Rates of Imposter Syndrome Among Female-Identifying Individuals in Undergraduate STEM Programs at McMaster University

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Abstract

Imposter syndrome is characterized by an individual lacking an internal sense of success, regardless of achievements, resulting in feelings of 'intellectual phoniness' (Clance & Imes, 1978). Regardless of their achievements, many academic professionals experience this phenomenon. Previous research shows that female-identifying individuals in STEM programs experience gendered expectations, biases, and stereotypes within male-dominated fields, creating barriers as a result of gender discrimination (O'Connell & McKinnon, 2021; Crawford, 2021). This research was conducted as part of a group-based thesis for SOCPSY 4ZZ6 and had received MREB ethics approval. This research aimed to determine if rates of imposter syndrome are higher for female-identifying individuals in male-dominated fields. Additionally, we aimed to observe the factors contributing to the persistence of imposter syndrome. We recruited 44 undergraduate McMaster students and collected data using an online, anonymous application, Lime Survey, to collect both qualitative and quantitative results to evaluate the levels of imposter syndrome among undergraduate students at McMaster. Our results showed that there was no correlation between higher rates of imposter syndrome and female-identifying individuals as well as those in STEM programs. Rather, we found that imposter syndrome is prevalent at equally high rates across faculty and gender. More research needs to be conducted on this topic to confirm our results.

Introduction

Despite high academic excellence and achievement, many academic professionals lack internal validation for their successes and fear exposure as an intellectual fraud (Mullangi & Jagsi, 2019; Clance & Imes, 1978). Imposter syndrome concentrates on students experiencing academic invalidation due to their own cognitive distortions. This phenomenon can be depicted as lacking an internal sense of success, regardless of achievements, resulting in feelings of 'intellectual phoniness' (Clance & Imes, 1978). The theory's origins focused on high-achieving women in academic spaces who continuously discounted their inherent abilities but attributed their success to external causes, such as luck (Clance & Imes, 1978). As a result of their internal feelings of fraudulence, the individual focuses on maintaining the impression of a scholar through self-monitoring behaviours (Parkman, 2016). As such, imposters have heightened stress and anxiety

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levels due to their hyper-focus on maintaining a false identity, internalizing failures, and fear of exposure as an imposter (Parkman, 2016).

Our team of researchers investigated the prevalence of the imposter phenomenon in undergraduate students at McMaster University. The theoretical frameworks selected in our research focus on imposter syndrome and intersectionality, a perspective to understand the interconnections of compounding social systems and categories (Atewologun, 2018). In concurrence, these frameworks provide a beneficial lens for understanding the prevalence of imposter syndrome within academic spaces resulting from societal and institutional oppression. This research evaluated the prevalence of imposter syndrome in female-identifying undergraduate students in science, technology, engineering, and mathematics (STEM) programs at McMaster University. For the purpose of our study, we refer to science, technology, engineering, or mathematics programs as STEM programs.

Purpose

This research aims to determine if rates of imposter syndrome are higher for female-identifying individuals in male-dominated fields, as well as the factors contributing to the persistence of the imposter phenomenon. The methods within this research included an anonymous online survey to collect demographic information and data measuring the levels of imposter syndrome among students. The final count of respondents for the survey consisted of 45 McMaster undergraduate students over the age of 18. The survey was completed anonymously and confidentially by each individual. Due to a facetious survey response, we analyzed 44 responses and excluded one as it may have skewed our results.

Research Question

Our team of researchers determined and examined the prevalence of imposter syndrome in female-identifying undergraduate students in science, technology, engineering, or mathematics programs, commonly known as STEM programs, at McMaster University. Through examining and comparing our chosen demographic and other groups of undergraduate students, such as non-female-identifying students in STEM programs and female-identifying students in programs not associated with STEM, our research identified the prevalence of imposter syndrome among female-identifying individuals in STEM programs. It is apparent that STEM programs in all different areas of work, such as undergraduate programs, fields of work, and more, are typically heavily dominated by male-identifying individuals.

In order to determine the prevalence of this phenomenon, our research question is: are rates of imposter syndrome higher for female-identifying undergraduate students in STEM programs compared to non-female-identifying undergraduate students in STEM programs or undergraduate students in other programs of study not related to STEM programs? Our research team has selected this research focus to better understand imposter syndrome and the ways in which this phenomenon impacts groups of individuals, as well as to evaluate the connection to female-identifying individuals in STEM undergraduate programs. We hypothesize that female-identifying individuals in STEM programs at McMaster University will display higher rates of imposter syndrome.

Literature Review
Origins of Imposter Syndrome
The literature surrounding the imposter phenomenon considers these cognitive distortions to arise from a combination of family dynamics, gendered social expectations, and historical representations of scholars. In their research, Clance and Imes (1978) found that family dynamics significantly impact the academic identity of women, starting from an early age. Clance and Imes (1978) argued that "imposters" can typically be categorized into one of two groups. The first group includes women with a sibling or relative who has been assigned the "intelligent" family member (Clance & Imes, 1978, p. 242). In this, she will struggle to prove her intelligence to her family members but will never be seen as having greater or equal intellectual skills. This type of imposter will use school as an opportunity to showcase her intelligence and search for academic validation, although the family is still typically unimpressed. As a result, she may begin to believe her family's interpretation that she is not "the smart one," and the imposter phenomenon emerges (Clance & Imes, 1978).

The second group comprises women who have been praised as superior in intellect and talents by their families (Clance & Imes, 1978). As such, her family promotes that she can easily accomplish any task with minimal struggles. When she begins to experience difficulties in achieving success, she will feel obligated to fulfill her family's expectations, even when it is not sustainable. This will invoke feelings of anxiety and doubt when she cannot live up to the standard of "perfection with ease"; as such, she will conclude she is not intelligent and must be an intellectual imposter (Clance & Imes, 1978). The results from Clance and Imes (1978) indicate that imposter syndrome develops in relation to familial and societal expectations.

The socially enforced expectations of gender roles and historical representations of scholars contribute to feelings of imposter syndrome. In Meyers' (1987) work on the paradox of feminine socialization, it was discussed how feminine socialization threatens personal autonomy through the construction of the traditional woman. This depicts the 'traditional woman' as including the grooming of feminine roles since birth, deep emotional ties to others, and a home-centred orientation (Meyers, 1978). The sex-role stereotyping begins in early childhood and is maintained through parental expectations (Clance & Imes, 1978). This type of socialization directs women away from academic and professional spaces by promoting an ideology that they belong elsewhere.

In contrast, masculine socialization promotes work-oriented options free of stigmatization (Meyers, 1978). With this, Edwards (2019) discussed the implicit messages presenting dominant social identities in conceptualizing a traditional scholar. These socially constructed messages included White, affluent, cis-gendered males like Albert Einstein. The overrepresentation of the dominant identities reinforced messages that result from macro-level racism, sexism, and classism (Edwards, 2019). This creates a societal stereotype that women are less intellectually able than men which is exacerbated by social forces (Clance & Imes, 1978).

The social factors contributing to imposter syndrome concur with intersectionality, as the ideologies presented are rooted in privilege and oppression (Edwards, 2019). Marginalized groups internalize these dominant ideologies creating a sense of "otherness" to which the feeling of not belonging contributes to the prevalence of imposter syndrome (Edwards, 2019).

Persistence of Imposter Syndrome

Imposter syndrome asserts itself through persisting cognitive distortions and their related behaviours. Gadsby (2022) explained that the imposter phenomenon is perpetuated through cognitive distortions within the individual's interpretation of their intellectual capabilities and accomplishments. Imposter syndrome persists through the affective and doxastic features of these cognitive distortions (Gadsby, 2022). The affective features pertain to a fear of being discovered as an imposter while in a position one does not deserve. The fear of exposure as an imposter creates adverse psychological consequences, including anxiety, stress, and emotional exhaustion (Gadsby, 2022). The doxastic features concern exposure and belief in inadequacy and lacking ability (Gadsby, 2022).

These features will create a biased perception of their personal evaluations, as the individual will attribute their successes to situational factors rather than dispositional factors. In this, the individual will avoid objective and external evidence of their intelligence as a form of self-deception (Gadsby, 2022). These self-deceptive interpretations of the evidence are maintained by focusing on supporting evidence, avoiding contradicting evidence, sampling memory supporting these biases, and interpreting evidence following biases (Gadsby, 2022). Through these cognitive distortions and self-deceptive biases, individuals will begin to believe in their own inadequacy.

The experience of the imposter phenomenon is maintained through the behaviours associated with cognitive distortions. Clance and Imes (1978) describe four sets of behaviours as manifestations of imposter syndrome. The first group of behaviours consists of diligence and hard work motivated by a fear of avoiding discovery as an intellectual imposter. As such, the individual will engage in a cycle of worrying about their intelligence, working hard, and attempting cover-up strategies, all reinforcing temporary feelings of approval (Clance & Imes, 1978). The main priority becomes impression management through self-monitoring behaviours (Parkman, 2016).

The second classification of behaviours pertains to intellectual inauthenticity, in which the individual will engage in intellectual flattery with academic peers. This includes supporting their biases and avoiding disagreement with their viewpoints due to fear of their judgements (Clance & Imes, 1978). In this, the individual will avoid the judgement of their authentic views to prevent the discovery of their imposter status (Gadsby, 2022).

The third set of behaviours individuals with imposter syndrome engage in consists of using charm and perceptiveness to seek approval from academic peers and supervisors (Clance & Imes, 1978). Clance and Imes (1978) explained that these women would use their charming interpersonal skills to become well-liked by an admired, professional mentor. In this, she will search for recognition and validation of intellectual abilities from her mentor (Clance & Imes, 1978). The final group of behaviours is categorized by the negative consequences of displaying confidence as a woman (Clance & Imes, 1978). There is a conflicting disconnect between autonomous competency and femininity (Meyers, 1987). Clance and Imes (1978) argued that independent, successful women are portrayed as hostile and destructive. They explained that a woman might be rejected or considered less feminine due to her achievements, stating that "as long as she maintains the notion that she is not bright, she imagines that she can avoid societal rejection" (Clance & Imes, 1978, p.6).

Undergraduate STEM Programs

To understand STEM programs, they must be evaluated and defined in addition to the stereotypes and societal standards associated with these programs. According to many scholars, there is a lack of a standard definition for what is considered a STEM job or program (Beede et al., 2011). Typically, STEM fields are comprised of programs with a strong focus on physical sciences, technology, engineering, or mathematics (Beede et al., 2011). There is a debate as to whether fields relating to healthcare, education, and social sciences are to be included in the STEM field (Beede et al., 2011).

Currently, STEM is the fastest-growing field among different levels of professionalism; however, this field still faces issues, such as inconsistency and a significant lack of representation among female-identifying individuals (Cadaret et al., 2017). It is possible that the severe lack of representation and inconsistency of women in STEM programs is related to the general decline of interest in STEM programs in recent years (García-Holgado et al., 2020). Individuals from all groups are beginning to turn their attention away from jobs in the STEM field and focus more on jobs and programs in various fields (García-Holgado et al., 2020). Scholars and researchers claim that young female-identifying individuals in their high school years do not often see or consider STEM-based undergraduate programs as an option for their future. This, in turn, creates a significant gender gap in STEM programs globally (García-Holgado et al., 2020).

This gender gap is also heavily influenced by the stigmatization of female-identifying individuals in STEM fields, which will be discussed further. STEM programs globally are heavily male dominated. Female-identifying individuals are severely underrepresented within the population of STEM-related positions globally; however, female-identifying individuals make up most of the population enrolled in undergraduate and graduate programs (García-Holgado et al., 2020).

The Stigmatization of Women in STEM

A common theme seen throughout much of the research collected on female-identifying individuals in STEM undergraduate programs is that these individuals often face stigma and harsh stereotypes, which in turn prevents them from going into these STEM-related fields (García-Holgado et al., 2020). As of 2011, female-identifying individuals held less than 25 percent of STEM-related jobs due to the stigmatization these individuals felt in their workplace (Beede et al., 2011). Gender stereotypes play a prominent role in how individuals plan for their future and choose the path they want to explore further. According to many scholars, children can identify gender stereotypes by the second grade and typically begin associating mathematics with male-identifying persons (Kahn & Ginther, 2017).

School-aged boys typically assume themselves to be associated with mathematics and science, whereas school-aged girls will begin associating themselves with reading and writing skills (Kahn & Ginther, 2017). These strong stereotypes, as they grow, will begin to prevent young girls and female-identifying individuals from pursuing STEM-related careers and education in fear of going against societal values and expectations (Beede et al., 2011). Preferences heavily influenced by societal gender norms and gender stereotypes are a major driving force in individuals' life choices and the underrepresentation of female-identifying individuals in many fields of study (Kahn & Ginther, 2017). Gender stereotypes, preferences, and stigmatizing forces are behind the

underrepresentation of female-identifying individuals in STEM-related fields worldwide (Reilly et al., 2019). Female-identifying individuals are highly underrepresented in STEM fields for various reasons (Beede et al., 2011).

According to Reilly et al. (2019), the predominant reason for the underrepresentation of female-identifying individuals within STEM programs is due to stigma consciousness (Reilly et al., 2019). Typically, this underrepresentation level is associated with male-identifying individuals and female-identifying individuals' choices regarding their careers through incentives and education (Beede et al., 2011). STEM career paths are highly associated with and are highly populated by male-identifying individuals; therefore, these job placements are made to be more accommodating to that group of people (Beede et al., 2011). Due to this lack of accommodation, female-identifying individuals feel pressure to switch careers and turn to a position in a field unrelated to science, technology, engineering or mathematics (Cadaret et al., 2017).

These female-identifying STEM employees often claim that this pressure will cause them to give in to societal norms and leave their STEM field mid-career (Reilly et al., 2019). The previously mentioned awareness of stigmatization will create an internalized awareness of stigmatization for female-identifying individuals in STEM-related fields, which is another reason for this group to leave their positions in STEM-related jobs (Reilly et al., 2019). A familiar feeling shared by this group is that they do not feel as though they belong in STEM-related fields and are often told how STEM-related fields are much better suited for male-identifying individuals (Reilly et al., 2019). These are just a few of the reasons female-identifying individuals feel they do not belong in a specific field that researchers have touched upon.

