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Analysis of Relation of High School Students' Math and Science Motivational Belief and Their Subsequent STEM Major Choice in College and the Gender Difference

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Abstract: Expectancy-value theory and Dimensional comparison theory were used to design the instrument of this research. This study examines the relationship between the grade twelfth (G12) high school students' math and science motivational belief and their STEM major choice in college. Additionally, this study examined how math and science motivational beliefs and STEM outcomes varied by gender. This research is conducted by 30 secondary students who is the twelfth grade students and participates into the entrance of university examination in Guangzhou China through questionnaire. The collected data were analyzed by qualitative method structural equation modeling with SPSS and Python to modeling the variables to find the coefficients. From the SEM analysis, it is shown that confidence in acquiring skill in mathematics (0.35) and science (0.08) enables G12 students to choose empirical major but not math-intensive STEM college major such as engineering, agriculture or medicine. Meanwhile, the anxiety of the mathematics score (-0.02) and the science score (0.29) present that students are highly involved in their related subject studies even though they suffer academic pressure. According to the broken-line analysis, students consider mathematics mostly as a benefit to future university study (3.65), and science is more for daily life function (3.71). Lastly, it is proposed that the male performs better than the female but there is no apparent gender difference in STEM performance.

Keywords: STEM education, motivational belief, college major choice, gender difference

1. Introduction

It is assumed that students' mathematics and science positive motivation will affect their STEM major choice in college. At present, the most prominent problem in the development of science and technology in China is the shortage of top talents. Applied foundation research driven by top talents has a significant effect on science and technology innovation capability. In the United States' experience, science and technology development enables a country to maintain its original innovation vitality, proceeds emerging technology industries, and promotes rapid economic growth. When comparing the number of Nobel Prize-winning scientists in China and the United States, the lack of award-winning scientists might have a potential latent relationship with China's educational system based on the GDP per person. The motivation of high school students in STEM performance has been well studied, and it has been shown that positive motivation is associated with STEM achievement

[1]. However, STEM motivational belief on the Chinese high school students are limited research. This research investigates the STEM achievement related to motivational process from Chinese emerging adolescent through the national college entrance examination. Drawing on Eccles' expectancy-value theory it is examined how students' math and science motivational belief as regards self-efficacy and subjective values in grade 12 (G12) students related to their college major choice in STEM field [2]. Moreover, dimensional comparison theory supports that the achievement in the domain with positive effect on self-concept in the matching domain [3]. That is, the higher motivational belief on STEM produces more higher achievement on STEM. Meanwhile, this study also proposes examining how gender affects the college major selection process in the China. Equipping students with the STEM education will promote national human capital development and innovation, helping the nation grow and compete in the global knowledge economy.

2. Literature Review

2.1. Expectancy-value Theory

Achievement motivation theory is to attempt to explain people's choice of achievement tasks and performance on the people themselves. One of the perspectives on motivation is expectancy-value theory. According to Eccle's expectancy-value model of achievement-related choices, the expectancy and values are assumed to be influenced by specific task beliefs such as perception of competence, perception of difficulty, individuals' goals and self-schema [3]. Eccle et al. described four components of task values: attainment value, intrinsic value, utility value and cost. Attainment value is the personal importance of doing well for task performance. Intrinsic value is the subjective enjoyment or interest in the individual task doing. Utility value is how a task fits into an individual's current or future goals. Cost is the critical component value in terms of the negative aspects of task performance [2]. The current research is focused on all of those task values as shown in figure 1.

Bandura proposed a theory of self-efficacy, which is a social cognitive model of the role of perceptions of people's efficacy and agency, and performs actions to accomplish tasks. However, the individual can believe a specific behavior will produce a specific outcome (outcome expectation) does not mean that the individual can believe he can perform the behavior (efficacy expectation). Bandura initiated that people's efficacy expectation are the major consideration of his goal setting, choice and persistence on the certain activity. Based on the stand-long self-efficacy theory of Bandura and Eccles et al., personal self-concept should influence its development of task values. Theorists of achievement motivation argued that individual's choice, persistence and performance can be explained by their beliefs as regards how well they will do and the extent to do on the value of task [2].

