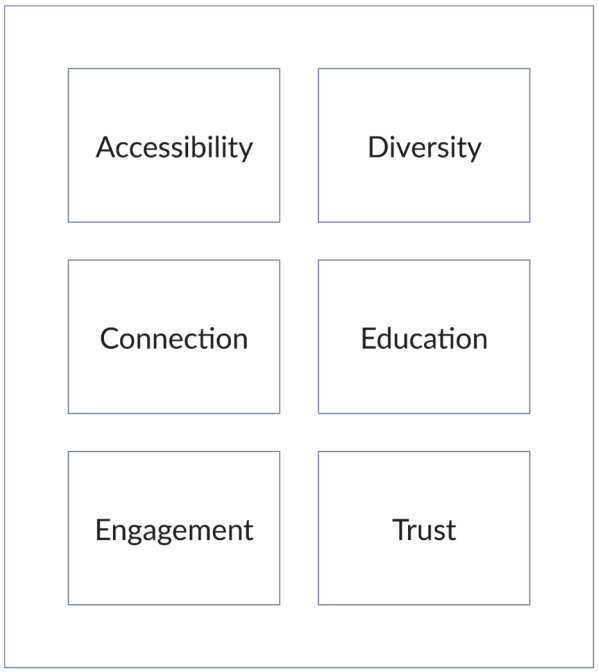


Figure 11: Key pillars developed by workshop participants

Although the Deconstruction and Point of View steps included the perspectives of women in STEM and education industries, the remainder of the MRP centered around women in digital games, specifically, younger women in educational settings. This was due to primary research uncovering the insight that the majority of women involved in this study were introduced to digital games under the age of 12. The primary and secondary research insights were reconstructed into a systems map and *Causal Layered Analysis* in Step 3: Reconstruction. Furthermore, the key pillars, as defined in Figure 11, guided recommendations in Step 4: Expression

Step 3:

Image Source: Ayse Birsel, 2015

Step 3: Reconstruction

The goal of the Reconstruction step was to consolidate the findings, insights, and reflections from previous steps (Deconstruction and Point of View) into tools that uncovered critical leverage points and metaphors in the larger system. In this step, systems mapping identified elements and stakeholders within the digital games space. Elements were discovered through primary and secondary research and composed the landscape of the current state of the system. In this step, connections between elements were further examined to uncover opportunity spaces and leverage points for change. Leverage points identified in this step were based on Donella Meadows' *Leverage Points: Places to Intervene in a System* which is further explained in the CLA section (1999).

Additionally, primary and secondary research were used to inform a *Causal Layered Analysis* (CLA). The CLA was used within two contexts, one within the current context of women in digital games, and a second within a desired future context. The CLA was useful for analyzing underlying causes and worldviews representing the current state, and uncovering powerful metaphors representing an alternative future (Inayatullah, 2008). The alternative future is set as a goal in the Expression step to act as a north star for the recommendations.

Systems Map

After establishing key insights through the Deconstruction and Point of View steps, this step utilized a systems map that visualized key elements surrounding young women who participate in digital games. Systems mapping identified important connections, linkages, and influences between each element in the system, supporting a deeper understanding of the relationships between them (Meadows, 2008). Young women that play digital games were identified as the central element of the system, in which all other elements surrounded. The following map in Figure 12 illustrates system elements that influenced, supported, or deterred the wants and needs of the player.

In an initial analysis of the systems map, elements were compared based on the number of connections they had, which revealed three elements with greater connections in contrast to the others. Aside from the female player located in the middle of the map, the elements that stood out with the largest number of connections included: Digital Games (ie. Game Publishers, Developers/ Creators), Primary and Secondary Schools (ie. Teachers/Educators), and Gaming Community Leaders. Therefore, a deeper analysis was conducted on these connections specifically.

This analysis identified important subsystems surrounding Digital Games, Primary and Secondary Schools, and Gaming Community Leaders as the following:

- Subsystem 1 - Gaming Industry Subsystem (green)
- Subsystem 2 - Educational Subsystem (orange)
- Subsystem 3 - Recreational Subsystem (purple)

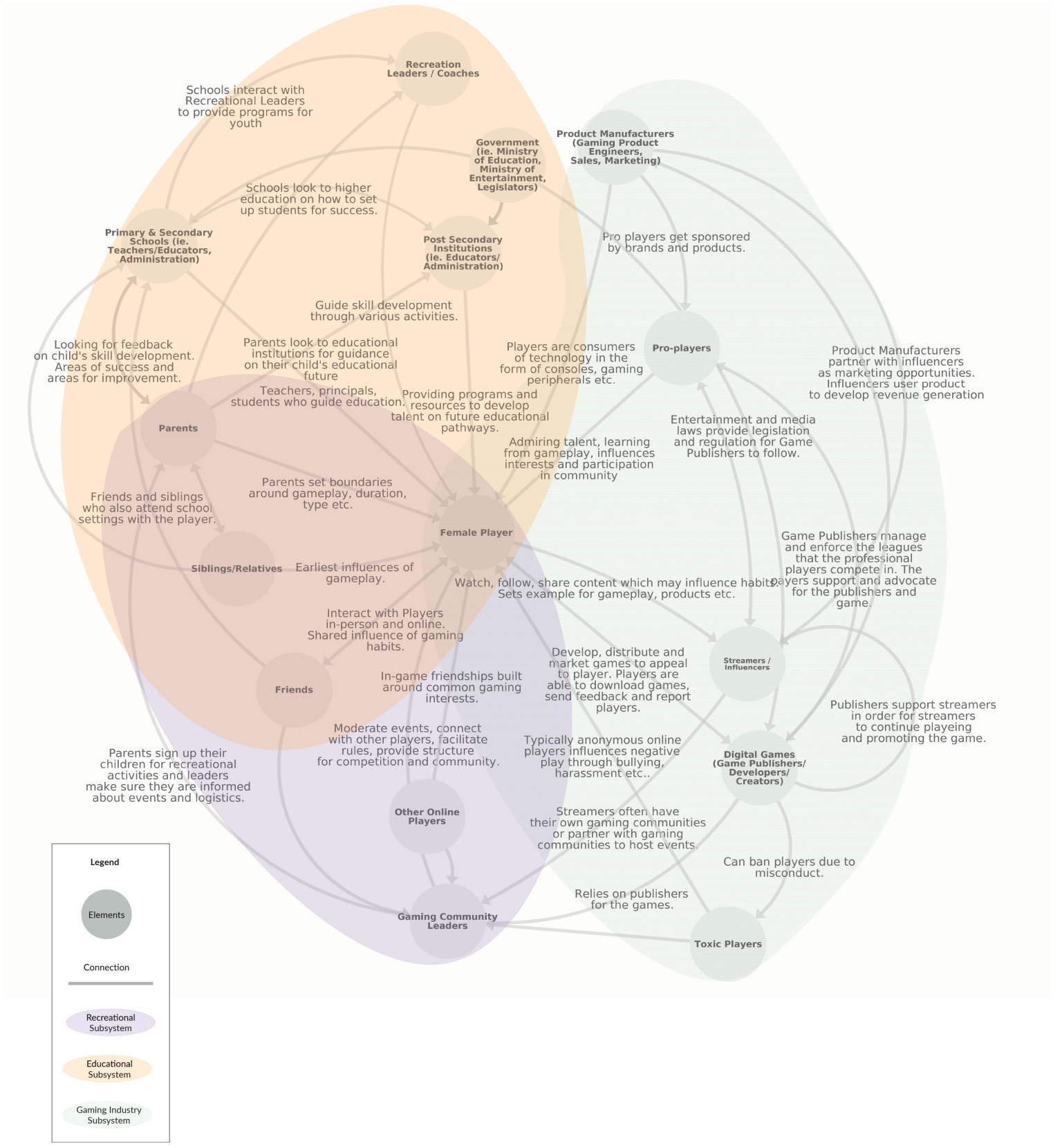


Figure 12: Systems map of female players in digital games

After identifying the three main subsystems, an analysis was conducted on each subsystem identifying the elements within, where connections overlapped, and where potential connections could be made.