Imposter Syndrome Among Women in STEM

The barriers faced by female-identifying individuals in STEM programs create biases that adversely affect female-identifying individuals in male-dominated environments. Stereotypes and biases about female-identifying individuals' ability to engage with STEM programs reflect the male orientation of the field (O'Connell & McKinnon, 2021). The 'lack of fit' model explains the perceived incongruity between the requirements for a job and the individual's attributes and skills (Crawford, 2021). Due to the societally constructed expectations of STEM fields, female-identifying individuals are less likely to be considered a good fit within masculine jobs. There is a predisposition toward negative perceptions and judgements of female-identifying individuals in STEM (Crawford, 2021).

The gendered evaluations of female-identifying individuals as warm and nurturing effect academic perceptions, in which female-identifying people are more likely to be judged on appearance and personality rather than acknowledge their professional abilities (O'Connell & McKinnon, 2021). These create biased perceptions of female-identifying individuals in STEM fields, including the tightrope bias and the prove-it-again bias (Crawford, 2021). The tightrope bias pertains to gendered stereotypes of how female-identifying individuals should present in male-dominated spaces. In this, female-identifying individuals struggle to conform to societal expectations of feminine qualities while fitting into the necessary masculine qualities of the job, such as being assertive, direct, and competitive (Crawford, 2021).

Similarly, the prove-it-again bias refers to individuals who do not exemplify the traditional characteristics of the career position they hold, resulting in feeling as though

they must continuously prove their competence and abilities over and over again (Crawford, 2021). Crawford (2021) explained that female-identifying individuals are punished when they do not conform to gendered expectations of behaviour, forcing them to act in ways that do not advance their careers. These double standards produce microaggressions creating societal and institutional disadvantages for female-identifying individuals in STEM programs (O'Connell, 2021).

The biases in male-dominated fields reinforce gender stereotypes in STEM fields. This encourages female-identifying individuals to internalize gender discrimination about who participates in STEM fields, contributing to the prevalence of imposter syndrome (O'Connell, 2021). In concurrence with these barriers, the experience of the imposter phenomenon for female-identifying individuals in STEM programs can produce negative psychological effects on the human psyche, including anxiety, depression, low self-esteem, and self-handicapping behaviours (Crawford, 2021).

Limitations of Research

The limitations within the literature surrounding imposter syndrome exist in the structure of the study and data collection. Firstly, much of the research consisted of studies mainly focusing on the experiences of White women (Cadaret et al., 2017, Reilly et al., 2019). Much of the data presented in these studies faced an underrepresentation of individuals who identify as part of Black, Indigenous, and People of Colour groups. It is important to recognize the intersectionality of multiple identities and the ways in which they create unique experiences based on the combination of race and gender (Crenshaw, 1989). Female-identifying individuals of racial minorities have lived experiences that differ from White female-identifying individuals. As such, gender identity, in combination with racial identity, creates unique intersections of systems of oppression. This can effect the interpretation of the results and the generalizability of experiences of imposter syndrome for female-identifying individuals.

Second, the results of the experiences of imposter syndrome for women in STEM may not be generalizable within each individual STEM program (Reilly et al., 2019). Much research focuses on STEM programs as an entire category rather than evaluating experiences of imposter syndrome within each program. As such, it is not known which programs experience the highest rates of imposter syndrome; rather, STEM programs have a higher prevalence as compared to non-STEM programs. Additional research would need to be conducted on the individual programs and how they compare to one another.

Finally, most data collections utilize cross-sectional, self-reported data (Reilly et al., 2019). This type of research evaluates individual experiences at one point in time. Longitudinal observational designs would strengthen the validation and robustness of the findings, as individuals' attitudes and behaviours could be measured over time. This would allow the researcher to investigate the interaction between intrapersonal and social factors, as well as the ways in which these factors affect feelings of fraudulence. Additionally, the researcher can evaluate the correlation between attitudes and behaviours exemplifying the traits associated with imposter syndrome over longer periods of time.

Theoretical Framework
Imposter Syndrome

Throughout our research, we drew upon two theoretical frameworks: imposter syndrome and intersectionality. Imposter syndrome is a term used to define individuals who distrust their abilities and fear being discovered as a fraud (Mullangi & Jagsi, 2019). This phenomenon is especially apparent in women (Clance & Imes, 1978). Individuals who suffer from imposter syndrome do not exhibit specific diagnostic criteria; however, they typically show symptoms relating to generalized anxiety, an absence of self-confidence, depression, and frustration at being unable to fulfill standards set by themselves (Clance & Imes, 1978). This can have detrimental effects on the individual, such as issues with identity as a student, scholar, and professional.

The founders of this theory were Paulene Clance and Suzanne Imes, who worked together and coined the term 'imposter phenomenon' in 1978; however, in academic literature and casual conversations, it is more commonly known as 'imposter syndrome' (Clance & Imes, 1978; Bravata et al., 2020). Before their study, Clance and Imes felt that imposter syndrome mainly affected women (Rohrmann et al., 2016). This was seemingly confirmed in their study. Their study sought to investigate this phenomenon, showing that highly successful women feared failing. Even when faced with success, they attributed this to external qualities and situational factors such as luck (Clance & Imes, 1978). In comparison, men are likely to accredit their successes to internal and dispositional factors.

There are three core characteristics of imposter syndrome (Rohrmann et al., 2016). The first core feature is that the individual must feel as if they have fooled those around them into overestimating their ability. The second characteristic is attributing one's success to external factors rather than intelligence or ability (Rohrmann et al., 2016). This is a protective mechanism from imposter syndrome itself, and it does not allow the individual to feel a sense of pride or relief but rather feelings of being a fraud. The last element is an intense fear of one day being exposed as a fraud (Rohrmann et al., 2016). This is more apparent when the individual is faced with a new task or challenge.

The use of this theoretical framework was crucial for the implementation and analysis of our research. This theory allowed us to define and utilize the research topic of our study. Additionally, the definition of imposter syndrome was utilized to create the questions within the survey to investigate the prevalence within undergraduate students at McMaster. As this concept was the main focus of our study, it provided us with the foundation for analyzing survey responses pertaining to feelings of academic inadequacy and   fraudulence.

Intersectionality

Intersectionality allows us to observe the interconnections and interdependencies of varying social systems and categories (Atewologun, 2018). Utilizing this theory in research has become the prevailing method of visualizing the relationship between systems of oppression and social hierarchies of power (Carastathis, 2014). It offers researchers the understanding that a single process does not create the studied issues, but rather multiple systems. While this framework began exclusively in an anti-racial context and feminist movements, it has widely spread across many domains (Cho et al., 2013).

The term 'intersectionality' was coined by Kimberle Crenshaw in 1989 (Crenshaw, 1989). It was initially created as a metaphor but later elaborated as a provisional notion to conceptualize the relation between systems of oppression and the construction of multiple identities (Carastathis, 2014). Crenshaw observed how numerous systems exist in society that overlap and are often oppressive in nature. When these systems interact with one another, those in vulnerable positions are oppressed, forgotten, and abandoned (Crenshaw, 1989). Observing society through a single-axis framework ultimately diminishes the struggles these people face (Cho et al., 2013). Before Crenshaw coined the term, academic writings published during the political movement of Black women in the early 1980s used the term 'intersections' (Carastathis, 2014). This political movement drove Crenshaw to create this theoretical framework. Since then, it has spread across other domains such as history, sociology, philosophy, queer studies, and legal studies (Crenshaw, 1989).

This framework has four main principles: simultaneity, complexity, irreducibility, and inclusivity (Carastathis, 2014). Simultaneity argues all aspects of a person must be simultaneously evaluated rather than independent factors (Carastathis, 2014). Secondly, complexity describes the ways in which intersectionality can account for structural and experiential complexities that a monistic approach cannot describe. Irreducibility is derived from simultaneity and complexity (Carastathis, 2014). It states oppression comes from interactions between numerous factors. The final principle of inclusivity claims to bring visibility to possible elitism, ableism, heteronormativity, or other issues that may have been hidden with the monistic approaches of the past (Carastathis, 2014). These principles bring forth the intertwined categories of social institutions and lived experiences depicting intersectionality.

In our research project, intersectionality aided in analyzing the connections between gender identity and programs concerning imposter syndrome. It allowed us to observe other explanations for rates of imposter syndrome that we may not have thought of previously. Intersectionality was relevant to our research as it offered insight into the ways in which specific groups experience social institutions differently depending on intersections of identities. For the purpose of our research, we focused on how female-identifying individuals experience the educational institution of university based on the intersectionality of their gender identity and program. This framework was utilized in the analysis of our findings.

Methodology

Participants

To evaluate levels of imposter syndrome among STEM McMaster University students, we conducted an anonymous online survey through the MREB-approved program LimeSurvey. The research was approved by the McMaster Research Ethics Board (MREB#: 0327). Our questionnaire focused on female-identifying individuals and whether their experiences with the imposter phenomenon differ from non-female-identifying students. A purposive sampling technique was used to study a small subset of the larger population, undergraduate students at McMaster University. Our ideal sample size was a minimum of 75 participants across all faculties so that we could generalize our results to the McMaster student population. However, we were only able to recruit 44 survey participants. More specifically, we recruited female-identifying individuals in STEM, non-

female-identifying individuals in STEM, and female-identifying and non-female-identifying individuals not in STEM from all levels through various platforms. Our team primarily recruited through social media by contacting McMaster student groups, program societies, and class Facebook groups. Upon receiving approval, our participant recruitment started on November 14, 2022, and ended on February 17, 2023, with data analysis following.

Lana Abdul Raheem emailed the following groups to post our recruitment poster on their social media pages: McMaster Humanities Society, DeGroote Commerce Society, McMaster Engineering Society, McMaster Science Society, McMaster Life Science Society, Health Sciences Society, McMaster Social Sciences Society, McMaster Kinesiology Society, McMaster Social Psychology Society, McMaster Anthropology Society, McMaster Economics Society, Health and Aging Society, McMaster Sociology Society, Psychology Neuroscience and Behaviour Society, The School of Earth Environment and Society Student Association, Labour Studies Student Association, McMaster Political Science Student Association, Social Work Student Collective, Society Culture and Religion Society, The Cooperative of Indigenous Students Studies and Alumni.

Materials

The materials within our survey consisted of 12 close-ended and 3-open ended questions. The survey was made accessible via LimeSurvey and was distributed to McMaster undergraduate students through recruitment over social media platforms to increase outreach. Our survey also included questions concerning demographic information, ethnography, and gender identity. Additionally, our survey featured a Likert scale system specific to our research to measure levels of imposter syndrome among students.

Procedure

Once the participants agreed to participate in the survey, they were directed to a questionnaire via the online LimeSurvey platform. First, the participants were presented with a Letter of Information specifying the research and data collection process and their rights to withdraw from the survey. The survey was accessible online through any technological device with internet access. Participants were then asked to sign a consent form detailing the confidentiality and anonymity agreement, stating that all participation is voluntary and that all collected information will remain anonymous before, during, and after data collection, giving participants the right to withdraw at any time before the survey submission. Upon reading the consent form, participants provided consent by clicking "Yes/I consent," confirming that they had read the consent form and were aware of the process, risks, and benefits of participating in the research. This survey posed no risks greater than those found in everyday life. Since the surveys were to remain anonymous, participants were informed that they could not withdraw after submission as it is impossible to trace the survey back to the correct participant. Participants were also informed that there are no penalties for withdrawal. The survey was estimated to take approximately 15 minutes to complete.

Data Analysis

The quantitative data was collected using a Likert scale and a frequency scale collected through the online platform LimeSurvey. The analysis of our results was conducted using the statistical software Jamovi. Responses were exported from LimeSurvey into an OMV file and imported into Jamovi. Our qualitative results were coded using a descriptive coding approach. Participants answered our survey questions, indicating whether they agreed or disagreed with the statements presented in the research survey. They also expressed how frequently they feel they have experienced a feeling or situation. We also included 3 open-ended questions that further detailed the participants' experiences with imposter syndrome. Furthermore, the demographic scale used in our survey was more specific and gave participants the option to describe their characteristics while maintaining anonymity.

Reflexivity and Positionality

Throughout our research process, we aimed to acknowledge our reflexivity by understanding our own social identities, recognizing how it impacts our lives, and acknowledging how our experiences differ from each other and the participants. Engaging in self-reflexivity allowed us to have varying viewpoints and perceptions of the world, which aided us when it came to analyzing the results of our research. As a group, we acknowledge our positionality. As university students of varying backgrounds, we may understand and relate to the experiences described by participants; however, we will not have experienced each element that participants have described, which can influence our choice of questions. We recognize the diverse backgrounds of our group members and our participant population and the varying ways in which gender identity can be perceived and identified. We understand that while we will be using our academic knowledge to communicate our questions and perceive our data accurately, we may not fully comprehend the different experiences of our participants as we all engage with gender identity in unique ways.

Ethical Considerations

Throughout our research process, we made sure to mitigate risks and concerns by implementing protocols every step of the way. However, while we have attempted to lower the number of risks that participants can encounter during our study, we recognize that most research studies still carry risks to those involved, despite protocols in place. A potential risk that participants may have encountered during the study is psychological harm. Some of our questions may be perceived as personal as individuals are asked to recount experiences of imposter syndrome and evaluate their justifications for their beliefs and actions. In asking questions that pertain to participants' lived experiences of imposter syndrome, it cannot be known what psychological impact this may have on them. Some questions may direct participants to recall moments when they felt anxious, unworthy, or unintelligent.