2.2. Dimensional Comparison Theory

Academic self-concept is individual perception ability in academic endeavors. The theory of dimensional comparison theory (DCT) showes that there were at least two different academic self-concepts precepted by students between school subjects that were mathematics (math, physics, and chemistry) and verbal self-concepts (language domains). Developed by Moller, DCT is defined as intraindividual comparisons that a person embraces his or her own achievements in two domains of subjects. This theory assumes that the students' perception of subject similarity would influence their academic self-concepts such that the students have a stronger self-concept difference between subjects perceived as dissimilar (e.g., math and English) or more similar (e.g., math and physics). As illustrated in figure 1, DCT assumes that students perceive academic subjects with low self-concept correlations as more similar than subjects with high self-concept correlations [4]. The analytical framework is guided by Eccle's Expectancy-value theory of expectation of success and subjective

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task value and Moller's Dimensional comparison theory of perception of subject similarity impacted on students' self-concept. This conceptual model accounts for individuals 'achievement related choice and performance in high school. Meanwhile, it is considered that social context and culture force contribute to gender role stereotype of subject matter and achievement choice.

2.3. Gender Differences

According to Expectancy-value theory, gender roles would affect individual motivational beliefs and performance outcomes, and the gender stereotype will influence individual math and science motivational beliefs and STEM outcome via internalization and socialization [5]. Meanwhile, male or female's perception of subject similarity would impact on their self-concept to achieve the academic success as depicted in figure 1. There is a study of the world's best math students. In this study, boys have a stronger sense of mathematical self-efficacy and perform well in mathematical orientation. Girls' reading ability is relatively better, and they are more balanced in math intensive. The girls and boys who performed best in mathematics showed similar STEM motivation and achievement. Boys are more interested in learning physics and engineering subjects, while girls are more interested in health and biology [6]. Even though more females completed the STEM MOOCs than males, females were less likely to enroll in the STEM MOOCs [7]. According to the research on how parents' different beliefs predict their children's confidence in mathematics and science academic abilities, gender bias might exist in the STEM area. [8].

