The Effect of Gender Stereotypes Found on Zhihu on STEM Career Perceptions for Chinese High School Girls

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Abstract

In China, societal norms and the education system are founded upon Confucianism, which highlights the yin-yang work balance. Within this work balance, males are often seen as having more chauvinistic qualities, such as individuality, independence, and competitiveness, traits often tied to STEM fields. On the other hand, females are seen as having soft and conforming characteristics that are related to raising children and being submissive in a familial role. Thus, societal expectations placed upon students in China often highlight female students as inferior to male students in the subjects of science, technology, engineering, and mathematics (STEM). This discourages high school female students from pursuing STEM pathways in their College Entrance Exam, which defines one's future career. A lack of social support for women's STEM career outlook has caused many female students to hesitate in choosing STEM careers over social science careers. This study uses critical discourse analysis to analyze responses on the impact of the social media platform Zhihu, the Chinese version of Quora, on reinforcing gender stereotypes and affecting career perceptions of Chinese female high school students regarding STEM vs. social science pathways. This work is grounded in social cognitive career theory, social role theory, and gender congruity theory to address the portrayal of females in STEM in Zhihu users' postings. The responses are categorized as either reinforcing or challenging these yin-yang gender stereotypes. Finally, this study ties the results found to previous research that highlighted the impact of social media on female high school students' STEM career outlook to conclude that there is a heavy emphasis on environmental stereotype themes and references to male students having more inherent talent suited to STEM than that of female students in Zhihu responses.

Introduction

Gender inequality has existed across diverse cultures for centuries. While there have been improvements in many fields of study and workforces across the globe, gender disparity remains a prominent issue in STEM fields such as the physical sciences (Hazari et al. 96).

In China, this gender disparity is apparent across all levels of education and even the workforce (Guo et al. 225–35). In one of China's leading science institutions, the Chinese Academy of Sciences (CAS), statistics released revealed that in December 2019, only approximately six percent of academicians of CAS were women, while only five percent of the Chinese Academy of Engineering were women (Gu 2). Between the two academies, there were less than 100 female academicians out of 1600 total academicians (Gu 2). Furthermore, data released by the China Association for Science and Technology (CAST) in 2015 demonstrates that while 21 percent of members of all CAST academic societies were women, only 13 percent of the society

council and an even smaller eight percent of presidents and vice presidents were women, underscoring the levels of underrepresentation of women in STEM in the Chinese workforce (Gu 2).

The underrepresentation of women in STEM does not originate in the workforce, but leads back to the Chinese education system. In this system, students across China have their future academic pathways dependent upon the major college entrance exam (deemed the “gaokao”) in order for them to enter higher-ranked universities, which open up better job opportunities (He et al. 1). When high school students begin their high school experience, they initially begin by taking every course subject: math, English, language (Mandarin), physics, chemistry, biology, politics, geography, and history. In their second year of high school, Chinese students must make one of the largest decisions of their lives and choose between the STEM education pathway, focusing on physics, chemistry, and biology, or the social science pathway, focusing on history, politics, and geography. The pathway chosen by students determines the materials they would ultimately be tested on in their college entrance exam and also the majors with which they apply to schools (He et al. 1). As these students are still young, their choices are heavily dependent on and influenced by societal expectations, which can impact their career perception and STEM self-efficacy (He et al. 3-4). STEM self-efficacy, which is the confidence that one has in their ability to pursue and to be able to resolve problems related to STEM subjects, is reliant on the social factors regarding an individual (Wang et al. 2-5) and is a major factor that shapes the decisions of female high school students in China when trying to choose their academic pathway (Chan 11). Negative experiences may deter students—especially women— from STEM pathways where some of these experiences stem from the Confucianist ideology (Doucette and Singh 3-4).

