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Literature Review: Exploring the Relationship Between Gender Cognition and Student Academics

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Abstract. In the course of human history, discussion regarding gender differences and sexual roles has never come to an end. In present-day society, cultural influences, together with the "discovered" physiological differences, have contributed to severe gender inequalities and bias that can be perceived in all aspects. Under this distressing situation, education should be an important aspect that must be paid attention to as it is a determining factor of societal development. Based on empirical research, it really should be concerned that the often biased gender cognition may have potentially contributed to educational impairment, for which the disparate attitudes, opinions, and assumptions that people hold about the two genders, based on sufficient empirical research, have strongly influenced students' academic performance and have further facilitated the formation of inequalities in future learning opportunities, career path, etc.; it is fair to say that these series of connections have gradually formed a negative feedback loop worsening the current inequality situation. This paper will focus primarily on finding the connections between the tendentious beliefs on gender cognition and students' academics; specifically, empirical research papers regarding how people's gender cognition may affect different aged students' academic performance and self-concepts at schools will be reviewed to look for possible relationships.

Keywords: Gender Cognition; Stereotype; Bias; Discrimination; Academic Performance; Self-concept.

1. Introduction

According to Bandura's social learning theory, learning is a result of both individual effort and environmental influences [1]. The behavior of stereotyping may influence people by posing extra negative cognitive burdens to impede achievement. Before looking deeply into this topic, a few concepts must first be clarified. In the articles regarding gender inequalities, words like "stereotype", "bias", and "discrimination" are common to be mentioned, and it is necessary here to distinguish between the terms. Gender stereotypes refer to the overgeneralization and attribution of particular characteristics on a certain group based on gender [2]. While bias and discrimination are more related to the behavioral aspects, for which people show favoritism to one gender and treat them unequally [3]. For the purpose of this review study, these three terms will be combined into the biased gender cognitions to be better assessed. In the present-day world, some widespread gender beliefs regarding education are, for example, that boys do better at math and science-related subjects because they tend to be more rational and girls do better at arts and literature because they are relatively more emotional; in addition, girls are generally expected to behave quieter and better engaged in the classroom than boys who are assumed to be naughty. These false beliefs in education, whether coming from parents, teachers, or even other students, are confirmed to have implicitly and explicitly contributed to academic achievement differences as well as students' self-concepts, for example, self-confidence, regarding particular subjects and future career choices. To make a more comprehensive evaluation, categorization has been made based on student age distribution (secondary school vs. college), social positions (teachers vs. students), and academic achievement (test scores vs. self-concept); so that this paper will examine four specific relationships: 1) how do the public's biased gender cognition cause influence on secondary school students' academic achievement; 2) how do the public's biased gender cognition cause influence on college students' academic achievement; 3) how do teachers' biased

gender cognition influence students' academic achievement overall; and 4) how to the biased gender cognition influences students' future career path and treatment.