Subsystem 1 - Gaming Industry Subsystem
The Gaming Industry Subsystem (green) depicts elements and stakeholders connected to the Digital Games element, which consists of Game Developers, Publishers, and creators that have varying degrees of influence on the player. More specifically, this subsystem consists of Players, Game Developers/Creators, Publishers, Product Manufacturers, Professional Players, Influencers/Streamers, and other Online Players. It is important to note that the whole system is dependent on the relationship between the player and digital games, without one or the other the system ceases to exist. Additionally, Players are often required to give permission to Publishers for their data in order to play a game. Player data allows Publishers to monitor user information such as: name, email, location, and other types of personal information (Office of the Privacy Commissioner of Canada). However, Publishers generally have their own interests and will utilize player data as ways to market and grow their game (Hodent, 2019).

Surrounding the Game Developers are Product Manufacturers, who design the gaming systems, software, hardware, merchandise, and products that players use to play, control, and interact within the digital game environment. Product Manufacturers often partner with gaming communities, professional players, social media influencers, and streamers in order to market and promote their products to consumers. Influencers/Streamers and Professional Players drive engagement within Gaming Communities through online interactions and social media content.

Subsystem 2 - Educational Subsystem
The Educational Subsystem (orange) depicts elements and stakeholders connected with Primary and Secondary schools that have an educational influence on the player. This subsystem consists of Players, Government entities (ie. Ministry of Education), Schools (ie. Primary and Secondary), Higher Education (ie. Post Secondary Education), Parents, Siblings, Friends, Recreational Coaches/Leaders, and Other Players. In the context of this subsystem, the Player is assumed to also be a student enrolled in an educational institution within a province in Canada. For example in Ontario, the Ministry of Education is responsible for establishing a curriculum for schools that teaches relevant skills, and sets students up for success in the future (Ontario, 2020b). Additionally, parents put their trust in educational institutions to keep students protected and safe, both online and offline within the context of a school setting.

Educational institutions are responsible for ensuring students meet curriculum requirements, and when students learn with relevant and captivating content they feel motivated and inspired to actively engage in their education. As a result, in March 2022 the provincial government of Ontario announced a $1 million dollar scholarship that will offer financial assistance to students pursuing programs related to game

design, development, marketing, and innovation industries (Osborne and Tinajero, 2022). This investment will support students as they pursue and prepare for careers in the digital game and esports sectors, while developing transferable skills valued by employers across numerous industries, including STEM (Osborne and Tinajero, 2022).

Subsystem 3 - Recreational Subsystem

The Recreational Subsystem (purple) depicts elements and stakeholders connected with Gaming Communities and Peer Groups that identify areas of influence on Players within their social groups. This subsystem consists of Players, Gaming Community Leaders, Friends, Other Online Friends, Toxic Players, and Recreational Leaders/ Coaches. The main connection in this subsystem is the connection between the players and their interactions with peers within gaming communities. Peer influence is a crucial factor highly impacted by players when they interact with each other online or in other social settings. Gaming Communities can have a major impact on social groups, as Gaming Communities are responsible for shaping each game's unique culture. Peer groups outside of the digital games also have a significant impact on gaming culture, influencing their gaming decisions, such as what game to play and how they socially interact while playing.

Systems Map Insights

After reviewing each subsystem independently, the system was further analyzed to identify gaps between each subsystem. Gaps between the subsystems were then expressed as opportunity spaces where new links could be made between to impact change on the overall system. Opportunity spaces were inspired by the intervention levels discussed in Donella Meadows' *Leverage Points: Places to Intervene in a System* (1999). These opportunity spaces and the leverage points from which they derived from are further detailed in the following section.

Opportunity Spaces

This section explored the relationships between educational (orange), recreational (purple), and gaming (green) subsystems. The current landscape of each subsystem appeared siloed from one another, which informed the need for a deeper analysis to uncover opportunity spaces between each subsystem. Overall, the goal was to link elements between subsystems which can support positive experiences of young women in STEM education through gaming. Opportunity spaces were developed between each subsystem by focusing on education, combatting toxic behaviour, and providing a more inclusive space for women in digital game environments. The following opportunity spaces were discovered:

- Opportunity Space A - Linking Educational and Gaming Industry Subsystems
- Opportunity Space B - Linking Gaming Industry and Recreational Subsystems
- Opportunity Space C - Linking Recreational and Educational Subsystems

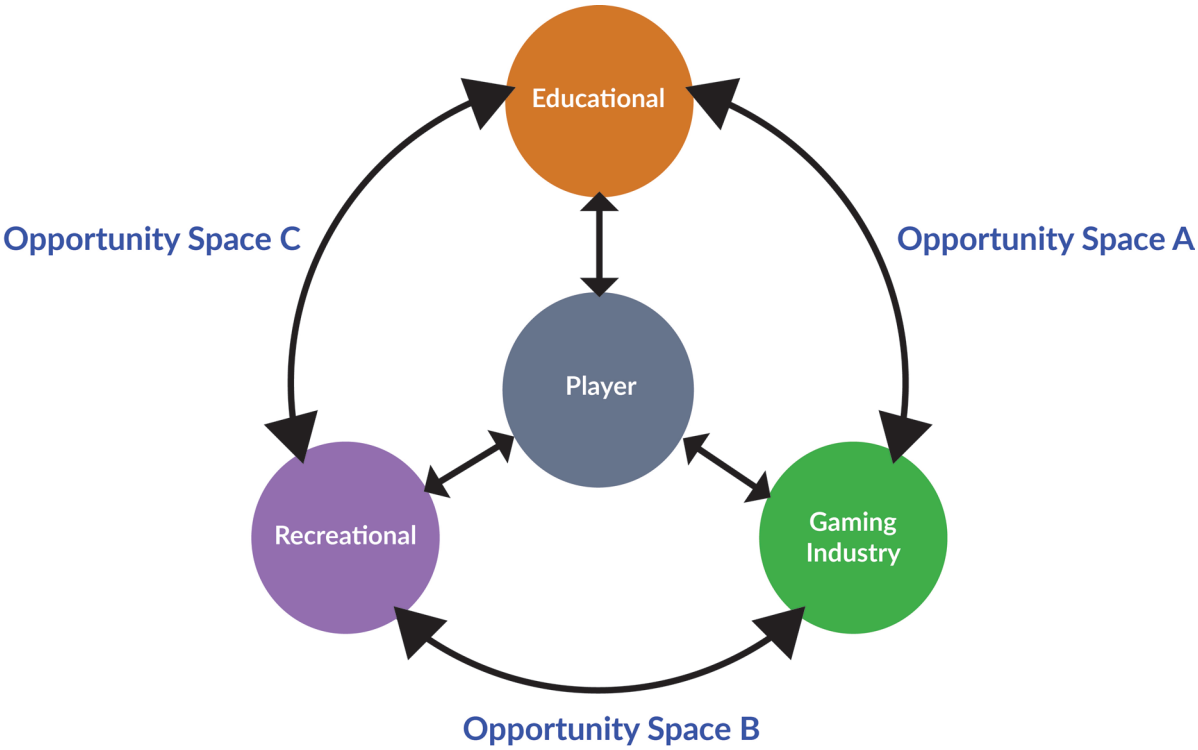


Figure 13: Overview of Subsystems and Opportunity Spaces

Further study of the opportunity spaces identified leverage points in the system. Donella Meadows stated that leverage points are areas in a system's structure where an intervening change force can be applied that impacts the system. Meadows further details 12 possible leverage points that exist across any system such as constants, positive loops, negative loops, materials, information, rules, distribution, goals, and mindsets (1999). For this MRP, the 12 leverage points were explored for each of the three opportunity spaces. Leverage points were then narrowed to the points which had the most significant impact on the corresponding subsystems. This resulted in identifying three key leverage points, one for each subsystem.