The concept of Confucianism is one of the major factors impacting familial expectations and the education system (Fang 212-14). Confucian teachings of filial piety and ideals of natural orders were passed down for many generations and the education system was remodeled upon it (Fang 213-14). Filial piety follows the values of being obedient and devoted and caring towards one’s parents and elderly family members under the basis of individual moral conduct and social harmony (Fang 212-13). In the Confucian belief system, upholding the natural order was what maintained peace and harmony in society, and this is done by respecting filial piety (Fang 212). To fulfill filial piety, this often meant following the yin-yang gender roles where women focused on the internal aspects of the family such as household roles, while men focused on the external aspects of the family such as earning money for the family (Gu 4). These gender roles from filial piety are also often applied to STEM-related fields. Since the STEM field is associated with being more assertive and competitive, qualities often associated with males under Confucianist ideals, female students are discouraged from pursuing STEM. On the other hand, female students are thought to be gentle, soft, and emotional, which are qualities that are associated

with the humanities field, hence reducing female students' STEM self-efficacy and ability to picture themselves within a STEM career.

In addition to Confucianism's impact on familial expectations, Confucianism also lays as the foundation for the Gaokao exam, a pinnacle exam in shifting the outlook of a Chinese local student's life, which has inherent biases against female students in the testing system. The Gaokao exam, which was made based on the old civil service exams, highlights the concept of merit-based success enabling greater social mobility (Fang 213). The old civil service exams tested scholars on their ability to retain knowledge through the several-day exams and only through good performance could poor people be able to join the educated elite. Similarly, the Gaokao exam also tests high school students on their retention of all the knowledge they learned throughout their high school career. Only by attaining a high score on the Gaokao exams can students apply for the highest-tier schools in the nation and eventually have the upper hand in earning higher-paying job opportunities quickly. Since the Gaokao is a high-stakes exam, this makes the exam biased against female students, as previous studies have shown that female students were not able to perform as well in high-stress level environments in comparison to their male counterparts due to factors of lack of confidence and greater societal pressures (He et al. 6).

Additionally, depictions of the role of women in Chinese textbooks often highlight women in domestic roles which are underscored by filial piety. Women are rarely shown taking on diverse management roles in comparison to their male counterparts, reinforcing gender stereotypes in the workforce and limiting career perception for female students (Fang 214). This then extends to the workforce where the stereotypes from the education system and from societal values have limited many women from challenging themselves to take on higher positions, thus limiting their mobility (Gu 2). Since female students are seeing these images over the course of their childhood and young adulthood, this degrades the ideas about themselves and limits the possibilities that they see their future selves being able to take on.

With the rise of social media platforms, adolescents are often caught in the crossfire of adults who try to emphasize different societal expectations, shaping the perspectives of these adolescents in their career perceptions. Zhihu is one of the social media platforms on the rise, where users can ask questions regarding any topic and have responders ranging from other students to experienced doctorates sharing their opinions through responding to the questions. Between 2021 and 2023, the monthly active users on the platform increased from 100 million users to 110.5 million users, highlighting the platform to be frequently used by students who seek guidance in choosing their academic pathways for high school (Statista). In order to investigate the specific ways in which female high school students in China are being pressured against choosing STEM pathways, this work aims to study the impact of social media platforms on a Chinese female high school student's STEM self-efficacy and career perception. By employing critical discourse analysis through analyzing Zhihu responses under the lens of the

referential, predicational, and argumentation strategies, this study reveals Zhihu responses having a heavy emphasis on environmental stereotypes - gender expectations created through social media, families, teachers, peers that are depicted as the defined image of what each gender is meant to do- relating to male students having more inherent talent than female students when it comes to STEM.

The research question for this paper is: How does the reinforcement of traditional Confucianist Yin-Yang gender roles through Zhihu, a Chinese social media platform, impact female high school students' STEM self-efficacy and career perception in China?

Literature Review

In recent years, many studies have been conducted to discover the most critical points in a female student's journey in academia to improve female students' STEM identity. In particular, Hazari et al. collected survey data from undergraduate female students in trying to find the time and sources of recognition that enabled persistence in physics interests. The study pinpointed high school as the key time for female students to gain interest in a physics identity (Hazari et al. 98). The study discovered the largest gain of 31.6 percent in interest in a physics career by female students between the beginning of high school and the beginning of college (Hazari et al. 98). The data also reveals how recognition by high school teachers for female students displays the largest increase in self-recognition (Hazari et al. 98-99). This highlights an opportunity for female students to be distinguished from their peers because of physics identities in high school, further underscoring high school as a critical point in time to engage in intervention to increase STEM self-efficacy among female high school students (Hazari et al. 99).