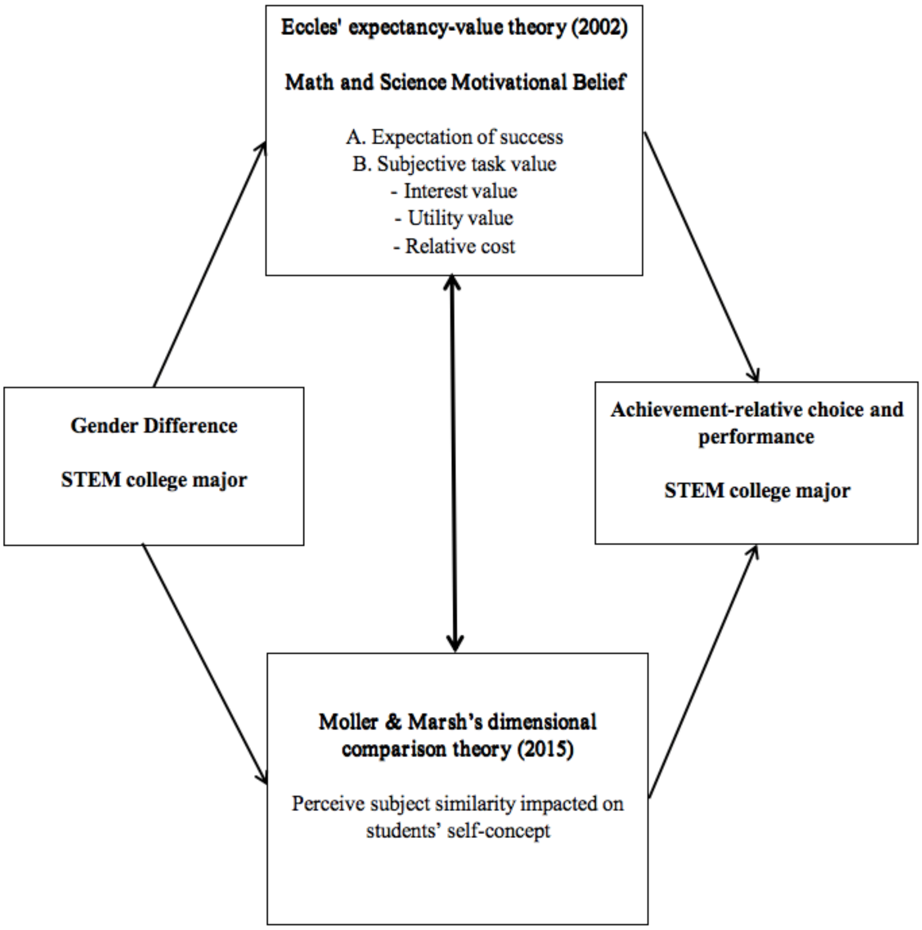

Figure 1: Conceptual framework of relation of high school students' math and science motivational belief and their subsequent STEM major choice in college and the gender difference.

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3. STEM Education

STEM program in the United States is mainly implemented in each state. The original creation of STEM schools was not to provide elite education for intelligent students but to develop students' special skills [9]. The core value of STEM is the essential to key competence for Chinese students. In the "Compulsory Education Curriculum Plan" promulgated by the Chinese Ministry of Education (MOE) in 2022, the development of quality-oriented education and key competence are taken as the guiding ideology to comprehensively cultivate students' moral, intellectual, physical and artistic skills. Emphasis is placed on learning activities with interdisciplinary themes to strengthen the comprehensive disciplines [10]. Science curriculum is an important part of key competence, which aims to cultivate students' scientific view of science, thinking, practice and responsibility and lay the foundation for scientific literacy and lifelong development. The science curriculum has been brought forward to the first grade of primary school and the proportion of the total hours of compulsory education has been raised to 8-10%, of which mathematics is 13-15% [11]. Fundamentally, mathematics is treated as an important foundation of natural science, which can directly create the economy value for society. Mathematics is a very important scientific foundation for contemporary big data analysis and artificial intelligence as well [12]. Science and technology integrated through engineering is all based in mathematics elements. According to *Charting a Course for Success: America's Strategy for STEM Education* (Polaris Program) issued in 2018, mathematics competence is the essential element in the STEM development [8].

According to the "Catalogue of higher education undergraduate major" issued by the Chinese MOE in 2012, there are twelve subjects in higher education in China [13]. Among them, the four traditional disciplines of "science, engineering, agriculture and medicine" correspond to the STEM fields as science, technology, engineering and mathematics in the United States. In the document of the national higher education institution in 2022, MOE puts forward plans to promote the construction of new engineering, medicine and agriculture, and to increase the cross integration of new majors [14]. According to the data inventory of Chinese postgraduate students in 2020, the student ratio of science, engineering, agriculture, and medicine is 2:8:1:3, while engineering students occupy the major academic field. The number of engineering postgraduate students (217590) is the greatest among the twelve academic fields. Medicine (74371) is the third rank, and Science (57273) is the fourth rank [15]. It is shown that engineering as a practical and useful major is popular among students. since the students enjoy this field and it is treated as a major that is more related to their future studies, life or career.

STEM is the transdisciplinary subject not only to develop students' learning motivation and interest but also to cultivate their problem-solving skills and high-level thinking skills. Chinese college students' critical thinking levels and gains reached the lowest level of 0.49 s.d. units in the college final year compared to 1.66 s.d. units for US students. According to the study, there is no discernible difference in critical thinking and STEM skills, but the males are slightly superior to the females [16]. On the other hand, the Chinese government promotes STEM education extensively. China is expected to produce twice as many STEM Ph.D. students as the U.S.A. by 2025, meaning that Chinese STEM Ph.D. graduates will be 77,000 compared to 40,000 in the United States [17].

However, China is still facing a great challenge in STEM education from different perspectives, such as teacher qualification, teaching curriculum, teaching approach, teaching materials, and assessment standards. For example, a study showed that the learning strategy of project-based learning (PBL) was a successful approach to STEM activities. The young preschoolers were able to engage the STEM curricula in a well-planned PBL learning environment, in which STEM concepts are best learned at an early age in elementary and secondary school because it is a prerequisite to a future career [18]. Nonetheless, project-based or transdisciplinary learning is only practiced in China

[10]. Furthermore, many STEM teachers were math and science teachers before becoming involved in STEM education, making it difficult for them to transform their professional identities and work to implement fundamental STEM reform [19]. It seems that STEM teachers are still cultivating their motivational belief in STEM teaching.