Questions regarding gender identity may cause feelings of distress as it questions the participant's relationship to their gender identity. As such, these questions may potentially cause negative emotions to resurface, causing them to feel embarrassed, ashamed, or judged. To mitigate these psychological risks, our researchers have created a survey with 12 close-ended questions and 3 open-ended questions. In this, there is a majority of

close-ended questions to reduce anxiety about creating an answer but rather can select from several options. Psychological risks were further mitigated by allowing participants to skip any question and/or withdraw at any time before the survey submission.

In addition, there was also a possibility of social risks to privacy involved in participating in the survey. These social risks can be identified through participants' responses, which evoke personal identifiers. This can have negative social consequences, such as fear of exposure, as an individual experiences imposter syndrome. To combat this, we advised participants to complete the survey in a private, comfortable, and safe space. Additionally, participants were reminded and reassured of complete anonymity and confidentiality in their survey responses. The only possible scenario in which a participant may be identified through their responses is in answering open-ended questions wherein participants could include specific details from their personal life, such as a name or other identifiers. In this case scenario, our team would have addressed this by removing the submission from the data to protect their identity.

Challenges

As our research question examines the differences in experiences of imposter syndrome between female-identifying individuals in STEM compared to non-female-identifying individuals and those not in STEM, we required a diverse population that may be difficult to meet. Preferably, our population required the participation of female-identifying individuals in STEM, female-identifying individuals outside of STEM, non-female-identifying individuals in STEM, and non-female-identifying individuals outside of STEM, all of which come from diverse demographics. Given the inherent need for diversity in our research, it was difficult to predict the recruitment process. A great deal of the challenges we faced arose from difficulty in gathering participants who are female-identifying individuals in STEM, female-identifying outside of STEM, female-identifying individuals in STEM, and female-identifying individuals outside of STEM.

Another challenge we faced was student engagement and recruiting individuals who were willing to participate in our study. Our primary method of promoting the survey was reaching out to student groups, university societies, and posting on LimeSurvey. This was a challenge, as we found difficulty in having student groups and societies advertise our study. Navigating recruitment was a challenge; however, we took preventative measures to ensure the proper protocols were in place to maintain the integrity of the research.

Another challenge we faced was the possibility of response bias from the participants. Despite the anonymity of the survey, respondents may engage in a social desirability bias to present themselves to be viewed favourably by others. Participants may also have answered in accordance with their interpretation of the desired outcomes of the research, for example, exaggerating their responses to exemplify imposter syndrome.

Apart from data collection challenges, data analysis introduced its own set of challenges. The primary challenge during the data analysis phase was internal biases affecting how we interpreted the data. To combat this, we added open-ended questions to our survey to ensure respondents had a sense of control over the ways in which their narratives were interpreted within the analysis.

Summary of Methodology

In summation, we developed a survey including quantitative and qualitative portions to answer our main research question. Our sample size was 44 undergraduate McMaster students recruited mainly through student groups. Our results were analyzed using the statistical software Jamovi, and our qualitative data were coded using a descriptive coding method.

Results

Sociodemographics

Our research study had a sample size of 45 McMaster undergraduate students. One of the responses was deleted as their answers were submitted with malintent, which may have skewed our results. Our final sample size consisted of 44 McMaster undergraduate students over 18 years of age (n=44). The demographic questions pertained to their study year, faculty, age, gender identity, and ethnicity.

Year of Study

The first demographic question asked respondents what year of University they were in. Responses included undergraduate year one, undergraduate year two, undergraduate year three, undergraduate year four, and undergraduate year five. Figure 1 shows that the majority of our participants were in their fourth year (58.1%). 16.3% of participants stated they were in their second year, 11.6% in their third year, 9.3% in their fifth year, and 4.7% in their first year.

Figure 1

Frequencies of Year

Levels	Counts	% of Total
Undergraduate Year One	2	4.7%%
Undergraduate Year Two	7	16.3%
Undergraduate Year Three	5	11.6%
Undergraduate Year Four	25	58.1%
Undergraduate Year Five	4	9.3%

Faculty

The second demographic question inquired about which faculty they studied in at McMaster University. As seen in figure 2, the Faculty of Social Sciences is where most of our participants study (40.9%). The second highest was the Faculty of Science (27.3%), followed by Faculty of Engineering (18.2%), Faculty of Humanities (4.5%), DeGroote School of Business (4.5%), and lastly, the Faculty of Health Sciences (2.3%).

For the purpose of this research, we have categorized the Faculty of Health Sciences, the Faculty of Science, and the Faculty of Engineering as STEM programs, and have categorized the Faculty of Humanities, the Faculty of Social Sciences and the DeGroote School of Business as non-STEM programs. Figure 3 demonstrates that 47.7% of participants were in STEM, and 52.3% of participants were not in STEM.

Figure 2
Frequencies of Faculties

Levels	Counts	% of Total
DeGroote School of Business	2	4.5%%
Faculty of Engineering	8	18.2%
Faculty of Health Sciences	1	2.3%
Faculty of Humanities	3	6.8%
Faculty of Science	12	27.3%
Faculty of Social Sciences	18	40.9%

Figure 3
Frequencies of STEM versus Non-STEM

Levels	Count	% of Total
STEM	21	47.7%
Non-STEM	23	52.3%

Age

Our next demographic question had participants state their age from a range of 18-24, or 25+. Figure 4 shows that almost half of our participants were 21 years old (45.5%). The next being 20 years old (15.9%) and 22 years old (15.9%). Followed by 19 years old (13.6%), 18 years old (4.5%), 23 years old (2.3%) 25+ (2.3%), and lastly, no participant stated they were 24 years old.

Figure 4
Frequencies of Age

Levels	Counts	% of Total
18	2	4.5%
19	6	13.6%
20	7	15.9%
21	20	45.5%
22	7	15.9%
23	1	2.3%
24	0	0.0%
25+	1	2.3%

Gender Identity

Participants were asked in an open-ended question which gender they identified with, including an option to skip it if they were uncomfortable answering. Answers included responses such as 'biological female', 'female', and 'woman'. These were grouped into one category titled "female". As demonstrated in Figure 5, 81.8% of participants self-identified as female, 11.4% self-identified as male, 2.3% self-identified as nonbinary/demigender, 2.3% responded cisgender, and 2.3% of participants did not respond.

Figure 5
Frequencies of Gender

Levels	Counts	% of Total
Female	36	81.8%
Male	5	11.4%
Non-Binary/Demigender	1	2.3%
Cisgender	1	2.3%
No Response	1	2.3%

For the purpose of our research, we have grouped everyone into 'female-identifying individuals' and 'non-female-identifying individuals'. Female-identifying individuals include those that responded 'biological female', 'female', and 'woman'. Non-female-identifying individuals included those that responded 'male', 'nonbinary/demigender', and 'cisgender'. As shown in Figure 6, 81.8% of participants will be analyzed as female-identifying individuals, and 15.9% of participants will be analyzed as non-female-identifying individuals.

Figure 6
Frequencies of Female-Identifying versus non-female-identifying

Levels	Count	% of Total
Female-Identifying	36	81.8%
Non-Female-Identifying	7	15.9%
No Response	1	2.3%

Ethnicity

In the last demographic question, we asked participants to write in the ethnicity they identify with most. Any answer that is a variation of 'white' or 'Caucasian' is grouped into the category 'Caucasian'. Answers including 'Chinese', 'Filipino', 'Taiwanese', and 'HongKongese' are grouped into the category 'East Asian'. Responses including 'Mixed' and 'White/Asian' were placed into the category 'Other'. As seen in Figure 7, the majority

of our participants identify as Caucasian (63.6%). This was followed by South Asian (13.6%), East Asian (6.8%), Middle Eastern (4.5%), Other (4.5%), and lastly, Latin America (2.2%). 4.5% of participants chose not to answer this question.

Figure 7
Frequencies of Ethnicity

Levels	Counts	% of Total
Caucasian	28	63.6%
Latin America	1	2.2%
East Asian	3	6.8%
Middle Eastern	2	4.5%
South Asian	6	13.6%
Other	2	4.5%
No Response	2	4.5%

Quantitative Results

This section outlines the results of our 12 close-ended questions, showing results categorized by STEM versus non-STEM programs, as well as for female-identifying versus non-female-identifying. The main purpose of these questions was to observe feelings of inadequacy and fraudulence within our two selected demographics. Responses to our questions included a 5-point Likert scale where 'strongly disagree' or

Figure 8a
Faculty-Specific Feelings that Successes are a Result of Outside Factors
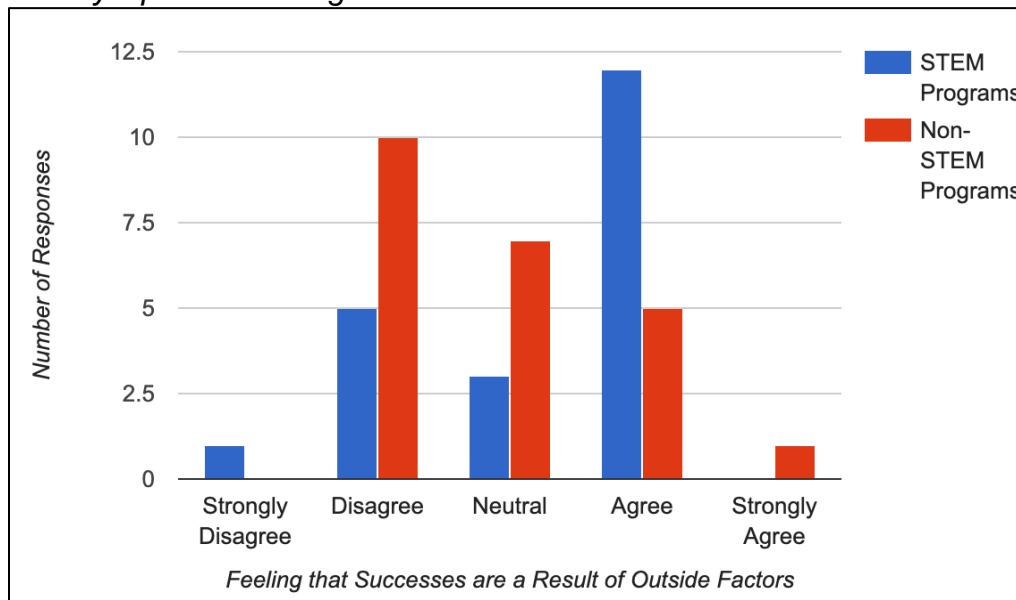
'never' indicated lower rates of imposter syndrome, and 'strongly agree' and 'always' indicated higher rates of imposter syndrome. Our sample size showed a fairly even distribution for STEM versus non-STEM programs; however, the majority of our participants were female-identifying which may skew the results in relation to gender. The following figures will show responses split by the two categories for each question, followed by the means, and lastly, t-tests and a correlation matrix to test for statistical significance.

Figures 8a and 8b indicate participants' feelings that their successes and accomplishments were a result of outside factors, such as luck. When observing faculty, results show that STEM programs are more likely to attribute successes to external factors. As for gender, non-female-identifying individuals showed a higher likelihood of attributing successes to external factors, but this is only slightly observed.

Figure 8b
Gender-Specific Feelings that Successes are a Result of Outside Factors

Feeling that Successes are a Result of Outside Factors
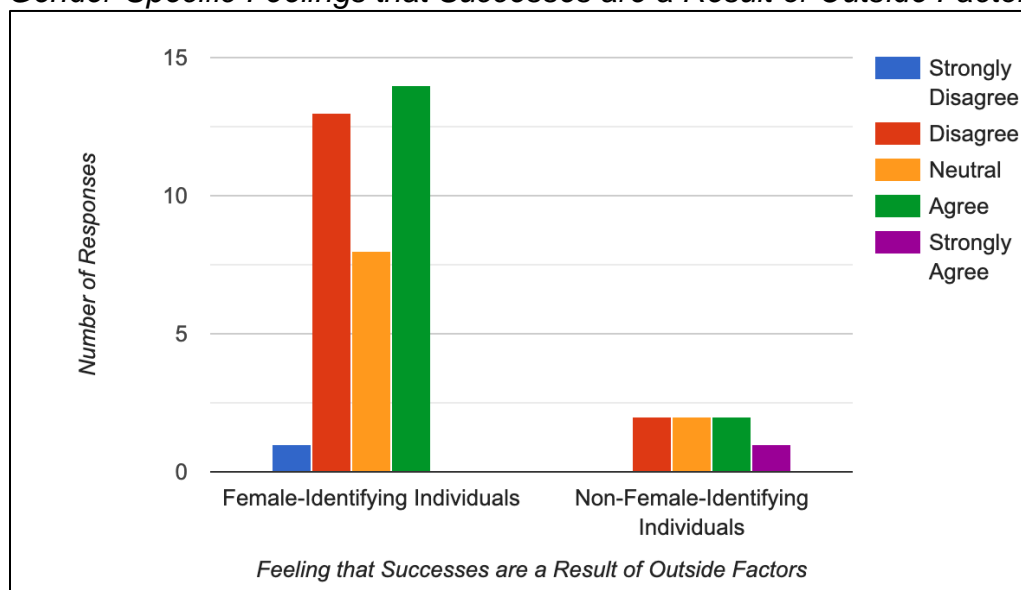
Figures 9a and 9b show results of academic comparison amongst peers and thoughts that others are more capable and more intelligent than they are. For faculty, results are similarly high for both STEM and non-STEM programs, with STEM portraying slightly higher rates of academic comparison. For gender, both female-identifying individuals and non-female-identifying individuals show a similar trend of higher academic comparison.

Figures 10a and 10b portray participants' thoughts that they could always work harder and devote more time to their work, despite their work ethic and past successes. Both STEM and non-STEM had a majority answer 'strongly agree', with non-STEM answering slightly higher with 69.5% of participants compared to STEM's 61.9%. Gender showed a similar trend with 71.4% of non-female-identifying individuals and 66.6% of female-identifying individuals answering, 'strongly agree'.