In the case of Chinese female high school students, the need for support from high school teachers to encourage STEM self-efficacy is ever more important considering the choice students need to make early on regarding taking the STEM or the humanities pathway (He et al. 6-7). In a study that collected qualitative data through the form of one-on-one semi-structured interviews with six female high school students enrolled in the social science stream, the six students touched upon the limited guidance from higher figures in choosing a pathway, resulting in reduced STEM career perception due to the stereotypes in job opportunities portrayed across media and reinforced in societal norms which highlighted filial piety (He et al. 7). Additionally, lack of ability to perform as well as their male counterparts in high-stress exams that determine their future also depletes science interest and STEM self-efficacy among these female students as they find it bleak in trying to improve their STEM test scores to be able to stand out when taking the college entrance exam (He et al. 5-6). Overall, there are various factors that push female high school students in China away from the STEM pathway.

Societal norms, specifically Confucianism in the case of Chinese students in particular, have been a major factor in decreasing STEM self-efficacy where a study of various secondary schools across China highlights that while in general, 37.5 percent of female students had

STEM self-efficacy in comparison to the 60.2 percent of male students who had STEM self-efficacy, only 19.8 percent of the female students wanted to pursue STEM careers in the future while 49.5 percent of male students wanted to pursue STEM careers (Chan 7). The data was also conclusive that female students who had high levels of endorsed traditional gender roles had lower STEM self-efficacy although conforming to the familial and social norms themselves had no significant impact on gender differences in STEM (Chan 8). Thus, this underscores how because of these societal norms, this has reduced confidence in enabling female high school students to pursue STEM careers.

In another survey conducted by Wang et al. that collected data from 10th-grade students in five schools in the Hunan province, the study discovered that while both male and female students perceived school education as the environmental factor was the least impact on student interest in STEM careers, the greatest environmental factor that impacted female students' interest in STEM careers was the media while for male students' was social support (13). However, the study does not delve deeper into the aspects of social media itself that impacted female students as it only stopped at the surface level, highlighting the need for further investigation on the specific effect of social media on Chinese female high school students' STEM career perceptions.

The few studies on the impact of social media on reinforcing harmful gender stereotypes in STEM have focused on female PhD students. Like Quora, on the platform Zhihu users can ask questions. One notable study was focused on the LM incident where a male PhD attempts suicide after breaking up with an intimate relationship with his girlfriend, a female PhD student, sparks fire across the internet (Peng et al. 2). By focusing on the stereotyping of accomplished women through responses of Chinese netizens on Zhihu, the study revealed how positions of female professionals were seen as subordinate to men and how the stereotypes undermined female PhD students' accomplishments, highlighting how social media responses were able to reinforce many gender stereotypes (Peng et al. 2-3, 21). Building on these previous studies, this study contributes to the growing literature on the impact of social media on women's participation in STEM fields in China. It does so by investigating the impact of social media platforms under the lens of female high school students in choosing STEM pathways as a starting point to intervene with the lack of gender diversity in STEM careers in China.

Theoretical Framework

The social cognitive career theory model is a model that examines how the dimensions of individual characteristics, psychological factors, educational environment, and family link to an individual's career perceptions (Lent and Brown 11-12). The social cognitive career theory is often used as a model to investigate gender stereotypes in its impact on education such as its usage in investigating "Gender differences in high school students' interest in STEM careers" (Wang et al. 4-5). Due to the complexity of the model, this often results in the different dimensions intertwining with one another, tying together self-efficacy, STEM identity, societal

statuses, gender role socialization, and outcome expectations as factors that all impact students' career perceptions (Fouad and Santana 26-27). Since the initial development of the model, many educators have used the model to evaluate how performance and environmental support enable STEM self-efficacy and positive outcome expectations which increased interest in STEM subjects among students (Fouad and Santana 34-35). Having an interest in STEM subjects increases satisfaction among students in learning STEM which predicts higher levels of persistence in students in pursuing STEM fields. However, because of negative environmental factors such as lack of support from society and gender role socialization, many minority groups such as female students do not feel recognized as capable and lack a STEM identity, inhibiting persistence in STEM careers such as physics or engineering (Lent et al. 28-29). Hence, it is vital to evaluate the individual components that make up the environmental factors in order to investigate their impacts under the social cognitive career theory.