2. Exploring Different Pairs of Relationships

2.1. Biased Gender Cognition in Secondary School

In secondary school, curriculums are restricted to only include general education such as literature, science; therefore, research areas were also narrowed down to a few aspects. With the limited choice offered, math ability often became the most discussed and controversial field of study; in research done in Udi Education Zone, Nigeria, researchers sought to establish a cause-and-effect relationship of gender stereotypes on senior students' academic performance and self-concept in secondary school [4]. The act of choosing the Udi Education Zone was done purposefully because this area has an obvious preference for boys' education over girls. A total of 342 students were recruited with 228 males and 114 females; potential confounding variables such as school location and school types were carefully considered and managed. Two materials were used in this study: a Students' Stereotype Self-concept Questionnaire (SSSCQ) which measures students' self-concepts such as honesty and emotional stability, and a Students' Mathematics Achievement Test, namely the SMAT, which assesses the mathematical abilities of students. Multiple t-tests were conducted, results indicated that gender stereotype has a significant influence on both students' self-concept and academic achievement, meaning that the social stereotypes have encouraged male students and discouraged female students in mathematical study and thus causing female students to underachieve and in the same manner impacting their self-concept [4]. Potential limitations of this study may apply to the generalization of the result on a larger population since data was collected only in Nigerian public schools; additionally, the use of a questionnaire to evaluate self-concept may lead to report biases. It can be inferred from the research that negative social opinions and expectations could essentially become an obstacle that hinders female students' performance and leads them to poor self-image and emotions. Another research in China also examined the effects of math-gender stereotypes; it was hypothesized that the stereotypes might positively predict academic burnout, which refers to negative emotions and reactions such as frustration and low motivation due to prolonged study pressure [5]. The participants, 1170 students with 552 boys and 618 girls, were all recruited from secondary schools in Hebei province, China. The measurement of this study includes a self-report questionnaire that measures the level of math-gender stereotype, a scale that measures the level of math achievement, and an Adaptive Social Behavior Inventory (ASBI) that measures the level of academic burnout. The result based on SPSS analysis demonstrated that the math-gender stereotype can significantly predict academic burnout, illustrating that in the girl's group, their academics and stress level were largely influenced by the negative stereotypes [5]. This study, similar to the previous one, also has limitations of generalization on multi-cultural backgrounds and self-report biases. The study certainly confirmed the emotional stresses as a result of heavily applying social stereotypes on female students; but it also provided further concerns, for which the burnout could have possible subsequent negative impacts on the female students' mental health stability and individual development. Besides these prevalent public gender stereotypes, another form of stereotype must also be mentioned, which is the notion of sexualized gender stereotypes (SGS); the term describes the idea that adolescent girls aim to make themselves sexually attractive as a means to enhance their social status [6]. Based on previous research, people, including children, tend to hold the stereotype that sexualized women are less intelligent; moreover, there is sufficient evidence suggesting the probability of establishing a relationship between endorsing SGS and academic achievement. In recent research, a two-year longitudinal study has been conducted to explore the link between SGS endorsement and poor academic outcomes followed by low self-concept [6]. 99 seventh-grade girls were sampled in the first year and 77 of them remained in the study in the second year; measurements include a placement test for academic performance, a scale that evaluates academic self-concept such as self-efficacy, and an assessment of SGS endorsement. Using SPSS analysis, statistics have shown that girls' SGS endorsement in seventh grade predicted their low academic performance and self-

efficacy in eighth grade [6]. The implication of this conclusion is significant because SGS endorsement could result in long-term consequences, for which poor academic achievement and diminished self-concept are linked to later choices, persistence, and ramifications. Summing up all findings, the research designs of the discussed studies are relatively simple with extensive use of surveys and self-reporting scales, giving rise to potential biases and result inaccuracy. However, students in secondary school are generally in a critical stage of learning and forming their fundamental values, when the external environment can easily shape their cognition and behavior. Therefore, the biased gender cognition people hold has caused severe consequences on secondary school student's academic achievement and self-efficacy; to a certain extent, one may say that it has potentially impacted both short-term and long-term personal development.

2.2. Biased Gender Cognition in College

Compared with secondary school education, college education tends to be inclusive but at the same time specialized in many areas of study to ensure that both interests and skill requirements are satisfied. In every university across the globe, one can easily find that more male students are accepted into departments such as engineering, data science, etc. This phenomenon remains to be a controversial topic of whether the dominance of male students is due to "innate differences" or "environmental influences". In a study regarding college engineering students, researchers aimed to investigate the effect of gender stereotyping on students' math performance and self-concept [7]. A total of 340 undergraduate engineering students in Spain participated in the study, 175 males and 165 females were randomly assigned to control and experimental conditions. Both groups were asked to first complete a self-report scale regarding their perceived self-concept, followed by an Implicit Association Test (IAT) that measures the strength of implicit stereotype associations; a distraction task was used and then comes the major part, which is a reading comprehension task that indirectly activated gender stereotypes in the experimental condition and on contrary a regular reading task in the control condition; the students performed a math-related effort task in the last step. A 2×2 ANOVA analysis was conducted with gender being the within-subject variable and experimental conditions being the between-subject variable. Results of this study further confirmed that the activation of gender stereotypes can significantly promote male students' overall math performance and self-concept (e.g. self-efficacy and persistence) while at the same time lowering that of female students [7]. Though the study seems well-designed with careful manipulation of variables, limitations still apply to the generalization of results in students with different academic backgrounds as well as the insufficient stereotype activation that was artificially generated. Besides investigating the direct relationship between gender stereotypes and specific subject performance, one should also take the basic cognitive abilities involved in those subjects into careful consideration; in another study exploring gender stereotype impacts, two notions have been included: mental rotation ability, which is considered to be a fundamental skill for success in mathematics geometry and science-related subjects, and verbal fluency, which is usually outperformed by women [8]. The study recruited 88 students with different academic backgrounds from Durham University; similar to the previous study, gender stereotype was also implicitly activated, then followed by a self-rating scale, mental rotation test, and verbal fluency test. A 2×2 ANOVA test was used for analysis with results revealing a significant effect of gender stereotype on mental rotation performance, demonstrating the overachievement of male students in mental rotation ability; however, as for verbal fluency, there turned out to have no significant differences, that is to say, verbal fluency is less sex-sensitive; it is also important to note that female students showed an overall lower self-confidence level and higher anxiety levels in what is believed to be the "male cognitive domains" [8]. The perceived weakness of this study includes a small sample size, the difference in difficulty levels of the mental rotation task and verbal fluency task, and the extent of the intentionally elicited gender stereotype. Taken together, the two studies were designed experimentally to be more complex and therefore more convincing; the results, that gender stereotypes do have a strong influence on college students' academics and self-concept, have absolutely provided us with future insights on this topic. With universities now becoming more generalized and diversified, the problem of gender stereotypes should be paid close