Opportunity Space A - Linking Educational and Gaming Industry Subsystems
As seen in Figure 14, Opportunity Space A connects Educational and Gaming Industry Subsystems and is based on Leverage Point 6: The Structure of Information Flows (Meadows, 1999). Meadows explained that adding information through feedback loops is a powerful way to intervene in a system (2008). In the context of this opportunity space, feedback loops consisted of adding new information channels regarding a player's in-game behaviour. These feedback loops could enable parents, schools, and players to monitor and evaluate player behaviour through feedback channels that may not have existed before.

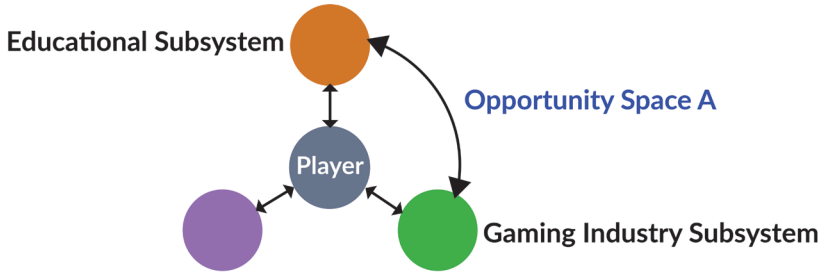


Figure 14: Opportunity Space A - Educational and Gaming Industry Subsystems

When it comes to player accountability and repercussions for toxic behaviour online, game developers and publishers have minimal legislation by which to abide. Currently, in-game solutions for reporting toxic behaviour often result in minimal player accountability and low impact on the overall system. For example, a common feature for players to report toxic behavior to the game developer is a 'report' function (Kou, 2020). This feature is often a single button that generates a petition for Game Developers to review. While this feature may be a quick way to report an individual breaking the rules for toxic behaviour, it is often lacking consequences that change the player's overall behaviour or prevent them from repeating those actions again in the future.

Since in-game reporting currently has little real-world consequences, when toxic behaviour happens in an online space, the process of reporting is typically not in real-time and the repercussions are not imminent. Generally, the consequence of being reported numerous times is a temporary account ban which prohibits players from playing the game for a set amount of time (Kou, 2020). An opportunity exists for the developer to build better reporting features that hold players in higher accountability for their own actions.

Implementing feedback loops between Education and Gaming Industry subsystems could be provided in the form of behaviour summary reports sent periodically to parents and schools. This could be enacted by providing reflection and statistic reports for players after they finish playing, and information regarding screen time or skills developed. If a link between the Gaming Industry and Educational Institutions ensures accountability for in-game behaviour, it may contribute to a safer online environment. If players are worried their actions will have consequences outside of the game, perhaps they will be more cognizant of their own behaviours.

Opportunity Space B - Linking Gaming Industry and Recreational Subsystems
As seen in Figure 15, Opportunity Space B connects Gaming Industry and Recreational Subsystems and is based on Donella Meadows Leverage Point 4: The power to add, change, evolve, or self-organize system structure (1999). Meadows explained that self-organization is the ability to change or add aspects of a system, including positive or negative loops or new rules (2008). In the context of this opportunity space, developers could provide in-game tools and resources that empower community leaders/coaches, gaming communities, and players to self-organize positive gaming initiatives. The addition of community-building tools within games would promote the development of gaming communities in ways that focus on etiquette and inclusion.

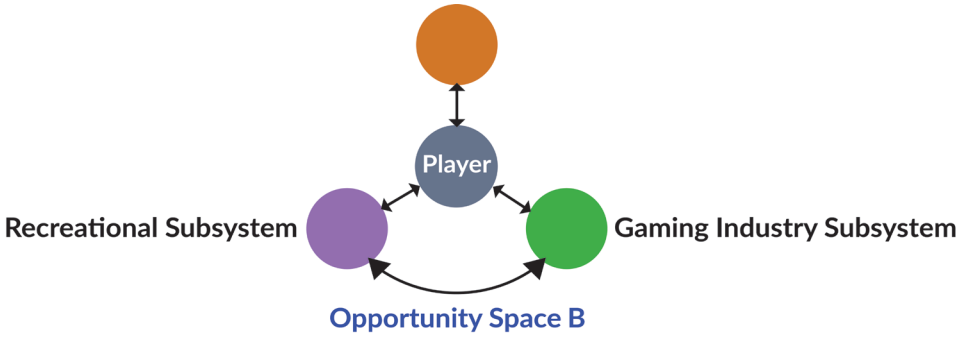


Figure 15: Opportunity Space B - Gaming Industry and Recreational Subsystems

With more than 23 million Canadians playing digital games in 2020, the number of players is expected to grow over the next several years (Entertainment Software Association of Canada, 2020) As more Canadians continue to play digital games an opportunity exists to provide players with recreational activities and localized community initiatives. Establishing recreational activities provides an accessible and safe space to play, while connecting youth with similar interests and helping to nurture social skills and friendships.

An alignment between the Gaming Industry and Recreational subsystems could encourage youth programming initiatives that focus on the education and skill development of players. Based on participant feedback during primary research, providing players with game-related in-person recreational activities that teach proper etiquette and inclusion, could positively impact their online behaviour. This means that players could learn to connect with a real person behind the gamertag and reduce the effects of dissociative anonymity. Furthermore, recreational and extracurricular activities at educational institutions could provide accessible and inclusive learning initiatives, programs, and resources that support student development.

Opportunity Space C - Linking Recreational and Educational Subsystems
As seen in Figure 16, Opportunity Space C connects Recreational and Educational Subsystems and is based on Donella Meadows Leverage Point 3: The Goals of the System (1999). Meadows explained that a system's goals dictate its behaviour, and changing or altering the objective of a system can alter other leverage points to adjust to the new goal (2008). In the context of this opportunity space, it is changing the goal of the system to teach fair play and good sportsmanship and reduce negative behaviour between players through positive goals. Changing the goal of the system means reframing the objective from 'prohibiting toxic behaviour' to 'adopting positive behaviour' in hopes of developing a positive gaming experience for everyone.

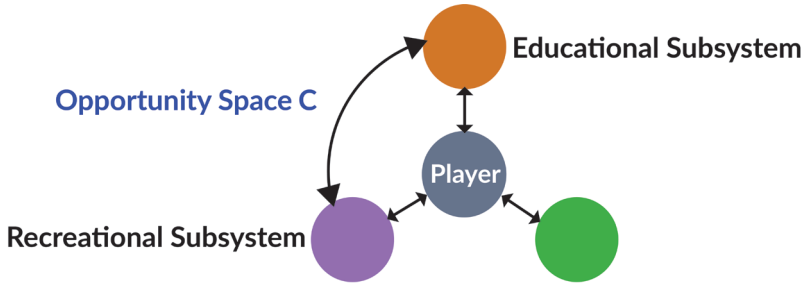


Figure 16: Opportunity Space C - Educational and Recreational Subsystems

The majority of Canadian children and youth participate in at least one extracurricular activity a year that has a positive impact on their learning development and skill-building (Guèvremont et al., 2008). Female adolescents involved with school extracurriculars have also developed higher self-esteem than those not involved (Eime et al., 2013). Furthermore, extracurricular activities play an important role in the success and achievements of youth in school work and decreases anti-social behaviours amongst students (Eime et al., 2013). Research shows that extracurricular activities have positive impacts on participants' lives and increase positive self-development (Eime et al., 2013).