In Figures 11a and 11b, we observe responses based on how strongly participants agree with the statement 'I am rarely satisfied with my accomplishments and often believe I could have performed better'. Non-STEM participants showed higher rates of this, with

Figure 9a

Faculty-Specific Academic Comparison

Figure 9a
Faculty-Specific Academic Comparison
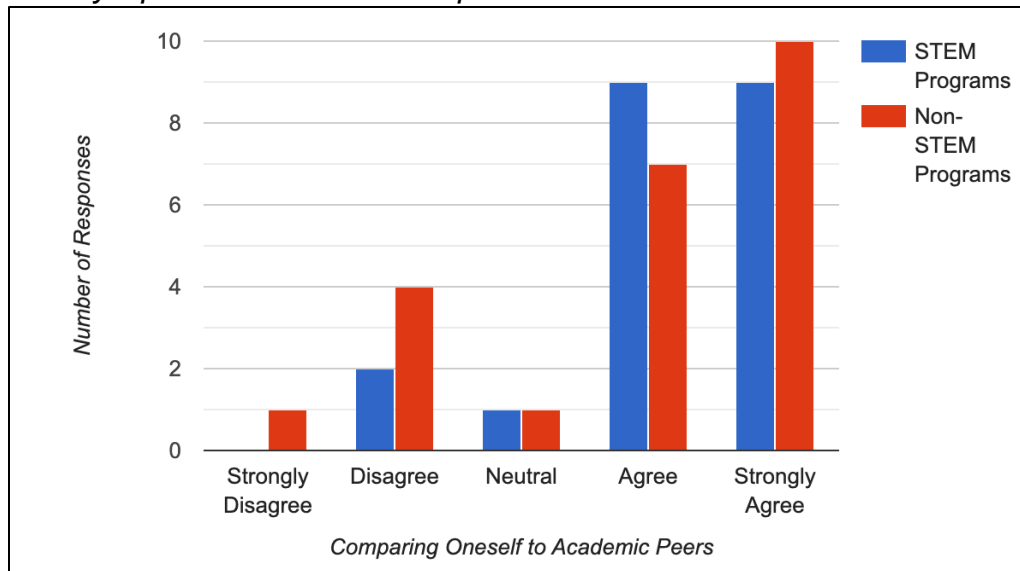
more answering 'agree' or 'strongly agree' than STEM programs. For gender, non-female-identifying individuals displayed a higher likelihood of being dissatisfied with their accomplishments.

This question sought to find out if participants avoided tasks and assignments out of fear of failure. Figure 12a shows that both STEM and non-STEM programs have relatively similar responses. There is approximately an even number of responses of 'disagree' and 'strongly agree', indicating a discrepancy in attitudes. Figure 12b shows that non-female-

Figure 9b

Gender-Specific Academic Comparison
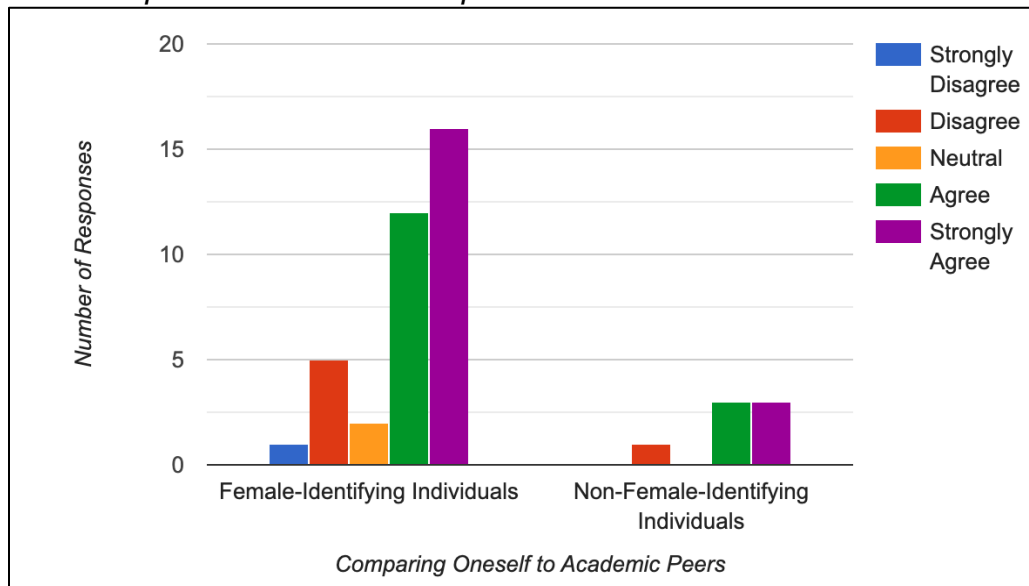
Figure 10a
Faculty-Specific Feelings That They Could Work Harder
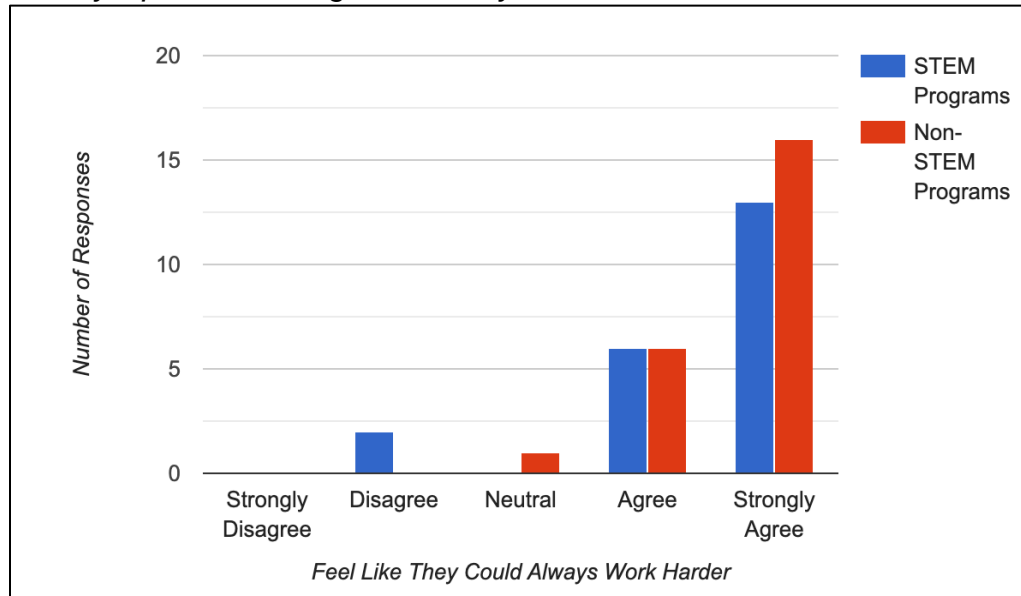
identifying individuals rate higher task avoidance, whereas almost half of female-identifying individuals rate lower on task avoidance.

Figures 13a and 13b portray whether participants worry that their peers may discover that they are not intelligent and do not deserve a place as a student at McMaster University. STEM programs responded at significantly higher rates, with 71.4% of participants answering 'agree' or 'strongly agree', compared to 47.8% of non-STEM programs. Female-identifying individuals and non-female-identifying individuals showed similar results, with 'agree' being the most chosen response.

Figure 10b
Gender-Specific Feelings That They Could Work Harder
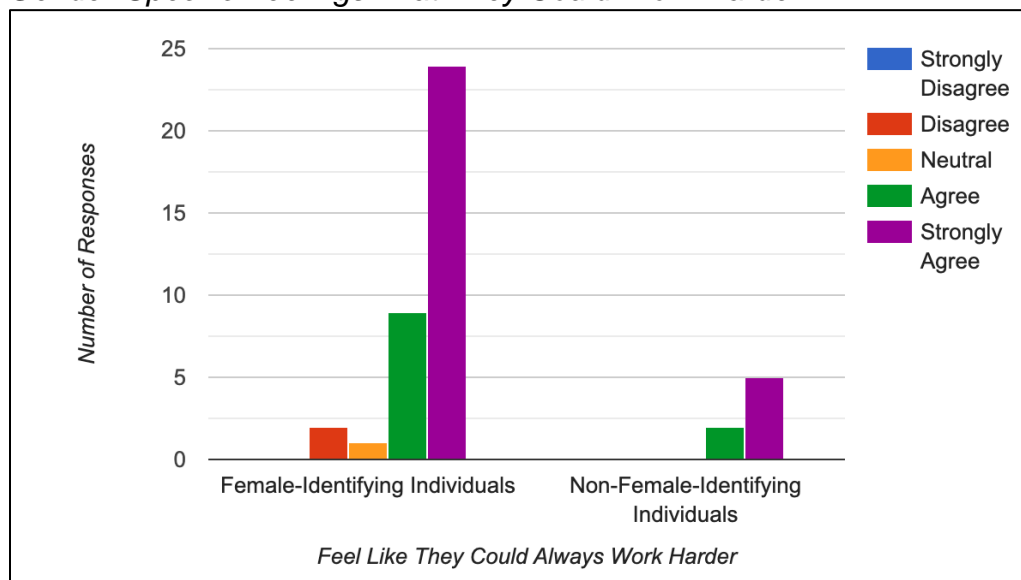
Figure 11a

Faculty-Specific Dissatisfaction with Accomplishments
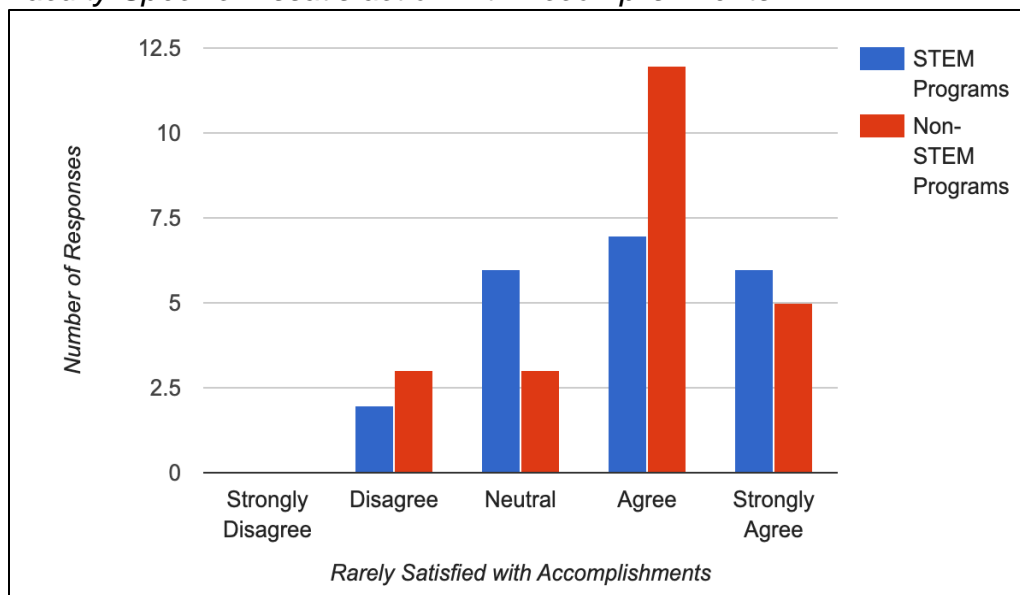
Figures 14a and 14b represent how often participants do not feel worthy of praise or recognition when they receive acknowledgement for their accomplishments. Almost half of the participants for STEM and non-STEM programs answered 'sometimes', indicating that they are neutral to these feelings. Gender showed similar results as faculty, with almost half of female-identifying individuals and non-female-identifying individuals responding, 'sometimes'.

Figure 11b

Gender-Specific Dissatisfaction with Accomplishments
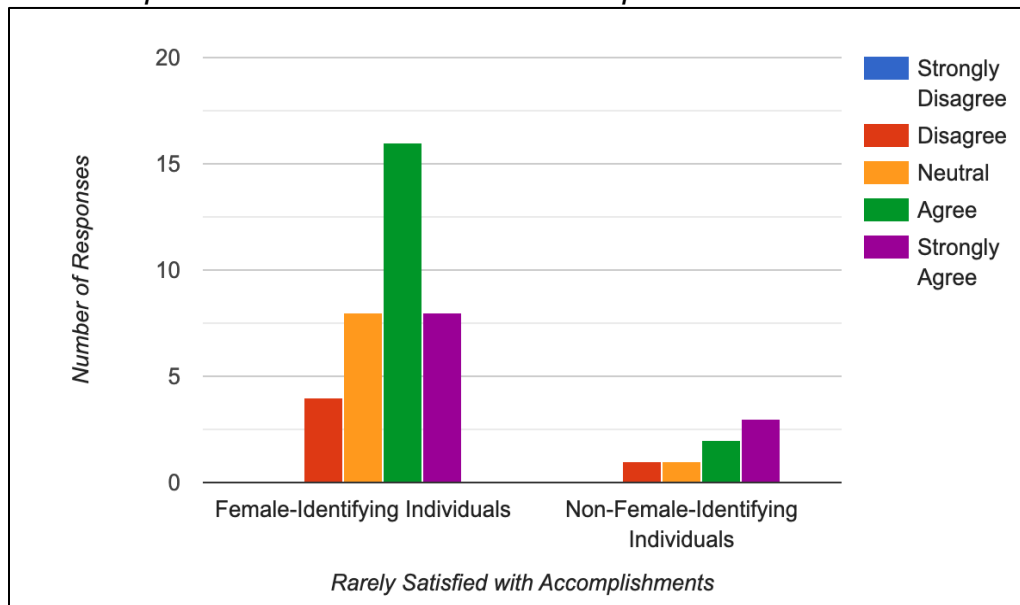
Figure 12a

Faculty-Specific Rates of Task Avoidance
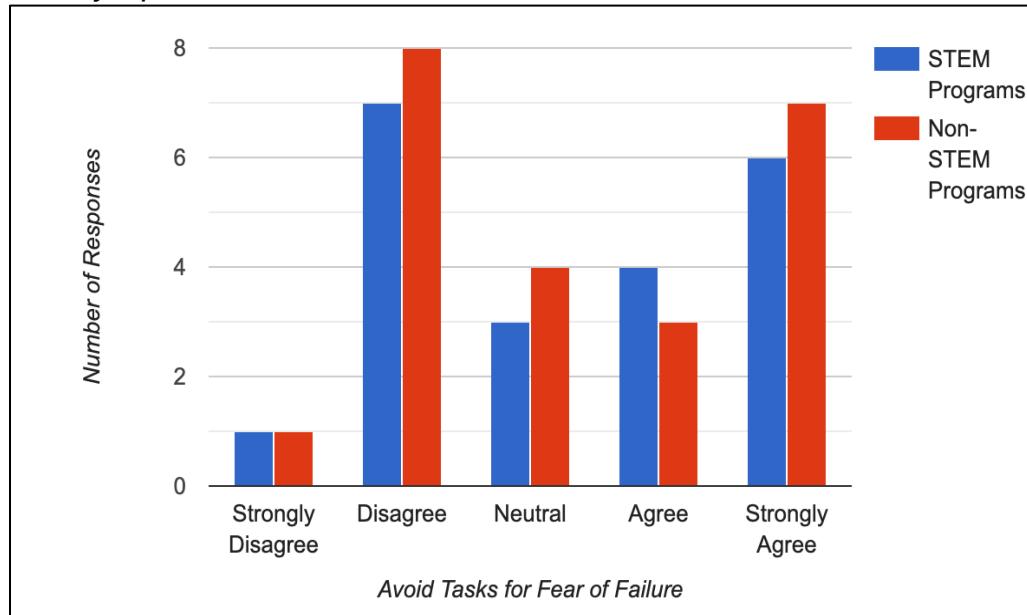
The next question in our survey asked participants if they worry about maintaining their level of success once they succeed at a task. Figure 15a demonstrates that non-STEM programs worry about maintaining their levels of success more often than STEM programs; however, this is minimal as both STEM and non-STEM answered 'often' or 'always' at a relatively high frequency. Figure 15b illustrates that non-female-identifying individuals record a higher rate of worrying about maintaining their success.