Due to gender role expectation stereotypes under Confucianist Yin-Yang ideals, this results in differences in acceptable behaviors for different gender roles. Since social roles link individuals to social environments, this causes society to shape common patterns of expectations under the social role theory, contributing to the internalization of social expectations and status and impacting gender role socialization. This is because shared gender stereotypes are stimulated through the gender division of labor which creates differentiated skills. Since men are often associated with characteristics of being assertive, competitive, and dominant while women are associated with characteristics of being warm and emotionally expressive (communal), this causes the different genders to have different expectations. In the case of Chinese society, as Confucianism was what shaped the social expectations in societies, this creates set expectations for the different genders and the different characteristics associated with different pathways for jobs and studies.

Moreover, derailing from the gender stereotypical expectations, especially for females, such as choosing to not be a housewife, often results in societal prejudice by peers and family. These prejudices can be taken through reactions of females being perceived as less favorable than their male counterparts when it comes to leadership positions which leads to attitudes less favorable for successful women to grow. This ties to female high school students when they do not follow the social expectation for them to become teachers or follow topics in the humanities. As a female, women often face prejudice in their initial salaries and injustices in the workforce that further discourage their involvement in STEM (Gu 2-3).

Methodology

In this paper, critical discourse analysis was used to conduct a qualitative study of the number of posts on the Zhihu platform. Critical discourse analysis was founded by Fairclough and Wodak, combining a theoretical approach with a textual analysis method that integrated language with contextual usage to critically analyze meaning (Peng et al. 6-7). This theory was developed by

assuming that discourse structures that govern and shape human interaction (KhosraviNik and Sarkhoh 7), are the foundation for people to exercise power in our present-day society. The widely accepted critical discourse analysis method utilizes a three-dimensional framework that looks at language from a textual, discursive, and socio-cultural level. In this study, this method will be used to analyze the content of 21 responses to Zhihu questions through only the textual level.

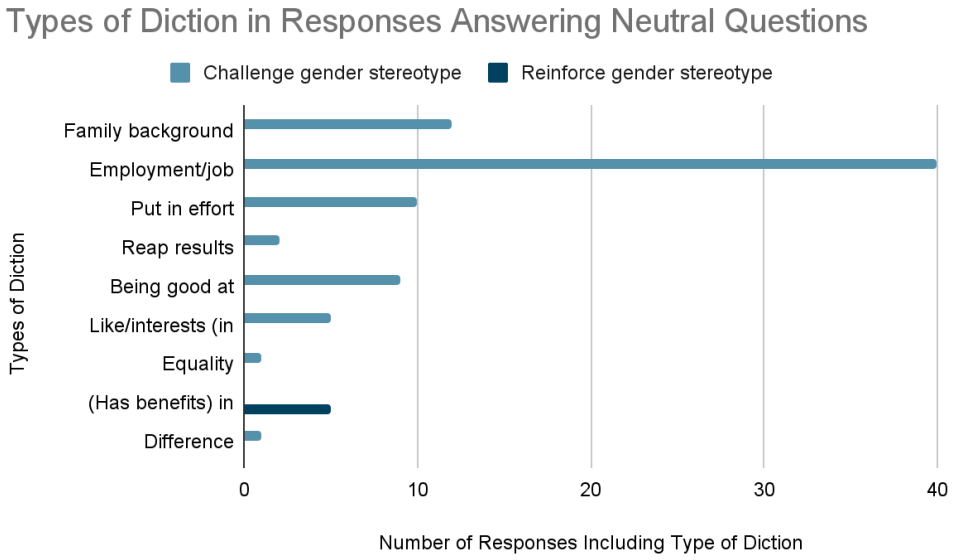
Since the social media platform used in the study was a Chinese social media platform, all responses were translated into English to be analyzed. For the original Mandarin statement, those interested can reach out to the corresponding author listed on the paper. In this study, the data was first chosen through selecting questions that came up that asked about choosing between social sciences or STEM for their high school pathway on Zhihu by high school students. Questions were then categorized according to whether they were written in a negative or neutral tone where the questions either reinforced or showed no bias toward gender stereotypes in choosing the pathway. Examples of negative questions included ones that had explicit bias of gender stereotypes such as “Why are girls not as good at science? Is it because we are stupid?” On the other hand, examples of neutral questions included ones that did not have any implicit bias towards any gender stereotypes, asking “Should girls study social sciences or STEM?” As a majority of the questions showed a neutral bias towards gender stereotypes, 76 percent of the responses were collected from neutral questions to create a representative sample.