An opportunity exists for educational institutions to integrate digital games into their curriculum in order to teach online etiquette, fair play, good sportsmanship, empathy, and compassion at an early age to combat systemic gender issues. Furthermore, public funding and government resources dictate how educational institutions are managed and operated. Further research into the benefits of digital games outside of entertainment is a crucial first step for incorporation into the curriculum as a potential tool for learning STEM skills. Funding to establish game-related recreational initiatives or after-school programs would encourage young women to engage with digital games.

Opportunity space summary

After examining the opportunity spaces within the system, it was determined that the opportunity spaces that will be built upon in the Expression step are:

- Opportunity Space A: Linking Educational and Gaming Industry Subsystems
- Opportunity Space C: Linking Educational and Recreation Subsystems

These opportunity spaces were determined by reflecting on the original purpose of the MRP, which was to provide educational institutions with valuable insights and recommendations as they navigate digital futures. Opportunity spaces were chosen because they directly involve the Educational Subsystem and their impact can directly support young women to better engage with digital games. Although the focus was set on opportunity spaces A and C, it was important to recognize that all opportunity spaces belong to a greater system and have an impact on one another.

Causal Layered Analysis

After completion of systems mapping, the Reconstruction step continued with a *Causal Layered Analysis (*CLA) to uncover future metaphors derived from primary and secondary research. CLA is a futures framework developed by Sohail Inayatullah which is used to unpack underlying causes, worldviews, and narratives (1998). In the context of this MRP, the CLA mapped the different perspectives and insights acquired through the Deconstruction and Point of View steps in order to create a new narrative in the system. Inayatullah explained that a CLA does not predict the future but rather designs alternative futures (2008). The CLA tool was designed for in-depth analysis of an issue and is categorized into four dimensions:

1. Litany - Unquestioned reality captured as insights from analysis of primary research

2. Social Causes - Deeper focus on social, economic, and political causes of the issue, captured as insights from secondary research

3. World Views - Societal beliefs, paradigms, and cultures that support the systemic causes and define the problem

4. Myths and Metaphors - Beliefs that steer worldviews, uncovering deep unconscious stories or visuals behind the issue (Inayatullah, 2008)

As outlined in Table 1, the CLA began at the litany level of the current context, which explored the observable systemic challenges surrounding women in digital games. Moving deeper into the layers of social causes and worldviews uncovered systemic issues of gender bias and misogyny. In the final layer, metaphors depicted give insight to the unconscious beliefs and deep emotional dimensions that women face in digital games (Inayatullah, 2008). After establishing the CLA in the current context, the metaphors discovered were then flipped to reconstruct and propose a new CLA, which established more equitable perspectives in the digital games system.

Causal Layered Analysis		
Layer	**Current Context**	**Desired Future**
Litany	• Characters with traditionally masculine traits are more respected or praised • Women playing offline or with gender neutral gamertags to avoid unwarranted attention and toxicity • Women are 'not as skilled as men' in games or STEM • Women often mute their microphone in online settings • Little accountability for poor behaviour in digital games	• Creating stories and games by people who do not feel represented • Creating strong online gaming communities, better relationships between people of all genders • Women are chosen to be leaders in the digital game space • Digital games are used as a platform for women to practice their voice • Games are purposeful, and support learning and wellbeing
Social Causes	• Lack of women in gaming companies and STEM leads to designing games with male bias • Lack of reporting, in-game policing methods do not have real life consequences or accountability • Accessibility and inclusion of minority groups takes a backseat	• Inclusion of women and other minority groups in STEM/gaming companies to develop equitable stories and characters • Introduction and access for anyone to participate in games • Self reporting, creating space for more empathy, and patience. Recognition of real life consequences • Games encourage good sportsmanship, reinforce codes of conduct and volition
World View	• Gaming/STEM is for boys/males • Gamers are nerds/geeks • Men are stronger and smarter, women are more supportive and submissive • Games are created for entertainment, and do not have real world impact	• Gaming/STEM is for everyone • Gamers are the heroes they play • Women can be strong and smart, men can be supportive and attentive • Games can have impact beyond the screen • Gaming/tech companies prioritize player wellbeing
Metaphor	• Damsel in Distress • On Mute • Wild West	• Empowered, educated woman • Voices are heard • Safe space for everyone

Table 1: *Causal Layered Analysis* of current context and desired future

Through the literature review and interviews with women in games and STEM, the research revealed metaphors driving the beliefs, systems and activities within the current paradigm. After completion of the current context CLA, the following three metaphors emerged:

- **Damsels in distress - Women are viewed not as capable as men**
- **On mute - The voice of women do not matter**
- **Wild west - Unsafe, unregulated digital space**

The current context CLA was then flipped and reconstructed into a future context CLA in order to establish underlying metaphors that represent a desired future. The Desired future uncovered hopes of empowering women to achieve their full potential through encouragement and purpose-driven play. The desirable future metaphors express alternative ways of thinking and playing in order to establish mutually beneficial relationships between all elements of the system.

The CLA was completed with the following Myths and Metaphors developed in the desired future CLA:

- **Empowered women - Women are given opportunities to succeed**
- **Off mute - The voice of women are heard**
- **Chaotically good - Safe space for everyone**

Causal Layered Analysis Insights

After reviewing the CLA, an analysis of the desired future metaphors revealed the following insights:

Empowered women - Women are given opportunities to succeed
This metaphor represents the desire for women to have equal opportunities as men to succeed in male-dominated environments. Women often encounter different experiences than men when pursuing similar careers or interests. In this desired future metaphor, women would be perceived as equally qualified, talented, and skilled as men.

Off mute - The voice of women are heard
This metaphor highlights the way women often feel unheard, silenced, or their opinions do not matter in male-dominated spaces. A woman's voice is more than just how they talk; it is a symbol of empowerment and leadership. This metaphor encourages a platform for women to practice their ability to communicate, be heard, and gain confidence in digital game environments.

Chaotically good - Safe space for everyone
This metaphor is derived from the often unsafe and unregulated online environments in digital games. This metaphor represents the need for a safe space within digital games that embraces the unpredictability of socializing online while encouraging kindness and empathy. Additionally, this metaphor expresses teaching digital etiquette and inclusion to develop digital spaces that promote positivity and wellbeing while playing.

Reflection

Reconstruction uncovered the stakeholders, connections, and metaphors that influenced the system through systems mapping and *Causal Layered Analysis* approaches. The systems map identified three opportunity spaces linking the Recreational, Gaming Industry, and Educational subsystems. The CLA identified deep metaphors that reflected the current context and desirable future through participants' feedback. The CLA insights were analyzed and synthesized into two main points, voice and digital etiquette.

If women feel silenced in online gaming environments, there is a chance they may feel silenced in the real world as well. Establishing a safe space for women to practice their voice and feel heard is essential to supporting confidence in women. There is a need for women participating in games to build self-confidence and practice using their voices in male-dominated spaces.

Furthermore, if discrimination and harassment are acceptable within peer communities, they will only be perpetuated and enhanced online. Proper education for online etiquette is essential in building a safe and inclusive gaming environment. A more considerable need exists for players to be educated on online etiquette, fair play, good sportsmanship, and inclusivity to encourage and teach empathy and compassion within digital games.

In the following step, recommendations were built around the Educational subsystem's opportunity spaces, incorporating insights discovered throughout the research. The last step in this MRP expresses findings and insights discovered throughout this research as recommendations to encourage more women to participate in digital games. The following recommendations aim to build confidence in women playing digital games through voice and focus on digital etiquette and empathy education.