Figure 12b

Gender-Specific Rates of Task Avoidance
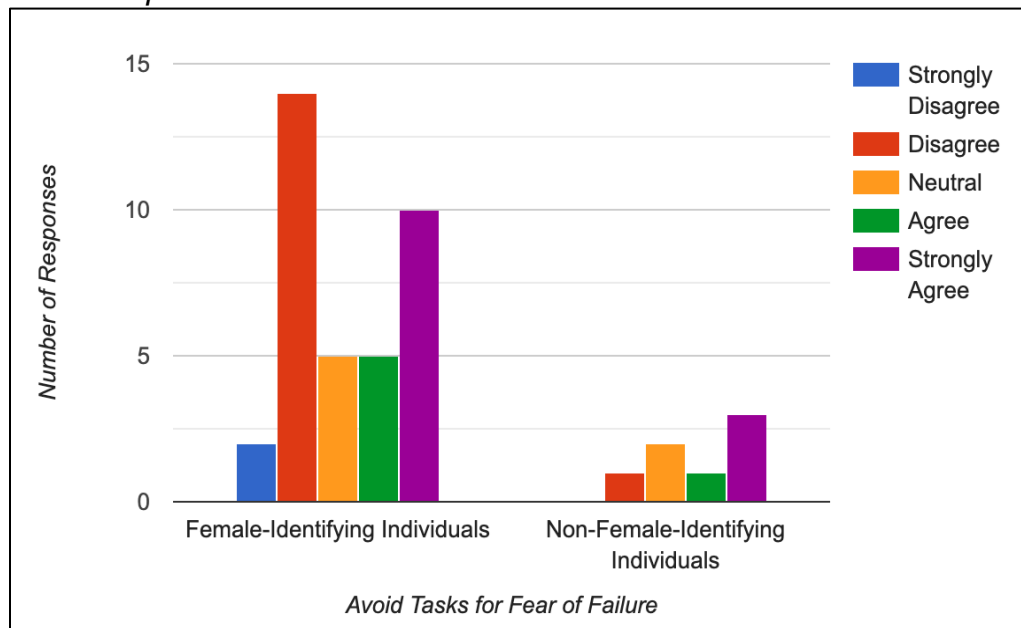
Figure 13a
Faculty-Specific Fear that Peers will Discover Lack of Intelligence
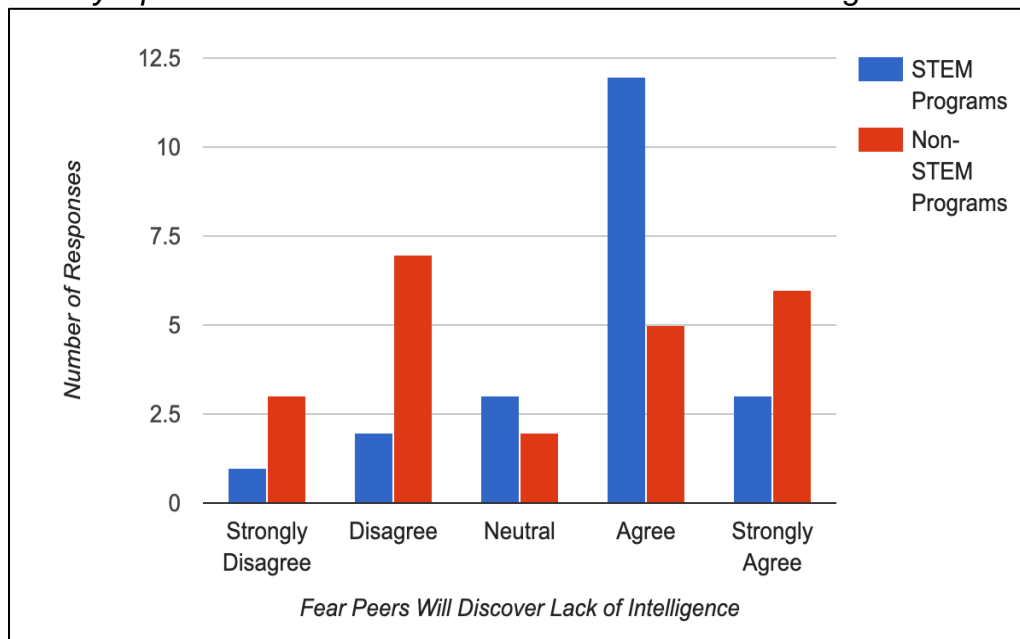
Figures 16a and 16b exhibit how often participants recall their failures more often than their successes. Figure 16a represents that STEM programs recall failures more often than not. Non-STEM programs were the only participants to answer 'never' and 'rarely' for this question. Figure 16b shows that the majority of female-identifying individuals and non-female-identifying individuals recall their failures.
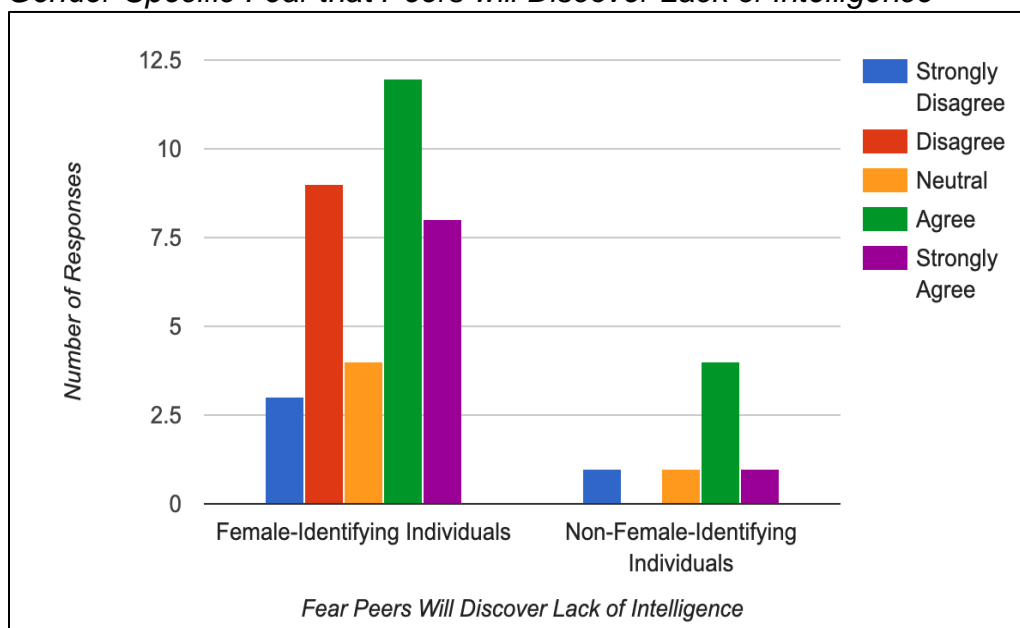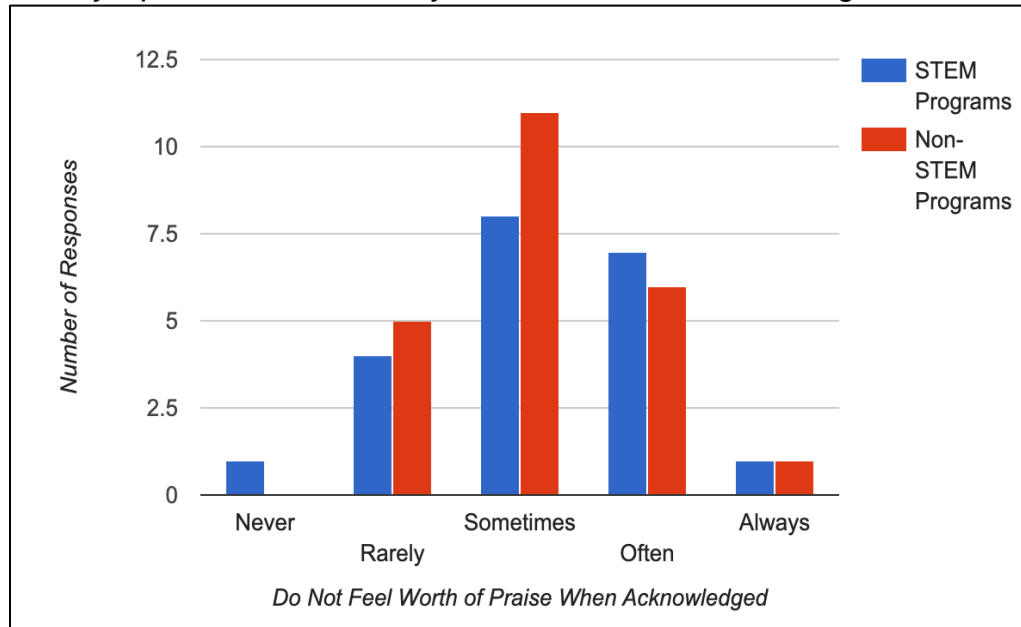
Figure 13b
Gender-Specific Fear that Peers will Discover Lack of Intelligence

Figure 14a

Faculty-Specific Feel Unworthy of Praise When Acknowledged for Accomplishments

Our next question asked participants if they focus more on the praise and recognition they obtain for their successes, rather than the importance of the task. Figure 17a presents the result that non-STEM programs rank higher than STEM programs in their focus on praise. Figure 17b presents the result that female-identifying individuals score higher than non-female-identifying individuals in their focus on praise.

Figure 14b

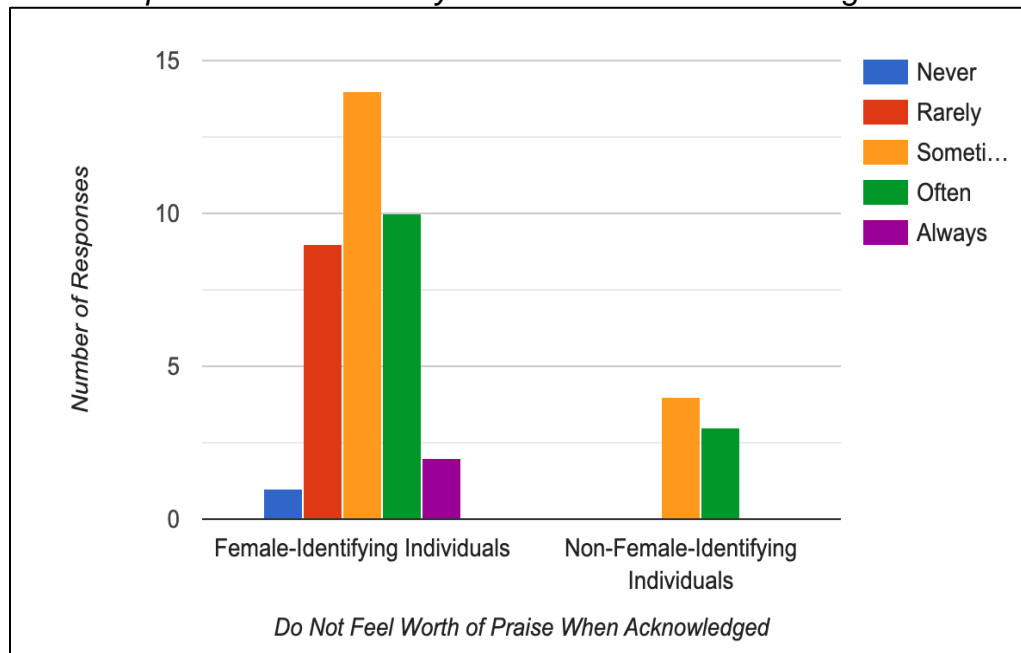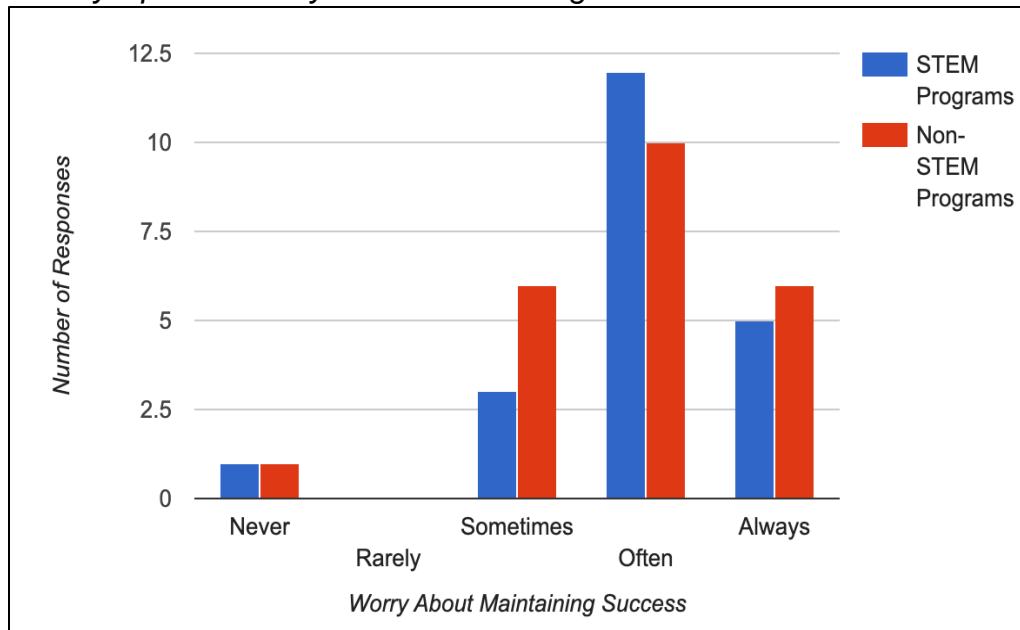*Gender-Specific Feel Unworthy of Praise When Acknowledged for Accomplishments*

Figure 15a

Faculty-Specific Worry about Maintaining their Success

Figures 18a and 18b portray how often participants search for academic validation from their mentors, such as Teaching Assistants and Professors. Non-STEM programs state that they seek academic validation more often, with 5 participants answering 'always', and 1 participant answering 'always' for STEM programs. Female-identifying individuals were more likely to seek academic validation, with 6 participants responding 'always', and no participants answering 'always' for non-female-identifying individuals.
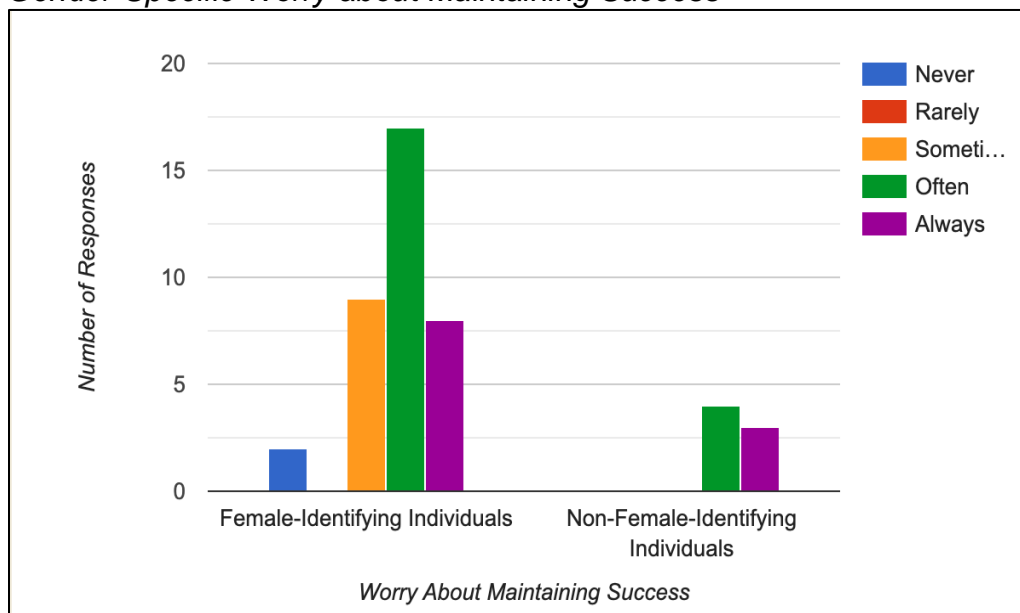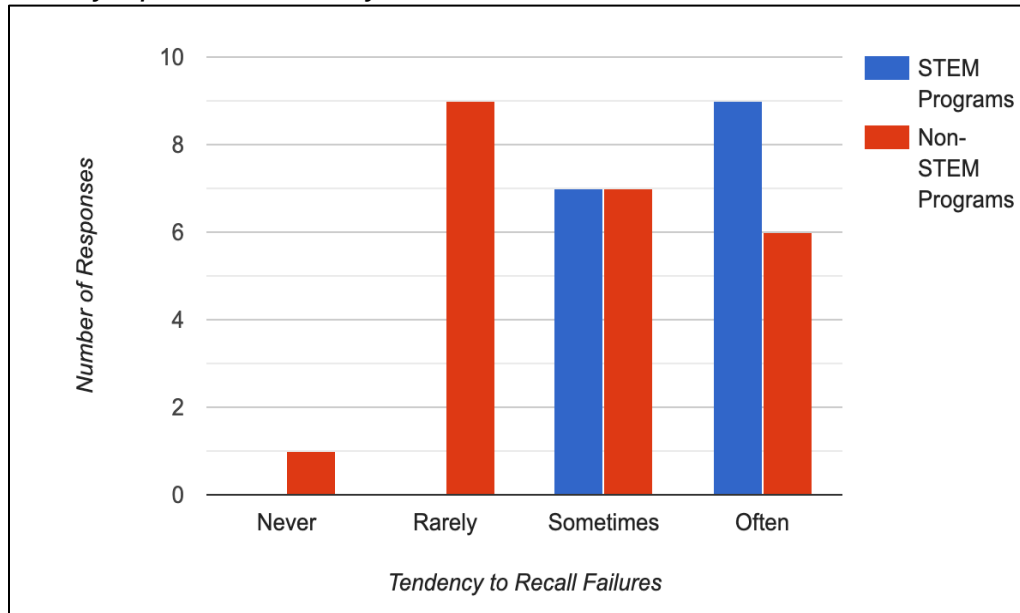
Figure 15b

Gender-Specific Worry about Maintaining Success

Figure 16a
Faculty-Specific Tendency to Recall Failures More than Successes

Our last close-ended question asked participants if they feel stressed, worried, or overwhelmed about being able to complete and succeed at a task when a new assignment is presented. Figure 19a shows that both STEM and non-STEM programs do this often; however, non-STEM programs report these feelings more often. Figure 19b shows that female-identifying individuals feel overwhelmed at the thought of being able to succeed at a new task more often than non-female-identifying individuals.
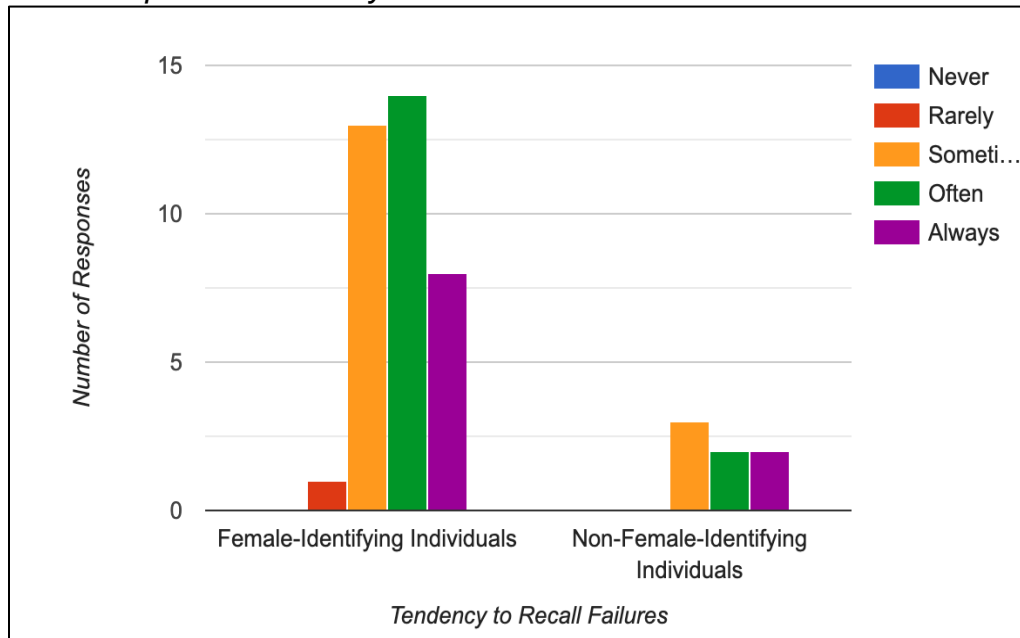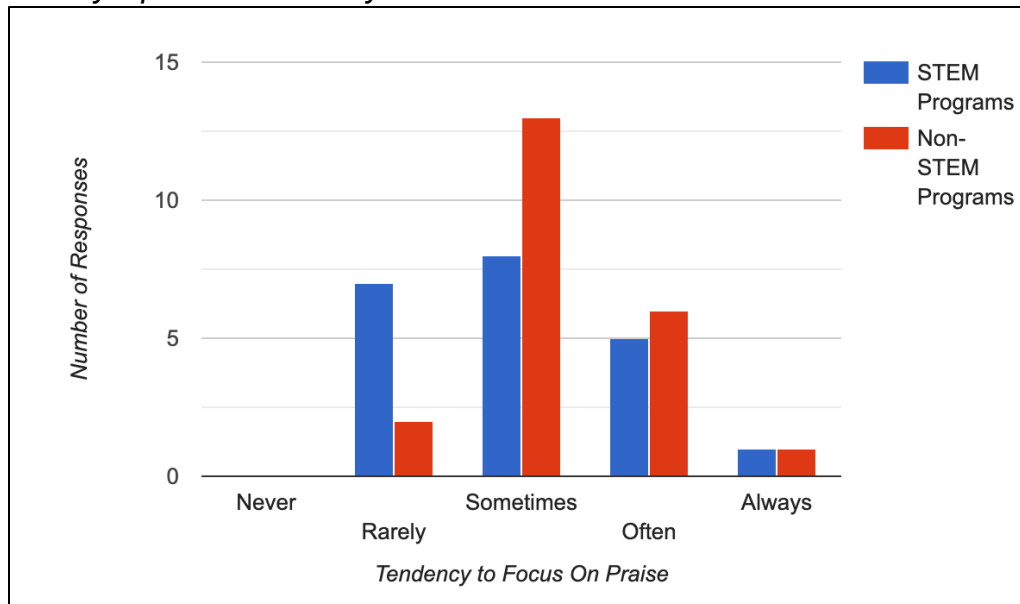
Figure 16b
Gender-Specific Tendency to Recall Failures More than Successes

Figure 17a

Faculty-Specific Tendency to Focus on Praise

To determine the rates of Imposter Syndrome across McMaster University faculties, as well as within female-identifying individuals and non-female-identifying individuals across McMaster University, we calculated the mean of responses for the close-ended questions. A lower value (1) indicates lower rates of imposter syndrome, and a higher value (5) indicates higher rates of imposter syndrome. Figure 20a shows the rates of imposter syndrome across faculty. The Faculty of Health Sciences exhibits the highest rates of imposter syndrome, with an average of 3.92. DeGroote School of Business

Figure 17b

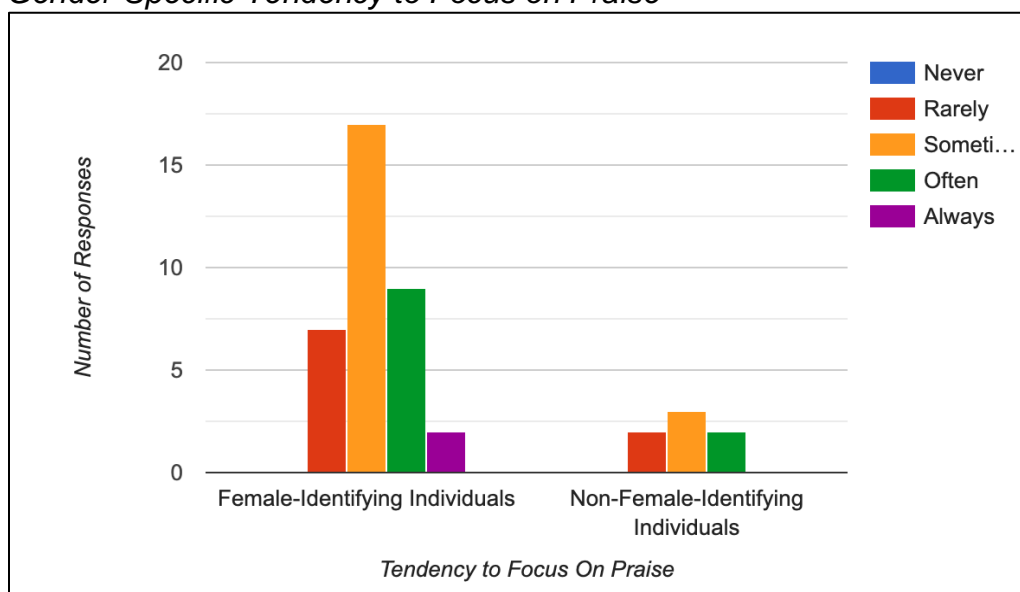*Gender-Specific Tendency to Focus on Praise*

Figure 18a
Faculty-Specific Seeking Validation from Mentors
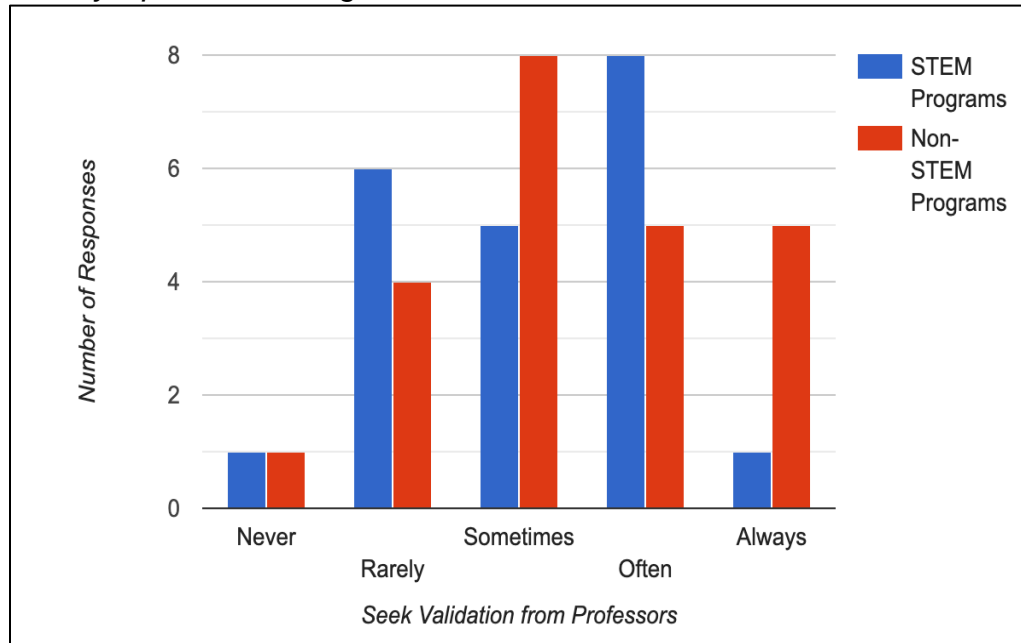
exhibits the lowest rates of imposter syndrome, with an average of 3.42. Figure 20b shows the rates of imposter syndrome, comparing STEM and non-STEM programs specifically. STEM portrays higher rates of imposter syndrome, but only slightly. This indicates that every faculty has similarly high rates of imposter syndrome.

Figure 18b
Gender-Specific Seeking Validation from Others
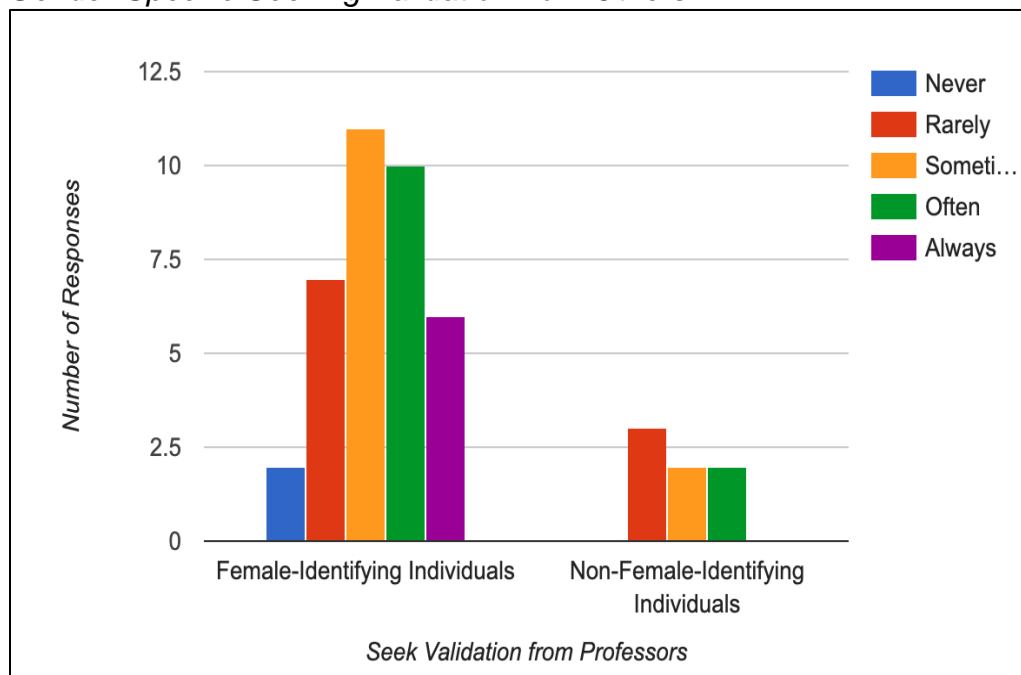
Figure 19a
Faculty-Specific Feeling Overwhelmed When Given a New Task
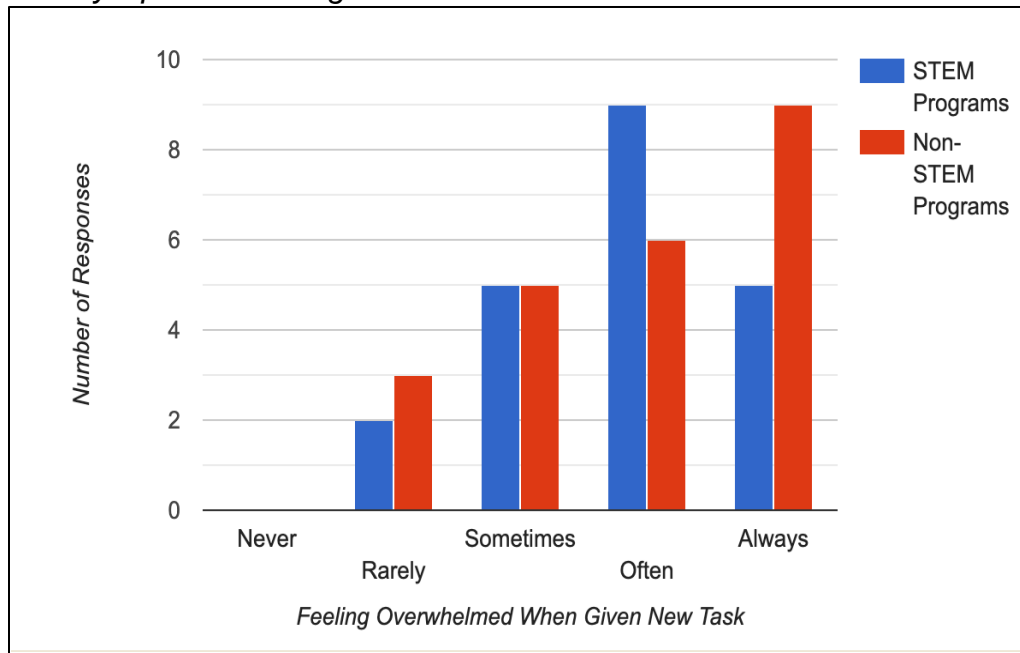
Figure 21 portrays the rates of imposter syndrome, comparing female-identifying individuals and non-female-identifying individuals. This figure shows that non-female-identifying individuals exhibit higher rates of imposter syndrome with a mean of 3.77, compared to 3.57 exhibited by female-identifying individuals. Although they are rated higher, these differences are minimal.
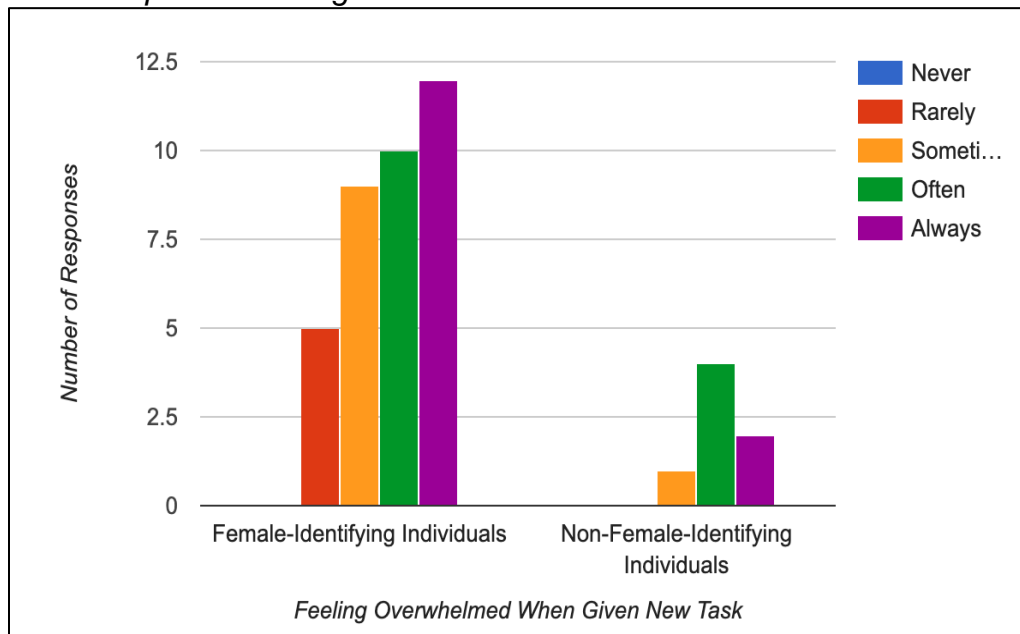
Figure 19b
Gender-Specific Feeling Overwhelmed When Given a New Task

Figure 20a

Rates of Imposter Syndrome across McMaster University Faculties

	Faculty	Rate of Imposter Syndrome
Mean	DeGroote School of Business	3.42
	Faculty of Engineering	3.61
	Faculty of Health Sciences	3.92
	Faculty of Humanities	3.89
	Faculty of Science	3.60
	Faculty of Social Sciences	3.58

To test if there is a correlation between imposter syndrome and faculty, as well as for gender, we conducted a correlation analysis. Additionally, we tested for statistical significance using an independent sample t-test. Figure 22 shows the results of the correlation tests, and the results of the t-test for faculty combined into one table. The Pearson correlation coefficient (r) shows that there is almost no correlation between imposter syndrome and STEM programs. The Pearson's r value 0.008 is a positive value, indicating a positive correlation; however, the value is relatively close to zero, so this correlation is insignificant. The results of the independent sample t-test show that the p-value is 0.957. Since this value is greater than 0.05, this is not statistically significant, indicating no relationship between imposter syndrome and STEM programs.

Figure 20b

Rates of Imposter Syndrome across McMaster University Faculties Categorized by STEM and Non-STEM

	Faculty	Rate of Imposter Syndrome
Mean	STEM Programs	3.71
	Non-STEM Programs	3.63

Figure 21

Rates of Imposter Syndrome within Female-Identifying and Non-Female-Identifying Individuals across McMaster University

	Female VS Non-Female	Rate of Imposter Syndrome
Mean	Female-Identifying	3.57
	Non-Female-Identifying	3.77

Figure 22

Faculty-Specific Results of the Correlation Matrix and T-Tests

	Pearson's r	df	p-value	Faculty	Mean	SD	SE
Rates of Imposter Syndrome	0.008	41.0	0.957	-	-	-	-
				STEM Programs	3.71	0.545	0.119
				Non-STEM Programs	3.63	0.564	0.120

Figure 23 shows the results of the correlation analysis and the results of the t-test for gender combined into one table. The Pearson correlation coefficient (r) for gender shows a slight negative correlation between imposter syndrome and female-identifying individuals, with a Pearson's r value of -0.136. The results of the independent sample t-test show that the p-value is 0.389. Since this value is greater than 0.05, this is not statistically significant, indicating no relationship between imposter syndrome and female-identifying individuals.

Figure 23

Gender-Specific Results of the Correlation Matrix and T-Tests

	Pearson's r	df	p-value	Gender	Mean	SD	SE
Rates of Imposter Syndrome	-0.136	40.0	0.389	-	-	-	-
				Female-Identifying	3.57	0.561	0.0948
				Non-Female-Identifying	3.77	0.515	0.195

Qualitative Results

To gain a better understanding of how students at McMaster University feel about their academic achievement, we used an open-ended question model and a descriptive coding method to examine the specific feelings these individuals may have. Our qualitative analysis used three open-ended questions to understand students' feelings about their academic achievement and to see if students attributed their success to internal or external factors. Those who associate their success with their own personal work or internal factors are less likely to experience imposter syndrome (Clance & Imes, 1978). Using 44 responses, we categorized students into four different groups, female-identifying

individuals in STEM, female-identifying individuals not in STEM, non-female-identifying individuals in STEM, and non-female-identifying individuals not in STEM.

Receiving Grades

Question one asked students to explain how they feel when they receive a good grade on an assignment. We categorized the responses into three categories, feeling positive emotions, feeling negative emotions, and feeling a mix of both positive and negative emotions. Out of 44 students who completed this survey, 41 responded to this question. The majority of female-identifying individuals in STEM claimed to feel positive emotions only, and few female-identifying individuals in STEM claimed to feel a mix of both positive and negative emotions.

There were no responses from female-identifying individuals in STEM that were strictly negative emotions. The question which was asked on the survey is as follows: in the space provided below, please explain how you feel when you receive a good grade on an assignment. Examples of the positive only responses we received are as follows:

- "I feel excited as my hard work paid off!"

- "I feel as if I am a valuable and worthy person. It makes me feel as if I deserve my

   place at McMaster and that I am succeeding as a university student."

Furthermore, examples of the mix of both positive and negative responses we received are as follows:

- "I feel proud of myself for getting a good mark but I always have a voice in the

   back of my head that tells me I don't deserve the grade for different reasons…"

- "First I feel relieved and proud and then I wonder where I went wrong and how I

   could've done better."

In comparison to female-identifying individuals in STEM, the majority of student participants in other groups resulted in similar feelings and responses. Most female-identifying individuals not in STEM programs felt positive emotions only when answering this question, and few felt a mix of both positive and negative emotions. However, within this category, very few responses showed only negative emotions. Examples of the negative only responses we received are as follows:

- "I've noticed that I don't feel proud like I used to feel in high school. Sometimes I

   think it's just because of luck but when I do get a 'bad' mark I always say negative

   things about myself."