4. Methodology

The questionnaire invited the Chinese fresh undergraduates who had just experienced the national college entrance examination in a secondary school in Guangzhou, China. The number of female participants was 17 and the number of male participants was 17. Both accounted for 50% of the total, and the questionnaires had all been collected. All participants were aged 17 to 19 years old. Science background examiners accounted for 65% of those who took physics, chemistry, and biology tests, and liberal arts background examiners accounted for 35% of those who took history, geography, and politics tests. All examiners must take Chinese, mathematics and a foreign language (English) as the compulsory subjects [20]. Moreover, most of the examiners had a basic science background. The questions were designed based on the gender variable to investigate how gender affects the G12 students' college major choice among each latent variable. Secondly, it dragged out the significant feature contributing to college major choice from all those latent variables and their relationship with the gender variable.

It first pre-processed the data to have numerical values to replace those answers from the questionnaire. This would help those algorithms to understand the data. From the data analysis perspective, it mainly focuses on the relationship between different variables. Compared to regression and classification, brute force machine learning algorithms would help to analyze those parameters that can affect the final result. Therefore, it was chosen structural equation modeling (SEM) using SPSS to help model the variables. With SEM, it was able to design our model to find the coefficients while finding the relationships based on the hypothesis instead of a neural network (MLP), giving random coefficients that people might not be able to understand [21]. This is one of the main benefits that the traditional statistical method outperforms some of the basic machine learning algorithms in the data mining area, while it is only suitable in this specific case. However, the processed data itself may be difficult to read or understand due to the attempt to include as many variables as possible.

It is found that the traditional way of doing SEM includes visualization of the relationship among different variables. Therefore, the visualization was applied to illustrate the result from the training log. It could be a very useful tool to generate visual analytics via VIS4ML workflow, and the visualization [22]. For both science and math, respectively, it used the same set of variables that included features of the confidence of the test. They calculated the estimate, standard error, z-value, and p-value. The visualization was conducted to illustrate the result. The first level is the gender variable so that the effect of gender differences on the college major selection process and each potential variable can be observed (table 1). In addition, the second layer is where we extracted all variables such as success expectations and subjective task values for math and science from the questionnaire. When the second layer is connected to the third layer, the relationship between the two can be found, as well as the contribution of each characteristic to the STEM college major selection process (table 2).

Table 1: STM analysis of the effect of gender variable on the college major selection process and each potential variable.

lval	rval	estimate	std. err	z-value	p-value
MConfidence_assignment	Gender	-0.27	0.45	-0.6	0.55
MConfidence_test	Gender	-0.33	0.44	-0.75	0.45

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Table 1: (continued).

MConfidence_skill	Gender	-0.2	0.43	-0.47	0.64
MConfidence_content	Gender	-0.27	0.43	-0.62	0.54
SConfidence_assignment	Gender	0.47	0.35	1.33	0.18
SConfidence_test	Gender	0.33	0.37	0.9	0.37
SConfidence_skill	Gender	0.4	0.35	1.13	0.26
SConfidence_content	Gender	0.4	0.37	1.09	0.28
MInterest_enjoying	Gender	0.27	0.43	0.62	0.54
MInterest_rewards	Gender	0.46	0.41	1.14	0.25
MInterest_boring	Gender	0.2	0.33	0.6	0.55
SInterest_enjoying	Gender	0	0.42	0	1
SInterestn_rewards	Gender	0.4	0.42	0.95	0.34
SInterest_boring	Gender	0.27	0.37	0.72	0.47
MUtility_life	Gender	1.2	0.41	2.89	0
MUtility_study	Gender	1.4	0.45	3.09	0
MUtility_career	Gender	1.66	0.41	4.07	0
SUtility_life	Gender	1.46	0.43	3.44	0
SUtility_study	Gender	1.86	0.38	4.91	0
SUtility_career	Gender	1.53	0.38	4.03	0
MAnxiety_pressure	Gender	0.46	0.37	1.25	0.21
MAnxiety_score	Gender	0	0.37	0	1
MAnxiety_tease	Gender	-0.13	0.41	-0.32	0.75
SAnxiety_pressure	Gender	0.33	0.32	1.05	0.29
SAnxiety_score	Gender	0	0.32	0	1
SAxiety_tease	Gender	-0.27	0.35	-0.75	0.45
MGender_male	Gender	-0.27	0.42	-0.63	0.53
MGender_female	Gender	0.26	0.32	0.82	0.41
MGender_balanced	Gender	-0.2	0.45	-0.45	0.65
SGender_male	Gender	0.13	0.39	0.34	0.73
SGender_female	Gender	0	0.34	0	1
SGender_balanced	Gender	-0.13	0.43	-0.31	0.76