As there were between 20-60 responses under each question, a representative sample size of five to seven responses was chosen from each question to show the overall reinforcement or challenging of stereotypes by Zhihu commenters for a total of 21 responses. One group of commenters that were excluded from the study were responders who simply copied academic papers word-for-word in a translated format and only included conclusions provided by the paper rather than personal opinions. As research papers contain a more objective tone due to formal language usage in comparison to social media language which includes more slang, therefore the responses that copied academic papers would not be able to accurately highlight the lexical choices of regular social media commentators since the posts did not originate from everyday language. Hence, the responses were excluded from the study.

For each response in the sample, the researcher recorded the word count for terms on the vocabulary list that related to gender, career choices, bias, or STEM words in accordance with the referential strategy. Then, each response was analyzed through the lens of the argumentation strategy to uncover the themes applied to each response. The themes stemmed from groups of words in the vocabulary list that related to common social issues with themes of “inherent vs. acquired talent”, “environmental stereotypes”, “effort vs. reward”, “equality”, “interest rather than expectation”, “career pathways”, and “family background.” While the theme

of “inherent vs. acquired talent” involved phrases such as “logical thinking”, “spatial imagination”, “inquired”, and “inherent talent”, the theme of “family background” included the terms “employment/job”, “social environment”, and “tomboy/masculine.” The last level of analysis involved analyzing the responses through the predicational strategy to understand the type of impact that these Zhihu responses may have. This study focused on two types of impacts: The challenging or reinforcement of the stereotype of female students being inherently weaker at STEM than male students.

Results and Analysis



Referential Strategy

Figure 1: Word count of lexical choices of Zhihu responses for Neutral Questions that challenged gender stereotypes vs. reinforced gender stereotypes

To highlight the gendered references in the text in order to uncover the stereotypes that are being reinforced or challenged, the referential strategy was applied to the Zhihu responses. As seen in Figure 1, the lexical choices were split based on whether or not those lexical choices were included in posts that reinforced or challenged gender stereotypes of female students being inherently weaker in STEM than male students, which will be analyzed in a further section. As the responses analyzed were chosen from both questions that were more neutral and also questions that had negative connotations towards gender stereotypes, the analysis in this study was also conducted based on the two different types of questions: For neutral questions, the responses that answered neutral questions talked about inherent qualities in relation to family background rather than gender and its impact on employment as seen by the high word counts in employment (40) and family background (12). Moreover, responses that

answered neutral questions also highlighted lexical choices of “putting in effort” (10) in order to “reap results” (2), “being good at something” (9), and STEM being an individual’s “likes/interests”(5). These responses to neutral questions highlighted the concept of merit-based and interest-based decisions for choosing STEM, challenging the gender stereotypes and tying the decision between STEM and social science to non-gender related factors. Despite the responses mainly focusing on lexical choices that challenged the gender stereotype, some of the responses still tied choosing the STEM pathway to lexical choices often associated with the reinforcement of gender stereotypes: Many of the responses discussed female students having to consider a lower-intensity but high salary job to have kids or to have benefits when going on blind dates (5), though the responses that mentioned this were of seemingly less quantity than that of responses regarding family background or employment.