attention, and actions to mitigate the problem should also be taken by school officials. In addition, future research in this field should focus on investigating possible solutions that can be adopted by universities, and whether the stereotype and its effect can be applied to other academic areas.

2.3. Teacher Expectations Influence Student Academic Performance

In the educational context, one must not ignore the importance of teacher-student interactions; as a special and vital role, teachers have long been recognized as those who possess good moral character and have the responsibility to pass on the knowledge and positively influence students in the moral perspective. Up untill today, plenty of research have explored how teachers' cognition and attitudes could potentially cast influences and possibly shaping students' individual development; and there is sufficient evidence of an established relationship between teachers' gender stereotypes (expectations), as a key component of cognition, and students' academic performances. As mentioned in the above paragraphs, reading ability has long been considered a special strength that belongs to girls; based on this deep-rooted belief, a study was done to investigate the so-called expectation effect, which refers to how teachers' gender-specific expectations can potentially affect students' reading achievement [9]. It was designed to be a longitudinal study, with a sample size of 1358 secondary school students and 54 teachers. At the beginning of the school year, teachers were asked to report their expectations of reading, which can be defined here as the teachers' perceptions of students' ability, achievement, etc., on a scale to be calculated later for stereotype levels; as for the students, they were required to complete a reading achievement test to be scored. Multilevel modeling method was used to obtain statistics, results indicated that 1) there is a significant relation between students gender and teacher expectations, for which it followed along with the belief that teachers hold higher expectations on the reading ability of girls other than boys; in addition, this gender-specific expectation is confirmed of positively associated with students' reading achievement, meaning that female students did actually performed better when their teachers hold high expectations on them instead of the boys [9]. Although the study has yielded significant relationships, limitation still applies to establishing and interpreting a causal realtionship as the study was not designed experimentally to rule out probable confounding variables; what's more, teachers' expectations were self-reported and explicitly measured, considering the distinctiveness of this social position and its social influence, it thus became reasonable to suspect that this measure allows for possible social desirability biases. Going back to the topic of male domination in mathematics, research was designed to address the possible influence of teachers' gender stereotypes on student mathematic achievement [10]. A mathematic gender stereotype likert scale was first completed by 393 primary school teachers in Turkey; then, researchers observed teacher-student interaction frequency during school time and completed an obervation form; and finally, students completed their parts consisting of a math achievement test and a gender stereotype questionnaire. Data was analyzed through SPSS, and it was observed that teachers with strong gender stereotypic idea have significantly more frequent interactions, such as giving feedbacks and asking quesitions, with male students; moreover, the result also demonstrated teachers' preference of asking higher order math questions to male students, considering their belief of male superiority [10]. Taking together the two studies, it is affirmed that teachers sometimes do hold gender stereotypes, and this view can be conveyed implicitly to students through behaviors and activities, thus making heavy impacts, either positive or negative, on students' cognitive and academic development; it is also important to note that this stereotype is often so strong that it can overrides individual's innate talent and efforts. Future studies regarding this topic should include experiments to successfully establish the causal link and focus more on the solutions to mitigate the problem.