Step 4:

Image Source: Ayse Birsel, 2015

Step 4: Expression

The goal of the Expression step was to develop recommendations based on the findings and insights uncovered during the Reconstruction step. In the context of this MRP, the Expression step proposes recommendations that aim toward the desired future metaphors discovered in the CLA. Additionally, recommendations focus on opportunity spaces ‘A’ and ‘C’ as identified in the previous step.

The Expression step intends to define, refine, and reinforce recommendations according to the intended audience and purpose of the research question. These recommendations were developed with the desired future metaphors discovered in the CLA and built on the key pillars discovered in the Point of View step. This step includes suggestions for educational institutions to consider as they navigate new digital futures or implement digital games into learning.

Recommendation 1

Improving diversity and building confidence through the female voice.
The final synthesis of this research demonstrated a need for women's voices to be heard in digital games and STEM industries. As discovered throughout the research, women are often judged, criticized, or harassed in online gaming spaces due to their voice. The voice is the only identifiable aspect of the player in online gaming spaces, and women often feel silenced, unheard, or 'on mute' while participating in these spaces.

This recommendation proposes the creation of a safe digital space for women to practice using their voices, with a focus on developing communication skills and building self-confidence. Developing a system that encourages women to support other women as they explore digital games would create a strong sense of community and empower those involved. Establishing mentors for underrepresented minorities is critical for delivering a positive space and encouraging the success of women in digital games.

Recognizing that educational institutions may not be fully equipped or knowledgeable in operating digital game spaces, this recommendation suggests a partnership between schools and existing gaming communities. Schools can provide equitable access and learning opportunities for all students, while the gaming community provides the knowledge and expertise on digital games. The relationship between education and recreation would require significant trust and privacy protection in regards to the personal information of students.

Recommendation 1	
Goal (Based on Metaphor)	Women have a voice / Empowering women
Who / Where (Based on opportunity space)	Opportunity Space C - Linking the Educational and Recreational Subsystems
Needs (Based on key pillars)	Diversity • Women's experiences are different than men's in digital games • Women-run initiatives connects like minded people with similar interests • The need for more women game developers, telling their own stories • More women playing digital games may lead to more women pursuing careers in digital games or STEM Connection/Social • Connecting women with other women to build community and mentorship Trust • That schools and gaming communities will use student information ethically • Player/student and their parents trust schools to keep them safe both during online and in-person school settings

Table 2: Recommendation 1 - Voice

Recommendation 2

Incorporating Digital Etiquette and Digital Empathy for all.
Online gaming experiences can be filled with unwarranted toxic behaviour. The primary and secondary research results highlighted a need for education in digital etiquette and empathy to promote positive behaviour. This recommendation requires an alignment of behaviour goals between educational institutions, parents, and game developers that fosters wellbeing for students and staff. The goal of this recommendation would be to focus on promoting positive behaviour rather than condemning negative behaviour.

Additionally, this recommendation suggests developing new tools on behalf of the Gaming Industry that can monitor and evaluate player behaviour during gameplay. In this recommendation, personalized learning environments could be created for each student where feedback is sent directly to educators in order to track performance, improve self-awareness, and assist in learning. In-game summary reports on player behaviour are sent directly to parents and educational institutions for evaluation. These reports would show data based on how other players rated their attitudes during gameplay and if any negative behaviours needed to be addressed. Schools and teachers act as the link between parents and game developers, ensuring alignment on behavioural goals and objectives.

This recommendation requires a strong connection between the Education and Gaming Industry subsystems to create the tools needed to monitor and track individual behaviours safely and responsibly. Reports on player behaviour would be sent periodically to parents, peers, and teachers to add an extra layer of accountability to negative in-game behaviour. The player themselves would also be able to self-evaluate their behaviour and compare the evaluations they have received from peers. This opportunity strategically supports student needs by incorporating new digital technologies into learning environments, better preparing them for future success.

Recommendation 2	
Goal (Based on Metaphor)	Safe space for everyone, making digital games better through education of digital etiquette and empathy
Who / Where (Based on opportunity space)	Opportunity Space A - Linking the Educational and Gaming Industry Subsystems
Needs (Based on key pillars)	Accessibility • If tech was more available in a social and emotional way more women might be more inclined to play • Financial barriers • Lack to internet / technology Education • Teaching digital etiquette and digital empathy to all students • Language skills and social development Engagement • Peer groups, holding each other accountable

Table 3: Recommendation 2 - Digital Etiquette and Empathy

Conclusion

Conclusion

Overall, the objective of this MRP was to focus on the experiences of women in gaming and STEM in order to identify barriers, benefits, and opportunities for change. The following research question, “How might we utilize digital games to support STEM education for young women in Canada?” guided the research towards an audience of educational institutions as they navigate digital futures into extracurriculars and curriculum development. Although every woman who participates in games may not want to pursue a STEM degree, the intention behind this MRP was to see how more women can be welcomed to play digital games while still gaining fundamental, practical, or advanced STEM-related skills.

The approach to the MRP was inspired by Ayse Birsel’s *Deconstruction: Reconstruction* framework, which incorporated various concepts from design thinking and systems thinking throughout the research. A literature review uncovered similarities between the skills needed in STEM and the skills learned while playing digital games. Additionally, further research uncovered the gender biases women face in STEM fields and digital games. Primary research validated the findings from the literature review and uncovered six key principles of importance. Systems mapping identified the gaps in the system between stakeholders and exposed opportunity spaces and key leverage points to apply the recommendations. Lastly, a CLA expressed the desired future that was used as guiding principles when designing the recommendations.

It was discovered through this MRP that an education gap exists regarding the proper social etiquette in digital spaces, and the space to build online confidence for young women. As digital technologies become increasingly important in everyday society and the professional world, it is essential to teach youth how to navigate these digital environments. In order to close the gender gap in STEM and digital games, a responsibiilty lies in educating future generations on proper digital etiquette for everyone to feel comfortable participating in online spaces. To build a future of STEM and digital games that supports the voices of all women.

While the recommendations proposed in this research encourage women to participate in digital games, more research is needed to understand the actionable steps required for change to make large scale impact. Incorporation of digital games into educational institutions will require extensive research on the expectations and limitations of school boards when introducing extracurricular activities, and more research is needed on intellectual property laws in order to incorporate games into curriculum. A co-creative approach is recommended to further ensure alignment between stakeholders on a desired future.

Citations

Citations

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Appendix

Appendix

Appendix A: Anonymous Interview Responses

2. What is your age group?

More Details

18 - 24	15
25 - 39	15
40 - 54	0
55 +	0
Other	0

3. To which gender do you most identify?

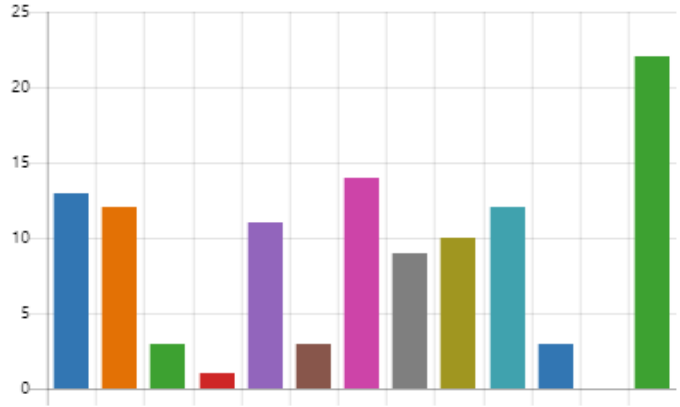
More Details Insights

Female	30
Male	0
Transgender Female	0
Transgender Male	0
Gender Variant/Non-Conformi...	0
Prefer Not To Answer	0
Other	0