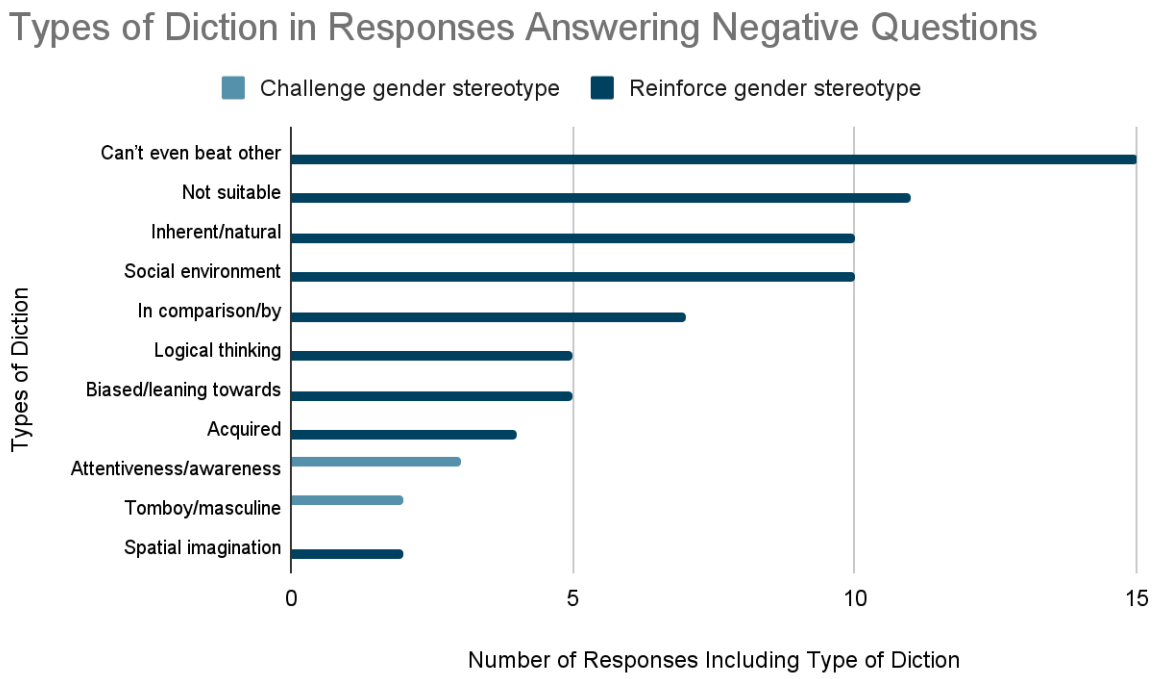


Figure 2: Word count of lexical choices of Zhihu responses for Negative Questions that challenged gender stereotypes vs. reinforced gender stereotypes

For negative questions, 80% of the responses that answered those questions reinforced the stereotypes. All of the responses to negative questions touched upon the idea of inherent qualities where the responses tied strong logical thinking (5) and spatial imagination (2) as inherent qualities (10) that male students had which were stronger than female students, quoting many girls to be seen as not suitable (11) for STEM due to their lack of inherent qualities. There was a large repetition of negative diction which are words with negative connotation that emphasize the stereotype of male students being more suited to choosing STEM than female students due to the possession of inherent talent that enforces bias and

gender stereotypes. Since the majority of the responses replying to the negative questions reinforce the gender stereotype, thus the overtly negative diction has negative impacts on the decisions of female students when having to choose between STEM and social sciences (Felmlee et al. 25).

Predicational strategy

By analyzing the general stance of each post with stating the stance as reinforcing or challenging the gender stereotype of female students being inherently weaker than male students, the data highlights that 38.1 percent of the responses reinforced the gender stereotype whereas 61.9 percent challenged the gender stereotype. This means that overall, the responses that Chinese female high school students come across mainly challenge the gender stereotype. However, there is still a large portion of responses that may negatively impact their decisions in choosing STEM or social sciences. Through previous research conducted by other researchers on the impact of the frequency of key derogatory terms used against women through social media platforms like Twitter on forming cyber aggression, the data highlighted that higher frequency usage of these terms enhances feminine norms and stereotypes (Felmlee et al. 17-18). Hence, on Zhihu, a similar case of repetition of responses that reinforce gender stereotypes may end up reinforcing the gender stereotypes that men are inherently better than women in STEM despite a majority of responses that challenged the gender stereotype. This is because there was enough repetition of responses within both neutral and negative questions that had inherently reinforced the gender stereotype which does not account for the questions themselves that include biases in the question which reinforces gender stereotypes, especially for negative questions.