2.4. Gender Cognition Influences Career Path and Labor Market

Continuing the discussion regarding how gender stereotype influences college student academics, an inevitable stage that college student must go through is looking for jobs and choosing their career path after graduation. The reality is harsh, gender stereotype and discrimination followed along to this phase, exerting pressure on graduates and further presenting high uncertainties. In a paper examining the existence of implicit gender discrimination on the initial hiring process of college

graduates in China [11], a correspondence study was designed by sampling hiring firms through two job searching channels: job fairs and online job boards. The researchers created different ficticious resumes, randomly assigned one of the two genders while controlling for other components and send them to different hiring firms both online and at the job fair. The call-back rates were measured for analysis; it is indicated by the result that with all other variables manipulated constant, female applicants on average received significantly less call-backs from hiring firms; in addition, the result corresponds to the role congruity theory of prejudice, for which women, who is usually perceived as the "weaker" group, appears to be incongruent with attributes required for jobs related to engineer, mathematics, etc., and was therefore discriminated by interviewers [11]. The remarkable differences revealed by this study may suggest further gender discrimination in the social working environment. In another study involving surgical trainees, the researchers sought to evaluate the effect of gender bias on career engagement and skill performance in academic surgery [12]. A two-phase general surgery study was conducted at three university medical campus in the United States; 84 general surgery residents were recruited based on eligibility. During phase 1, participants were asked to complete likert scale surveys regarding their psychosocial construct germane to professional achievement; then in phase 2, they were randomly assigned to either the experimental condition, stereotype threat triggering, or the control condition, protected from stereotype threat; after the intervention, participants completed an assessment named the Fundamentals of Laparoscopic Surgery (FLS) that assesses laparoscopic ability followed by a survey asking about their perception of performance. The result demonstrated that pro-male bias is positively associated with career engagement of male but not female; it is also discovered that triggering negative gender stereotype to female can significantly reduce their performance of FLS [12]. Looking the two studies as a whole, it is now affirmative that negative gender stereotype and discrimination toward female in specific areas of study can potentially influence skill performance and career engagement, and thus possibly shaping one's career choices and later personal development. Future studies in this field should focus more on mitigating these negative impacts from both student perspective and social perspective.

3. Discussion and Suggestion

Based on the current literature, a worldwide stereotypic view regarding gender cognition has been recognized with women being the main victims in terms of education, gender-specific preferences and expectations of particular subjects have appeared in the early school stages. Starting from secondary school, not only did researchers identify the causal relationship between math-related gender stereotypes and students' academic performance and self-concept, but they have also explored from the student perspective that the SGS endorsement can influence academic underachievement as well. Gender cognition in college appears to be very similar, for which studies have demonstrated the artificially implicit activation of gender stereotype contribute to an overachievement of male students in math performance and mental rotation ability, while also lowering female students' achievement and self-concept. Shifting attention to the teachers' perspective, it is evident that many teachers hold implicit gender expectations that could potentially contribute to the higher-level reading ability of female students and more frequent class interaction with male students. Once all education is finished, graduates now get into the labor market to look for jobs, and the biases followed along with females getting overall fewer interview opportunities and lower levels of career engagement. Looking at the studies as a whole, one major problem that stands out is the validity of establishing the causal relationship; it ain't hard to figure out that a majority of these studies were not designed experimentally, and that many methods of measurement were simply self-reports, which do not ensure accuracy and cannot interprete causal relationship. In addition, other studies of longitudinal design include many uncertainties, especially with children/teenager participants, so that potential confounding variables may present to influence results. For future studies, experiments should be designed to confirm the established causal link; besides, the current studies are mostly examining the combined gender cognition, from the culture, parents, etc., which should be separately examined to provide more plausible and specific solutions. What's more, public intervention should be made in

education and the labor market to help mitigate the problems generated by gender cognition to allow for better societal development.

4. Conclusion

In conclusion, gender inequality has long been a controversial problem to seek answers. In the current literature, the biased gender cognition from the public/culture, teachers, and even students themselves have been examined and have all yielded significant associations with academics of students of various ages. It is certainly positive to say that an association has been recognized between gender cognition, specifically gender-specific stereotypes and expectations, and student academics and self-concept; in addition, this connection was found to have occurred across different ages and have further extended on affecting students' career path after they graduate.

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