4. Which games do you currently play?

More Details

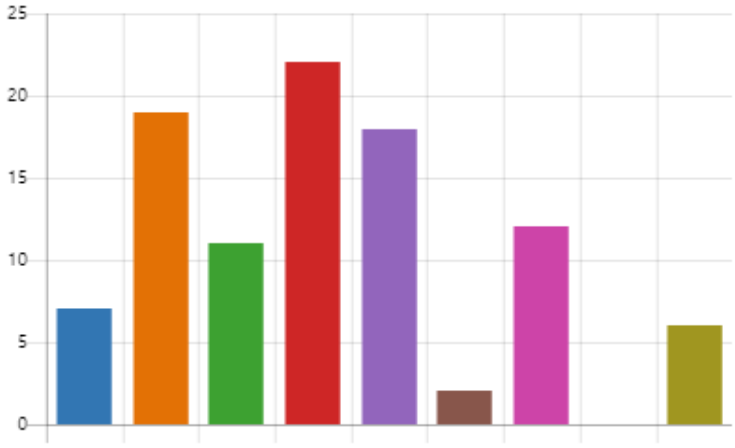
Among Us	13
Animal Crossing	12
Fall Guys	3
Fortnite	1
League of Legends	11
Hearthstone	3
Minecraft	14
Overwatch	9
Sims	10
Call of Duty	12
FIFA, NHL, NBA2k, MADDEN	3
I don't know	0
Other	22



5. What genres of video games do you enjoy playing the most?

More Details

Battle Royale (ie. Fortnite)	7
First Person Shooter (ie. Over...	19
MOBA - Multiplayer Online Ba...	11
Role Playing Game / Adventur...	22
Simulation Games (ie. Animal ...	18
Sports Games (ie. NHL, FIFA et...	2
Strategy (ie. Starcraft 2)	12
I don't know	0
Other	6



6. How old were you when you first started playing video games?

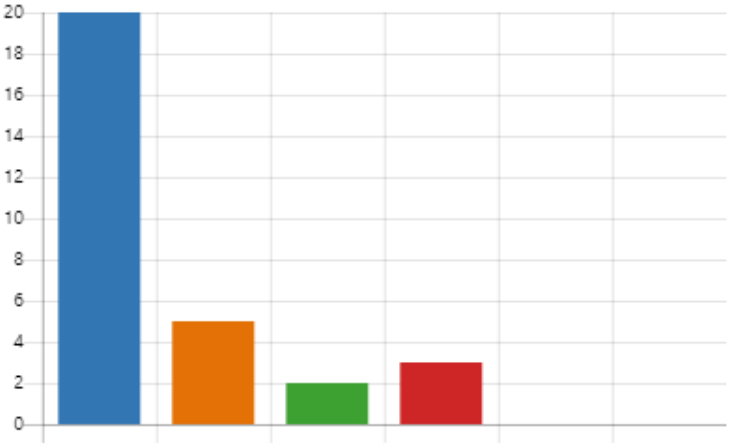
More Details Insights

Under 12	26
12 - 18	4
18 - 25	0
25 +	0
I don't know	0

7. How often do you play video games?

More Details Insights

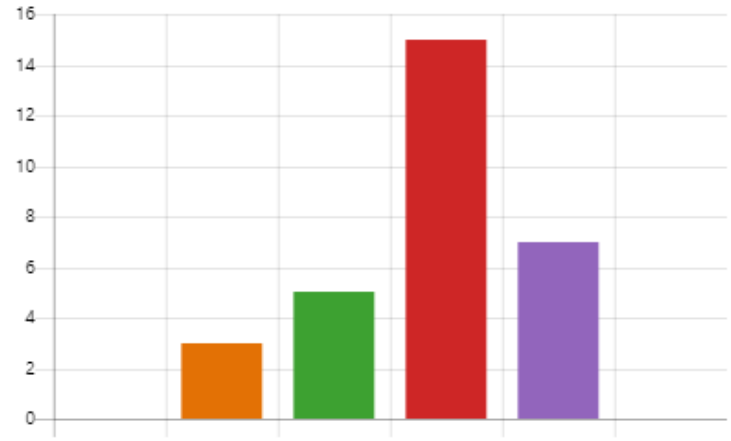
Every day	20
Every other day	5
1-2 times a week	2
Occassionally	3
I don't know	0
Other	0



8. On average, how long do you play video games per session?

More Details Insights

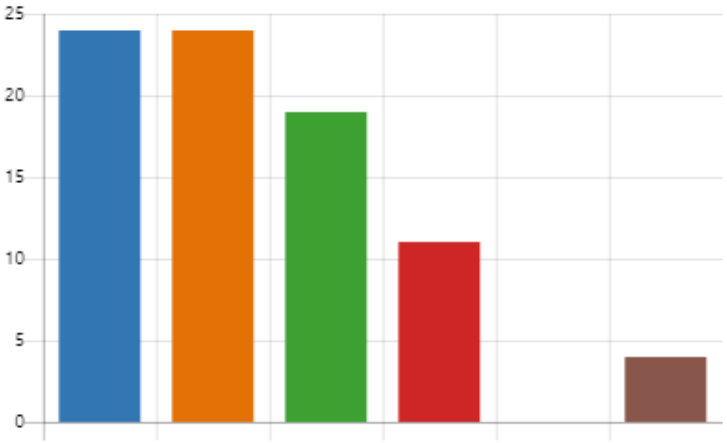
Under 30 minutes	0
30 minutes - 1 hour	3
1-2 hours	5
2-4 hours	15
4 hours +	7
I don't know	0



9. Who do you prefer playing video games with?

More Details

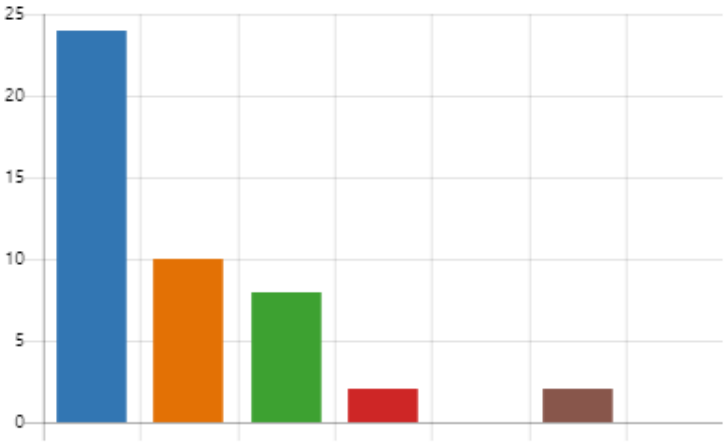
By myself	24
Friends	24
Online Friends	19
Sibling/Parent	11
I don't know	0
Other	4



10. Growing up, were there any other family members in your household who also enjoyed gaming?

More Details

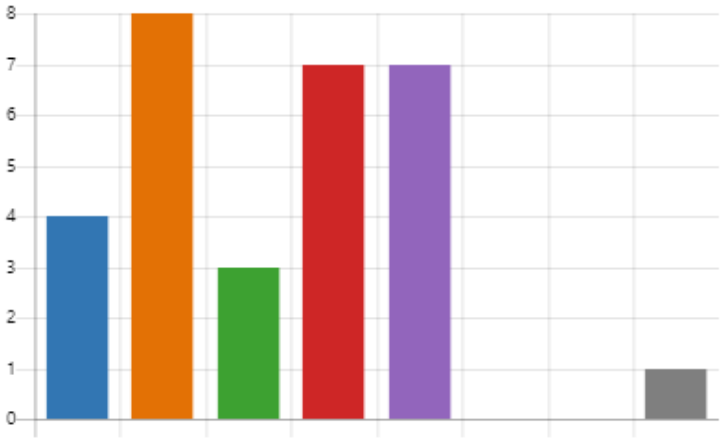
Sibling	24
Parent/Guardian	10
Cousin/Family Member	8
I did not play video games wit...	2
I don't know	0
No	2
Other	0