Table 2: STM analysis of the relationship of math and science expectancy and subjective task values as well as the contribution of each characteristic to the STEM college major selection process and the gender difference.

lval	rval	estimate	std. err	z-value	p-value
CollegeMajor	MConfidence_assignment	0.59	0.09	6.6	0
CollegeMajor	MConfidence_test	-1.66	0.09	-18.52	0
CollegeMajor	MConfidence_skill	0.35	0.09	3.79	0
CollegeMajor	MConfidence_content	0.33	0.09	3.57	0
CollegeMajor	SConfidence_assignment	-0.25	0.11	-2.22	0.03
CollegeMajor	SConfidence_test	0.65	0.11	6.03	0
CollegeMajor	SConfidence_skill	0.08	0.11	0.73	0.47
CollegeMajor	SConfidence_content	-0.38	0.11	-3.48	0
CollegeMajor	MInterest_enjoying	0.31	0.09	3.3	0
CollegeMajor	MInterest_rewards	0.55	0.1	5.64	0

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Table 2: (continued).

CollegeMajor	MInterest_boring	1.06	0.12	8.89	0
CollegeMajor	SInterest_enjoying	0.35	0.09	3.71	0
CollegeMajor	SInterestn_rewards	-0.05	0.09	-0.5	0.62
CollegeMajor	SInterest_boring	0.33	0.11	3.1	0
CollegeMajor	MUtility_life	0.01	0.09	0.11	0.91
CollegeMajor	MUtility_study	1.05	0.08	12.45	0
CollegeMajor	MUtility_career	-1.05	0.09	-11.49	0
CollegeMajor	SUtility_life	-0.11	0.09	-1.22	0.22
CollegeMajor	SUtility_study	0.51	0.1	5.36	0
CollegeMajor	SUtility_career	0.09	0.1	0.88	0.38
CollegeMajor	MAnxiety_pressure	-0.3	0.11	-2.85	0
CollegeMajor	MAnxiety_score	-0.02	0.11	-0.2	0.84
CollegeMajor	MAnxiety_tease	-0.36	0.1	-3.79	0
CollegeMajor	SAnxiety_pressure	-0.12	0.13	-0.92	0.36
CollegeMajor	SAnxiety_score	0.28	0.12	2.31	0.02
CollegeMajor	SAxiety_tease	-0.54	0.11	-4.86	0
CollegeMajor	MGender_male	-0.01	0.09	-0.15	0.88
CollegeMajor	MGender_female	-0.43	0.12	-3.47	0
CollegeMajor	MGender_balanced	-0.86	0.09	-9.64	0
CollegeMajor	SGender_male	0.69	0.1	6.76	0
CollegeMajor	SGender_female	-0.8	0.12	-6.8	0
CollegeMajor	SGender_balanced	0.59	0.09	6.38	0

5. Results and Discussion

This research included as many variables as it could in the model so as to cover more features in the study. This was not a back-propagation algorithm like the regression or the MLP, so it was no need to worry whether there was too much useless data or meaningless variables. On the other hand, the limit of this study was also quite obvious: the sample size is relatively small. Normally a dataset could be more than 500 to 1000 to give a proper training and predict the result. Therefore, data processing would require extracting as much information as possible from a limited size of data.