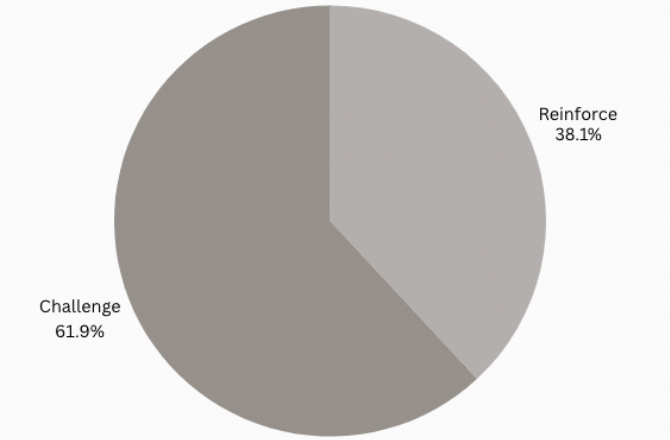


Figure 3: Percentage of Responses Challenging vs. Reinforcing Gender Stereotype of Female Students Being Inherently Weaker than Male Students at STEM

Argumentation strategy

In all 21 of the responses, each of the posts touched upon at least one of the seven themes: inherent vs. acquired talent, environmental stereotypes, effort vs. reward, equality, interest over expectation, career pathways, or family background. Despite the lower percentage of responses "challenging" stereotypes in the predicational section of the study, due to the high level of references to the theme of environmental stereotypes, this study can conclude that the biases prominent in daily life are further accentuated through the usage of social media (Felmlee et al. 16). By repeatedly referencing environmental stereotypes, this suggests that the environmental stereotypes related to gender differences in STEM are heavily prompted and suggested. As the

majority of the users who propose the questions have backgrounds that highlight the users as high school students, this means that high school students are engaged with these gender stereotypes often which further enforces the stereotypes the students heard in a school background and makes students hesitant to choose STEM.

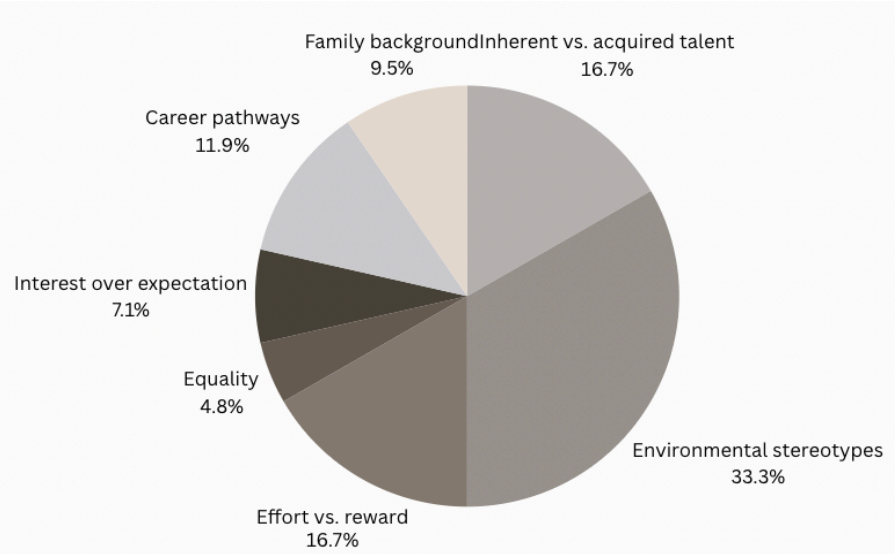


Figure 4: Percentages of Each Theme Mentioned in All Responses

Conclusion

Under the social cognitive career theory, in order to increase the involvement and persistence of females in STEM careers, especially with physical sciences, it is pertinent to start early in engaging female students to become interested and develop self-efficacy in their math and other STEM abilities. As social media is highlighted as a significant factor in previous research papers on impacting the STEM self-efficacy of female high school students, the responses of users to the questions posted on Zhihu are an important area to study. Although the majority of the responses challenging gender stereotypes in STEM fields, there is a heavy emphasis on environmental stereotype themes and references to male students having more inherent talent suited to STEM than that of female students. Not only does this further enforce the gender stereotype for female students, but it also deters them away from choosing STEM pathways. This study highlights the need to further investigate a direct correlation between the comments on Zhihu with the eventual pathways of female high school students in their choice of majors in college.

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