11. Did your parents/guardians encourage or discourage the activity of playing video games?

More Details

Actively Encourage	4
Passively Encourage	8
Actively Discourage	3
Passively Discourage	7
Neutral	7
They did not know I played vi...	0
I don't know	0
Other	1



12. Are you well-represented by the characters in the games you play?

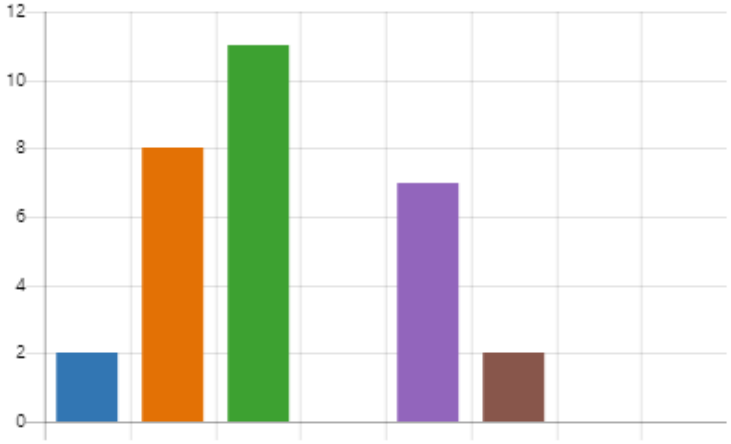
More Details Insights

I am always represented	3
I am sometimes represented	14
I am often not represented	9
I am never represented	2
Other	2

13. In general, are your experiences gaming online with other players positive or negative?

More Details Insights

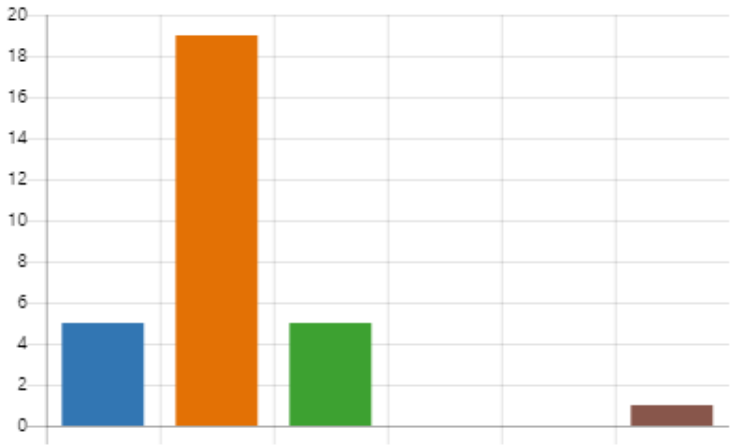
Always Positive	2
Mostly Positive	8
50/50 even split between Posi...	11
Always Negative	0
Mostly Negative	7
I don't play online with other ...	2
I don't know	0
Other	0



14. Do you play video games with audio/voice communication?

More Details | Insights

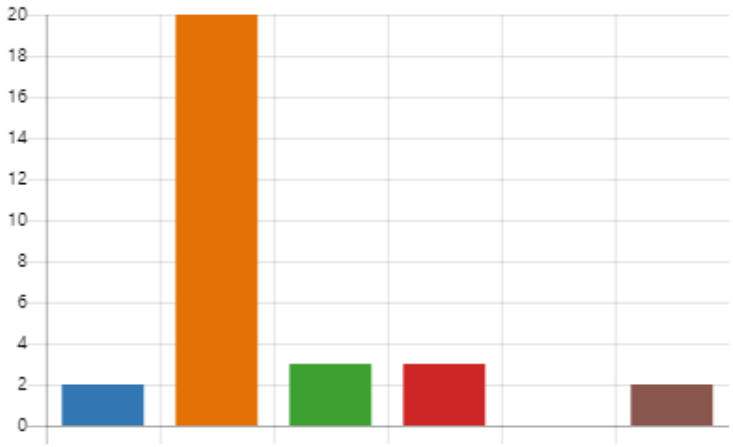
Always	5
Sometimes	19
Never	5
Maybe	0
I don't know	0
Other	1



15. While using a microphone how often do you mute your own microphone due to toxic behaviour from others?

More Details | Insights

My microphone is always mut...	2
My microphone is muted only...	20
My microphone is always ope...	3
I don't use a microphone	3
I don't know	0
Other	2



16. How often do you mute another player due to toxic behaviour?

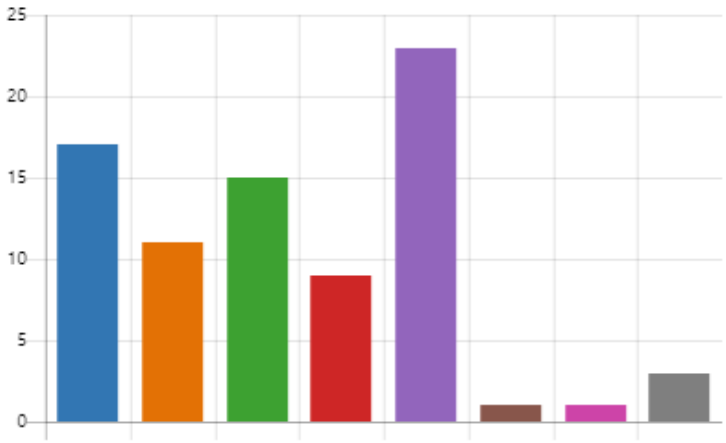
More Details | Insights

Always	8
Sometimes	13
Never	4
I don't know	1
Other	4

17. If you have experienced a toxic player online what do you do?

More Details

Continue playing	17
Defend yourself / talk back	11
Mute the microphone	15
Leave game immediately	9
Report toxic player	23
I don't encounter toxic players	1
I don't know	1
Other	3



18. On a scale of 1-5 what is your comfort level playing online with strangers?

More Details Insights

30
Responses

3.3
Average Number

19. Are there certain people you avoid playing with?

More Details Insights

I don't avoid anyone	13
I often avoid playing with peo...	9
I prefer to play offline to avoid...	4
I don't know	1
Other	3