(1) Confidence of Mathematics Performance

According to the broken-line analysis, students' mathematics confidence in assignment (3.24) and acquired skill (3.15) are greater than the exam (3.03) and understanding difficult content (2.88). Students have better motivation belief on mathematics assignment and skill. From the SEM analysis, mathematics motivational belief on assignment performance (0.59), acquiring the skills (0.35), and understanding the difficult content (0.33) are different. The assignment performance confidence is intended more for empirical STEM major selection. It can show that mathematics examination is not the positive indicator for students' performance.

(2) Confidence of Science Performance

According to the broken-line analysis, the confidence of science has positive motivation overall. The confidence of performance (3.35) and acquired skills (3.21) show that students have a positive expectation of success, whereas the confidence of the exam (3.09) and understanding the difficulty content (3.00) show a less exceptional performance. From the SEM analysis, the confidence of acquired skill (0.08) presents that it has a great relation with college major choice. Students will prefer to choose practical STEM over theoretical STEM majors such as engineering, agriculture, or

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medicine because science subjects are not only mono-subjects like mathematics but more integrated subjects like physics or biology. Confidence in assignment performance (-0.25) and understanding difficult content (-0.38), on the other hand, are less related to practical STEM major selection.

(3) Intrinsic Value of Mathematics and Science

According to the broken-line analysis, participant students all have interest and enjoy to enroll the mathematics (3.18) and science (3.56) courses. Students are less influenced by reward or praise to involve in mathematics (3.03) and science (3.06) courses. Conversely, students do not treat mathematics (2.79) and science (2.62) as boring subjects. It is revealed that secondary students have greater intrinsic value on the math and science, especially to science course. From the SEM analysis, the intrinsic value of mathematics (0.31) and science (0.35) is found to be highly correlated with the more empirical fields of engineering, agriculture, and medicine in the STEM major choices.

(4) Utility of Mathematics and Science

According to the broken-line analysis, G12 students consider mathematics merely a benefit to university study (3.65), and there is less utility in daily life (3.24) and career future (3.32). Interestingly, students think science is more for daily life function (3.71) but less for the future career (3.68) and university learning (3.65). We might predict that mathematics is a pure logic tool, so it is closer to the academic field. Science, as regards the empirical category, can be linked to daily common knowledge. From the SEM data analysis, it is shown that students' utility of study in mathematics (1.05) is inclined to choose a more math-intensive major, while students' utility of study in science (1.05) prefers to choose a more STEM-practical or non-STEM major.

(5) Anxiety of Mathematics and Science

Secondary students, according to the broken-line analysis, are under pressure in both mathematics (3.82) and science (3.68), and they are also afraid of lower scores in mathematics (3.91) and science (3.76). However, the data of being afraid of being teased by others in mathematics (3.24) and science (3.12) are quite minor effects of the anxiety cost. It is well known that mathematics is a difficult subject for students, putting them under a lot of study pressure. Meanwhile, because the participants are mature emerging adults, they will not be influenced by others and will make their own academic foundation decision. According to the SEM analysis, pressure (-0.30) and score anxiety (-0.02) in mathematics have additional relationships with the choice of a math-intensive college major. For the sake of science score anxiety (0.29), it has a stronger relationship with empirical science college major choice.

(6) Gender Difference

According to the broken-line analysis, there is no gender difference in mathematics performance (3.37), while participants believe the male is doing better (3.26) and some believe the female is doing better (2.74). In the perspective of science performance, the situation is similar as mathematics. There is no gender difference (3.38), but it is still thought that male (3.21) is more competitive than female (2.85).

From the SEM analysis of mathematics performance, the data presented that the participant considers the male has greater performance (0.27) than female (-0.2). They do not concern that male and female have not difference (-0.33). In terms of scientific performance, the data also reflects the phenomenon that male (0.13) performs well compared to female (-0.00), and the participant does not deem there to be any difference (-0.13).

From the analysis of SEM dimensional of confidence of mathematics of assignment performance (-0.27), understanding difficult content (-0.27), acquiring skill (-0.27) and taking exam (-0.2), it is shown that male and female participants alighted their consideration on each variables. Surprisingly, the confidence of science on assignment performance (0.47), understanding difficult content (0.40), acquiring skills (0.40) and taking exams (0.30) differs greatly between male and female participants. We might propose that the science subjects include different comprehensive subject related to STEM,

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and it is not the single liner subject such as mathematics, so that the confidence of science task would be multi-dimension.

From the analysis of SEM regarding the pressure study of mathematics (0.46) and the pressure study of science (0.33), it is revealed that male and female students have quite a difference in concerns about the pressure of these two kinds of fields. It may wonder that which gender type would contribute more pressure on the subjects. It can be found that the traditional concept of male is superior than female still exists among the secondary students, but there is minor gap as many of students hold the idea that male and female are balanced to achieve well both on the mathematics and science.

6. Discussion

This study clarifies the literature by assessing the degree to which STEM achievement and gender differences during adolescence and emerging adulthood were predicted by math and science motivational beliefs. But there are some restrictions that need to be thought about. Firstly, the sample quantity of participants was small, so the sample distributions were more likely to deviate from the normal distribution. Furthermore, the samples were selected from a high school in Guangzhou city, so data reliability and authenticity are insufficient. Besides, the data is collected from the university entrance examiner, which provides less insight into the development process than the longitudinal study. To acquire a complete picture of how students choose their STEM majors, qualitative research is required. Understanding the contextual influences on teenagers' STEM major decisions, such as the presence of their families, classmates, and teachers, as well as the quality of the college programs they applied to, would be helpful.

This research shows that G12 science background students' confidence in daily assignment performance and acquiring skills enables them to choose empirical STEM college majors such as engineering, agriculture, or medicine but not math-intensive STEM majors. Moreover, understanding difficult content in science subjects is less related to the students' practical STEM college major selection. Participant students place a higher value on science subjects and prefer to study science over math courses. Participants consider mathematics to be mostly beneficial for university studies and that science is more for daily life function. Some researchers have argued that math is a gateway subject for adolescents' STEM academic achievements. It was reported that low math motivational beliefs and performance early in high school would lead to low motivational beliefs and accomplishment in math-related STEM academic or career choices such as science, physics, and chemistry [23]. It is supposed that math is very crucial to STEM, but if the learning materials are too difficult for students, it might reduce their passion and encouragement. This study also discovered that the empirical learning process is more appealing to students who want to get involved in STEM subjects, and that the learning experience will help them develop critical thinking and problem-solving skills.

This research presents that teachers have the most valuable effect on math and science performance among the different types of people. Based on an explicit study of middle and high school adolescents, it was discovered that student perception of teaching care was critical in the development of their math motivation. The student-teacher relationships were positively associated with adolescents' math self-efficacy and subjective values [24]. For the gender difference, both mathematics and science are treated as having gender differences in math and science motivation, belief, and achievements. It is proposed that a male performs better than a female, but there is no big difference overall. Focusing on gender socialization within the family, the study showed that parents' perceptions of children's academic abilities would predict their own confidence in their academic abilities. This finding gave us an angle to gender bias affecting the STEM field, in spite of the fact that there was no gender difference in completing well in math and science activities [8]. In the longitudinal study about the impact of classroom characteristics on math motivational beliefs and future achievement among early

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adolescents, it was reported that teachers' friendly and fair attitudes could influence emerging adolescents' math motivational beliefs and could predict their choice of math-intensive college majors and occupations in adulthood. Students with low motivational beliefs and intrinsic profiles had a low likelihood of choosing a math college major. Therefore, it was suggested that teachers consider the personalized implement to enhance students' self-concept and intrinsic value in the math-related subject of motivational development and achievement in early adolescence [9].

7. Conclusion

This study analyzed the relationship between twelfth graders' motivational beliefs about math and science and their STEM performance and choices on high school national college entrance exams and their STEM major choices in college. According to the findings, math and science motivation beliefs both play important and distinct roles in STEM achievement throughout secondary school and into college. Besides, this research predicts that if students believe they are capable of math and science, they would like to have greater STEM achievement orientation and they are eager to pursue STEM majors in college. Although female students have lower confidence and self-efficacy than males, the general difference in performance is minor, which is the similar STEM motivational belief and achievement for all students in high and college. To summarize, the current research provides educators and policymakers with the substantive findings for the STEM equity study. In the future study, the research can consider inviting more students and they can be from different cities. Furthermore, the study would be designed as a longitudinal study tracing students' motivation during academic performance, ensuring that the findings are more reliable and valid.

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