- "Overwhelmed because I feel as though I have to up my standards and replicate

   that grade, so the pressure is higher."

Each of these responses provides us with a clear understanding of how individuals believe their grades are distributed and where they believe can be improved. Overall, many individuals feel proud of their grades and a sense of accomplishment in their academics.

Acceptance into Undergrad

The second question asked students to identify the factors they believe played a significant role in their acceptance into McMaster University for their undergraduate program. Each response was categorized into four different themes. These themes were then further categorized into two groups: internal and external factors. The initial themes were grades, academic motivation, grade inflation due to the Covid-19 pandemic, and luck. We categorized academic motivation as the internal factor and categorized grades, grade inflation and luck as external factors. Out of 44 students, there were only 41 responses to this question. The question which was asked stated: What do you think your acceptance into McMaster was based on?

The submitted responses to this question show that the majority of female-identifying individuals in STEM attribute their acceptance into McMaster University to external factors such as their grades, grade inflation, and luck. This shows that most female-identifying individuals experience feelings of imposter syndrome in relation to their sense of belonging at McMaster University. Similar results were found with all other groups. Most of the female-identifying individuals not in STEM and non-female-identifying individuals in STEM experienced similar feelings of acceptance based on mainly external factors. There were few responses from both female-identifying individuals in STEM and female-identifying individuals not in STEM that expressed solely internal factors and a mix of both internal and external factors. Examples of external based factor responses include:

- "I know it was based on grades. I was an overachiever in high school."

- "I feel as though my acceptance into Mac was based on my high secondary

  school GPA but I could not have gotten such a high GPA if it wasn't for online

  school (due to COVID lockdown) and the easy marks that come with

  unsupervised tests."

Likewise, examples of external based factor responses include:
- "My hard work and dedication in grade 12."

- "My work ethic in high school…"

These responses elicit the idea that McMaster University's undergraduate students feel as though they have earned their spot in their programs through external factors alone. This introduces the idea that students may feel high rates of imposter syndrome, however, this is not specific to only female-identifying individuals in STEM as other groups studied have exhibited similar results.

Academic Validation

The last question participants were asked to respond to was based on discovering what makes students at McMaster University feel validated in their academics. The question read: In the space provided below, please explain what makes you feel most validated as a student. The responses varied among answers and were categorized into four groups. These groups were grades, positive feedback and recognition, understanding of academic content, and comparison to peers. These four groups were then categorized further into two categories: internal factors and external factors. Out of 44 participants, there were only 40 submitted responses to this question.

The responses to this question show that the majority of female-identifying individuals in STEM validate their academic achievement through external factors. Alongside female-identifying individuals in STEM, many other groups looked at experienced very similar results. In total, there were very few responses which claimed feelings of solely internal factors or a mix of both internal and external. Responses which were deemed to be considered external factors included those which displayed validation through grades, positive feedback, and comparisons to others. Answers included in our analysis of external factors include:

- "I feel most validated when people tell me I'm doing well. Grades are good but having someone give a nice comment or let me know they enjoyed having me in class is much more satisfying."

- "As a student, receiving a good grade is a validating feeling. Even more so, positive feedback from professors and teaching assistants is very validating, as well as winning awards and scholarships."

Responses to this question which were considered to be validated through a combination of both internal factors and external factors include:

- "What makes me feel most validated as a student is getting good grades depending on the class average. So, if the class average is low and I get a grade the same as the average I wouldn't feel as bad compared to getting an under-average grade. In a way, I feel validated if my level of intelligence is the same or higher than everyone around me."

Through examining the ways in which students feel validated in their academic success, we can assume that female-identifying individuals experience high rates of imposter syndrome as they seek external sources for academic validation, which remain out of their control.

Discussion
Literary Findings

Concepts surrounding the literature on the persistence of imposter syndrome and the behaviours associated with these cognitive distortions were evident in the results of our study. This includes affective and doxastic features (Gadsby, 2022), as well as the cycles of worrying (Clance & Imes, 1978). These concepts are applicable to the entirety of our study, within all faculties and genders, as the majority of undergraduate students at McMaster University experience imposter syndrome. In regard to the literature surrounding imposter syndrome for female-identifying individuals within STEM programs, only one participant's answers resembled the literature. This student's answers can be evaluated through the prove-it-again bias (Crawford, 2021), a phenomenon commonly experienced by female-identifying individuals in STEM programs. The connections to the literature assist in evaluating the phenomenon of imposter syndrome for students. However, our survey did not provide results that can be related to other sections within the literature review, such as the origins of imposter syndrome, undergraduate STEM programs, as well as the stigmatization of female-identifying individuals in STEM programs.

In regard to affective features of imposter syndrome, about one-third of participants answered that they strongly agree to avoid tasks and assignments out of fear of failure. This can be inferred as a fear of exposure as an imposter through failing to maintain their level of success. Reviewing doxastic features, almost 40% of participants stated they agree that their accomplishments are a result of external factors. This reflects cognitive processes in which the student feels they are inadequate and lack abilities leading to success. When these features are combined, individuals experiencing imposter syndrome develop a biased perception in which they focus on supporting evidence of their beliefs, while avoiding contradicting evidence. This is evident in the question evaluating a tendency to recall failures more than past successes, as 36% answered sometimes, 36% answered often, and 25% answered always.

The literature states imposters continue to maintain these cognitive distortions through a cycle of worrying. This is evident within the results of our survey throughout 3 questions. The first question evaluates the idea that the student could work harder, regardless of work ethic and past successes, in which approximately two-thirds of participants answered they strongly agree. The second question investigates a lack of satisfaction with accomplishments and feelings as if they could have performed better, in which 43% agreed, and 25% strongly agreed. The third question pertains to worrying about maintaining the level of success after an accomplishment, in which 50% stated often, and 25% answered always. These results indicate a cycle of diligence associated with imposter syndrome, in which the student is motivated to work hard through fear of exposure as an imposter. In this, the student worries about intelligence, works hard, and attempts cover-up strategies, all of which reinforce temporary feelings of approval. These connections to the literature describe the ways in which individuals experiencing imposter syndrome maintain their cognitive distortions.

In regard to the literature surrounding female-identifying individuals in STEM programs, only one of our survey participants resembled the concepts within the literature. The singular female-identifying individual STEM participant resembled a prove-it-again bias. In their response to how they feel after receiving a good grade on an assignment, the

student answered they feel positive emotions for a short period of time, but soon begin to worry about upkeep their level of success. As such, this is related to the prove-it-again bias, a common trend in which female-identifying individuals in male-dominated spaces feel the need to prove their competence multiple times throughout their career. However, these distortions representing the imposter phenomenon within the literature are only applicable to one female-identifying STEM participant within our study, out of the fourteen female-identifying individuals in STEM who participated in our survey.

Research Findings

Based on our qualitative and quantitative data, we can conclude that female-identifying individuals in STEM programs at McMaster University experience high rates of imposter syndrome. However, it was discovered that all faculties at McMaster University experience a similar, high rate of imposter syndrome. The discovery made within our research has allowed us to understand the reasons why students may feel these rates of imposter syndrome, which we have determined to be external factors and negative emotions.

When analyzing our qualitative data, it is evident the majority of students within McMaster University's undergraduate programs are confident in their academic abilities when they experience validation through external factors such as their grades or recognition from their professors. The lack of internal confidence leads these students to experience the imposter phenomenon as they refuse to acknowledge their own hard work and motivation, which plays a significant role in academics.

Looking deeper into the specific questions asked in this section, we observe that students exhibit high rates of imposter syndrome in two of the three questions. External factors, specifically grades, were among the highest recorded responses leading us to infer that these students feel high rates of imposter syndrome as they attribute their success to elements outside their inherent abilities. These results show these students feel as though their position at McMaster University was not earned through effort and intelligence, but that their acceptance was based on luck. While this is usually not the case, these feelings can leave students feeling like they have to overwork themselves in order to compete with their peers. Using this understanding of imposter syndrome and our survey results, it is evident that the majority of McMaster University students experience imposter syndrome, regardless of program, or gender.

The quantitative data provides us with a much clearer understanding as the results of these questions suggested that the rate of imposter syndrome among all McMaster University programs is significant across all groups studied. As seen in Figure 20a, each McMaster University program feels a high rate of imposter syndrome which was concluded using many close-ended questions.

We used a multifaceted view for this research by evaluating gender and faculty as a way to observe the interconnections of various categories and how this may relate to imposter syndrome. Lastly, further research must be conducted to fully develop an analysis of the rates of imposter syndrome among female-identifying individuals in male-dominated fields, such as STEM.

Conclusion

Limitations

Our limitations include several factors including sample size, generalizability, lack of diversity, and misrepresentations of the collected data. Through varying methods of recruitment, our team of researchers managed to recruit 44 participants, with the majority being female-identifying individuals and only 7 participants being non-female-identifying. This further limited our sample representation as we only looked at McMaster undergraduate students. Therefore, our low number of non-female-identifying participants provided additional difficulty to explore gender differences in imposter phenomenon.

However, the main limitation of our research included a lack of generalizability and diversity of population. A crucial part of our research was to examine the influence of the participants' diverse backgrounds on their experiences with imposter syndrome and if gender identity influences their chances of experiencing the imposter phenomenon. As our sample population was strictly composed of McMaster University undergraduate students (n=44), it presented a challenging limitation for providing a diverse and representative sample group.

Furthermore, our research required the comparison of female-identifying persons (81.8% of our sample population) and non-female-identifying persons (15.9% of our sample population) from varying academic, ethnic, and cultural backgrounds, which required enough participants to be recruited. Evidently, our sample population lacked enough participation from non-female individuals which skewed our results in properly identifying the significance between rates of imposter syndrome and gender identity. During our data analysis phase, we interpreted our results and saw little to no significance in the relationship between rates of imposter syndrome and gender identity as our sample group was not representative enough. In the future, a larger population and increased participation from non-female-identifying individuals are required to effectively observe a correlation between rates of imposter syndrome and gender identity.

Another limitation we discovered during our research is the possible misrepresentation of qualitative data. This research seeks to identify the prevalence of the imposter phenomenon among female-identifying undergraduate students at McMaster University. As such, this study does not intend, nor qualify, to diagnose or label participants as an individual with imposter syndrome. Understanding the lived experiences of participants from varying backgrounds and reflecting them accurately through data collection and analysis presented the risk of possible misrepresentation of qualitative data. During the data analysis phase, specifically during the interpretation of the qualitative results, our team coded keywords associated with positive feelings and negative feelings in order to measure rates of imposter syndrome.

As qualitative research is interpretive, it was more likely for misrepresentation to occur when reviewing lived experiences of imposter syndrome. The conciseness of our survey may have encouraged participants to feel as if their views, opinions, and lived experiences may be misrepresented and/or taken out of context. Due to qualitative questions' susceptibility to misinterpretation, each researcher within our team analyzed the data to assess interobserver agreements. This was to confirm solidarity among the researchers during the analysis of the answers to avoid misinterpretation. In addition to the possibility of misinterpreting qualitative results based on subjectivity, participants

could have also been under-reporting feelings of imposter syndrome due to numerous reasons such as feelings of embarrassment and/or fear of exposure.

Future Directions

Though our hypothesis was not correct, our research still showed significant findings in regard to the topic of imposter syndrome. From a theory that originated from female-identifying individuals experiencing significant levels of imposter syndrome, our research shows progress in how the phenomenon is no longer isolated to certain groups (i.e., women) and is now something that everyone experiences regardless of their gender and/or field of study. Our research showed no significance for higher rates of imposter syndrome among female-identifying individuals and those in STEM, and that the phenomenon was consistently high across faculty and gender. The aim of this study was for the results to spotlight the effects a male-dominated field has on younger female-identifying individuals entering into adulthood. Our findings should serve as a starting point for future researchers to further explore this topic.

From our own research, future researchers should first take into account the importance of sample sizes. Our small sample size made it more difficult to find trends, relationships, and measuring significance in syndrome rates, especially since the majority of our participants were female-identifying. Future research might also consider extending this topic to other Ontario universities to examine if the choice of academic institution and social hierarchy plays a role in undergraduate students experiencing imposter syndrome. For example, comparing academic institutions that are known to be "STEM forward" to those that are not and seeing if there is a relationship that exists between students experiencing higher rates of imposter syndrome due to their school's prestige and reputation.

As our research focused on comparing female-identifying individuals in STEM programs to which there was no established significance, future researchers can broaden their scope by looking at individual programs across faculties and programs as our data concludes that imposter syndrome is not isolated to one, but rather experienced by all regardless of academic background. From our results, the non-STEM Faculty of Humanities was the second highest faculty to experience higher rates of imposter syndrome. It may be interesting to explore individual programs within other faculties to see if higher rates of imposter syndrome are occurring within the faculty and across different specializations.

Lastly, future researchers can also look at the relationship between the prevalence of imposter syndrome and the status one holds in the academic hierarchy. Exploring the varying levels of academia, such as undergraduate and postgraduate endeavours, and comparing them with one another may highlight the prevalence of imposter syndrome and reasons as to why individuals may experience the phenomenon when continuing with higher education. It would also be interesting to look at any cultural differences regarding imposter syndrome across societies beyond the Western world. If future researchers sought to expand their scope, they can explore the way individualistic versus collective societies influence female-identifying individuals in STEM and their rates of imposter syndrome, and whether there are any significant differences in their experiences in academia.

Summary and Concluding Thoughts

As a final takeaway for our research, our original hypothesis was not correct as we found no correlation between higher rates of imposter syndrome and female-identifying individuals as well as those in STEM programs. What our results did show is that imposter syndrome is prevalent among students, however, the rates were essentially equal across faculty and gender. This leads to an interesting discussion on how society treats people in academia in general and this may lead to further research on how we can change this mindset and reduce feelings of inadequacy. More research needs to be conducted on this topic with a larger sample size to confirm our results. Though our original hypothesis was incorrect, our research still contributed significant insights on this topic, posed further questions, and can serve as a stepping stone for future researchers to consider when exploring the topic.

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