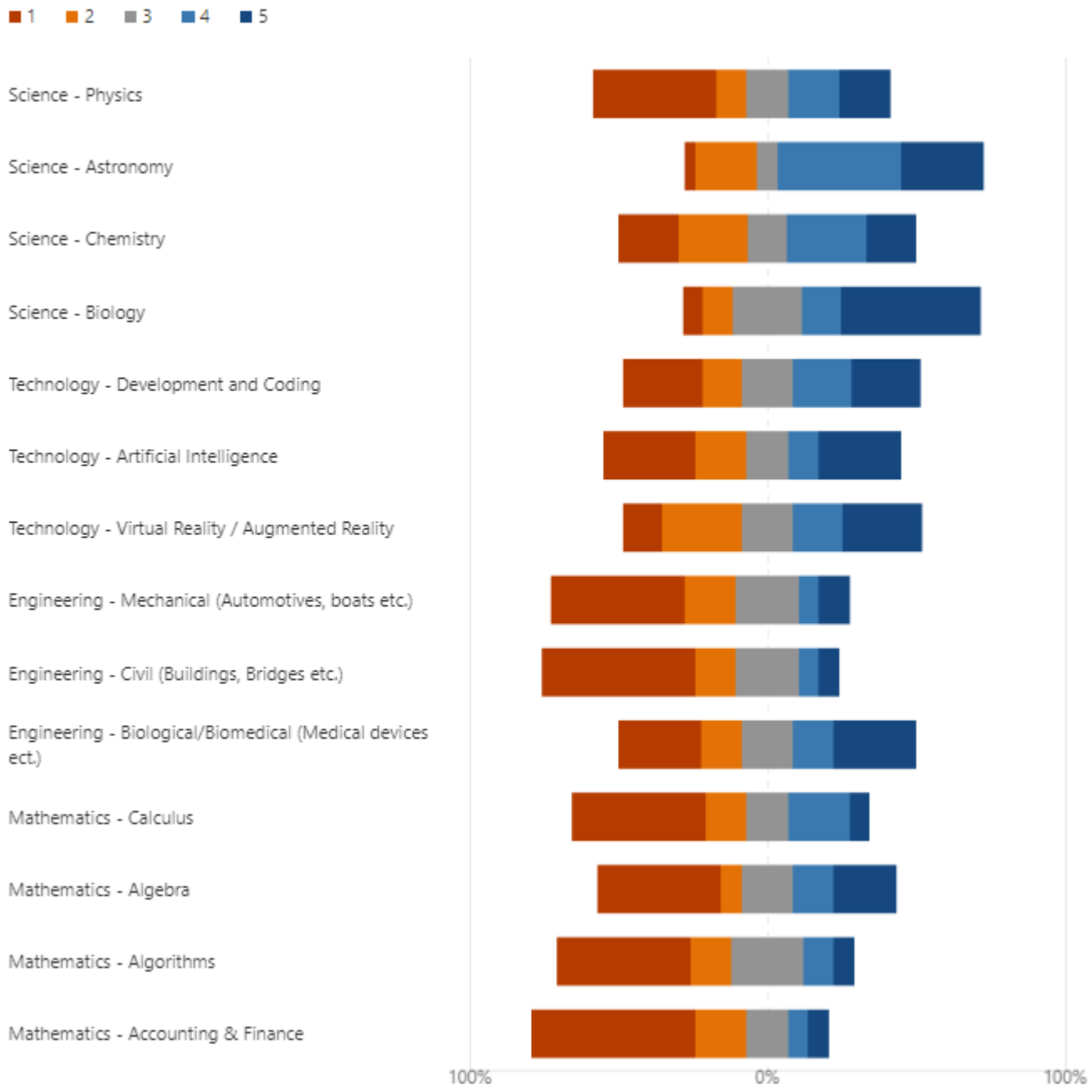
20. While gaming online, have you witnessed discrimination of any other players?

More Details

Yes	25
No	4
I don't know	0
Other	1

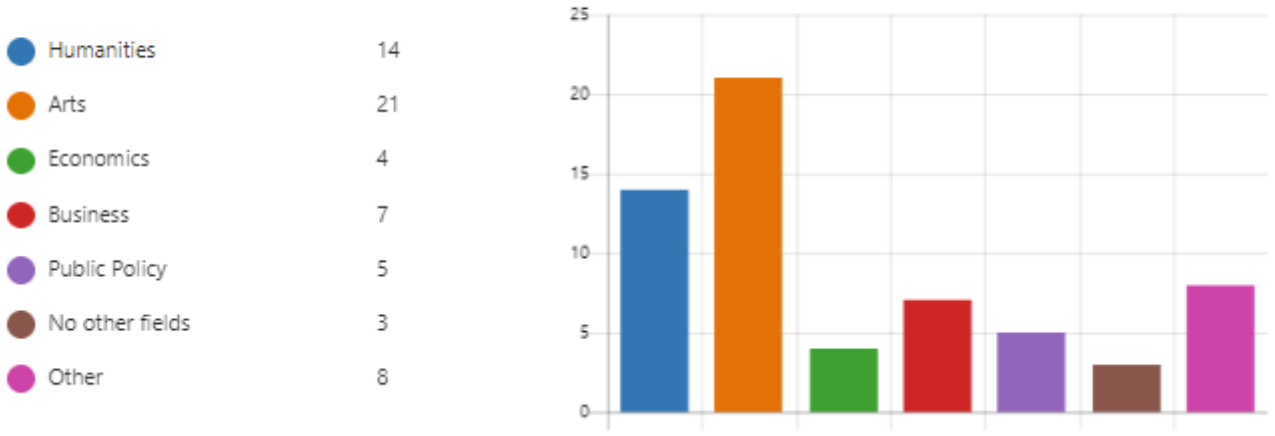
21. On a scale from 1 to 5, how interested were you in the following STEM fields growing up?

More Details



22. Are there any other fields you were interested in that are not listed? If so, please Specify:

More Details



23. Have you ever considered pursuing a career in STEM?

More Details

Yes	21
No	3
Maybe	5
I don't know	0
Other	1

24. Are currently pursuing a career in STEM?

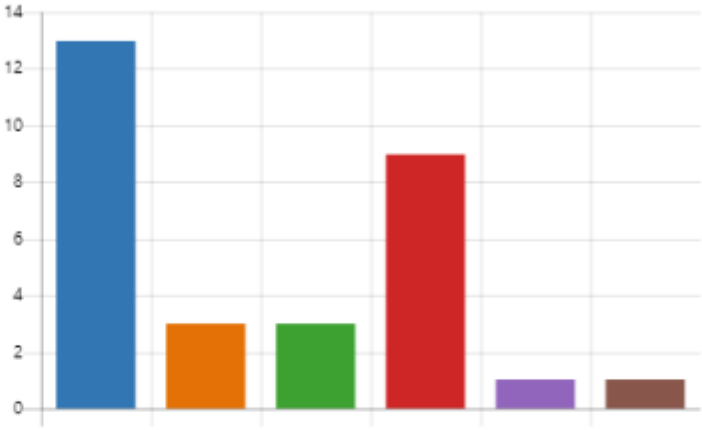
More Details Insights

Yes	11
No	15
Maybe	4
I don't know	0
Other	0

25. Do you think video games have supported your interest in pursuing a STEM field?

More Details Insights

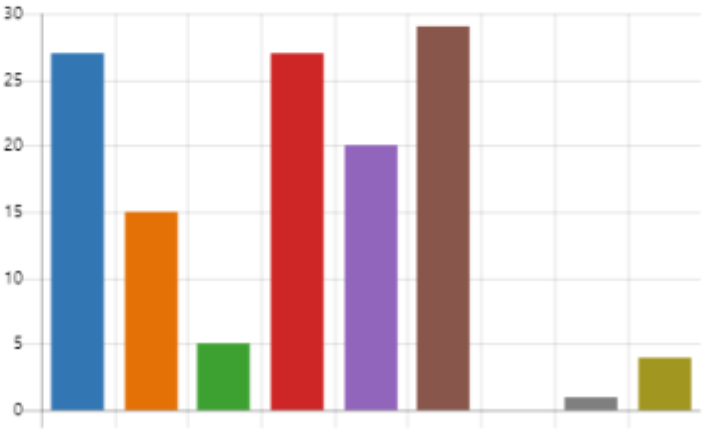
Yes	13
No	3
Maybe	3
I am not in a STEM field	9
I don't know	1
Other	1



26. What skills do you believe you have gained from playing video games?

More Details

Critical Thinking	27
Leadership	15
Math	5
Problem Solving	27
Social	20
Strategy	29
I don't know	0
None	1
Other	4



Appendix B: *Bull's-Eye Diagrams* from Co-Creative Workshop

Participant A:

Participant B:

Participant C: