The Impact of Self-efficacy on Mathematics Academic Performance among Chinese High School Students

Jiaying Liu[1,a], Yutong Wu[2,b], and Fangxian Zhao[3,c,*]

[1]*School of Chemical Engineering and Pharmacy, Wuhan Institute of Technology, Wuhan, Hubei, 430205, China*
[2]*Department of Economics and Management, College of International Business and Economics, WTU, Wuhan, Hubei, 430202, China*
[3]*Faculty of Economics, Yunnan University, Kunming, Yunnan, 650504, China*
a. 2068644101@qq.com, b. 57259457@qq.com, c. A02497267@lawsonstate.edu
*corresponding author

Abstract: Mathematics is a vital subject in Chinese high school study. Many studies have indicated that high school students' self-efficacy may have a great impact on students' mathematics academic performance. Therefore, based on a summary of previous research, this paper will investigate how self-efficacy influences academic performance in mathematics learning and the score of Chinese high school students get. Meanwhile, it also explores the relationship between Chinese high school students' evaluation of their confidence in learning mathematics and their true sense of self-efficacy. Data will be gathered for all of the studies using questionnaires, and descriptive analysis, correlation analysis, and regression analysis will all be used. Authors get the following findings from data analysis: firstly, students' self-efficacy is positively correlated with their math grades, which means the more students believe that they can learn mathematics well, the higher their math grades will be. Secondly, males have a stronger sense of self-efficacy in learning mathematics than females. Finally, the respondents have a relatively accurate assessment of their confidence in learning mathematics.

Keywords: self-efficacy, high school student, mathematics learning, influences

1. Introduction

Self-efficacy refers to a person's assumption and assessment of his or her capacity to carry out a specific conduct, or the level of assurance that persons feel in their ability to perform a particular job activity using their talents [1]. At present, experts have studied how students should improve their sense of self-efficacy and the cultivation of self-efficacy. Although it is connected to someone's skill level, it does not accurately reflect that skill level. In recent years, mathematics, as one of the most important subjects in the college entrance examination, mathematical scores have become more and more important, the difficulty of math problems in the college entrance examination is also increasing, and the proportion of mathematical scores in the college entrance examination is also very high. This article aims to study the impact of self-efficacy of Chinese middle school students on the mathematical performance of the college entrance examination. It can better study the relationship between students' sense of self-efficacy and academic performance and

to guide the teaching of high school mathematics. This article will study the impact of self-efficacy on the mathematical performance of the college entrance examination.

2. Literature Review

2.1. Self-efficacy and Perceived Mathematics Learning Self-efficacy

An individual's belief and assessment of whether they are able to carry out a particular behavior is referred to as self-efficacy. "The degree of confidence that people have in their ability to use the skills they have to perform a certain work behavior" is how Bandura defines self-efficacy [2]. Following the concept's introduction, extensive research in the disciplines of organizational behavior, psychology, and sociology was conducted. There is a statement according to Bandura saying that self-efficacy is a driving force to complete a task or excel academically. According to Bandura, the four key psychological influencing variables for the mechanism of developing self-efficacy are emotional arousal, verbal persuasion, personal experience of the success or failure of one's own activity, and vicarious experience [3]. To be more specific, perceived mathematics learning self-efficacy refers to the assessment of students' self-confidence in their ability to successfully accomplish mathematical learning assignments using their skills or abilities. An individual's capacity to manage their mathematical learning behavior and academic success is assessed subjectively [4]. In learning mathematics, many students develop negative emotions such as timidity and anxiety, which undoubtedly hinder mathematical learning. Therefore, in mathematics teaching, it is particularly important to help students actively adjust their mindset, build their self-confidence, and strengthen their sense of self-efficacy [5].

2.2. The Influence of Self-efficacy on the Mathematics Performance of Chinese High School Students

Song and Su's studies show that students' math grades and their sense of self-efficacy are closely related. However, most high school students lack confidence and their perceived mathematics learning self-efficacy score are much lower than other subjects [6,7]. To be more specific, during the process of mathematics learning for Chinese high school students, males have a higher sense of self-efficacy than females. Furthermore, a notable distinction can be observed in the self-efficacy of high school students in mathematics learning at their academic level, which means that students with better mathematics scores have a stronger perceived mathematics learning self-efficacy. Senior students scored the highest in math self-efficacy, followed by sophomore students, and grade one students in high school scored the lowest [7,8].

3. Methods

3.1. Participants

The participants of the project are one hundred and twenty Chinese college students who have taken the college entrance examination filled out the questionnaire, which included the self-efficacy scale and the test results for the college entrance exam in math. Among the 120 Chinese college students, there are 60 boys and 60 girls. They come from different parts of China and are from different grades.

3.2. Research Questions

The research questions of the group are as follows:

RQ1: How is the self-efficacy related to the Chinese high-student mathematics score and how does the self-efficacy predict the Chinese high-student mathematics score?

RQ2: Do males or females have a higher sense of self-efficacy in learning mathematics?

RQ3: How do Chinese high-student feel about their self-efficacy when learning math?

3.3. Measures

The "Academic Self-Efficacy Questionnaire" developed by Liang Yusong for his master's thesis in 2000, which was modified to reflect the characteristics of college students in my nation and Pintrich and De Groot's self-efficacy questionnaire, the use of students led to successful measurement outcomes as well [3]. There are a total of 22 questions, which are separated into two aspects [3]. Academic ability efficacy variables range from 1 to 11, whereas academic behavioral efficacy factors range from 12 to 22, using a 5-point scale, the rating method assigns a grade of 1 for "completely disagree" and 5 for "completely agree." [3]. Group's questionnaire was based on the scale and asked college students about their math scores in the college entrance examination.

3.4. Data Collection

The authors collected a total of 120 questionnaire results, including 60 boys and 60 girls. The authors sent the questionnaire which included the self-efficacy scale and the mathematics score of the college entrance examination to the students who had taken the college entrance examination. The students filled in the relevant data of self-efficacy and the college entrance examination mathematics score in the third year of high school and collected them together.

3.5. Data Evaluation

SPSS was mostly used to analyze the survey data. A correlation analysis is to analyze whether there is Chinese high school pupils' self-efficacy and mathematical achievement are related. And regression analysis is used to determine whether and how much self-efficacy affects Chinese students in high school arithmetic performance.

On the survey results and the overall self-efficacy score on the college entrance exam, the authors performed a correlation study and logistic regression analysis. Multiple-choice inquiries on the questionnaire divide the math portions of the college entrance exam into several periods. Questions with multiple choices have little effect on the analysis of data because the answers are directly proportionate to the score intervals.

4. Data Analysis

4.1. Examination of the RQ1

RQ1 is: How is the self-efficacy related to the Chinese high-student mathematics score and how does the self-efficacy predict the Chinese high-student mathematics score?

It was discovered through the use of SPSS correlation analysis that there is a positive link between self-efficacy (full score 110) and mathematical grades on the test for college admission. The value of the correlation coefficient between the mathematics scores on the college entrance exam and the total score of self-efficacy (full score 110) is 0.476, and it indicates a 0.01 significance level (see Table 1).

Table 1: Pearson relevant.

		College Entrance Examination Mathematics Results
Total Self-Efficacy Score	correlation coefficient	0.476**
	p-value	0.000
	sample size	120

* p<0.05 ** p<0.01

Among these, the self-confidence scale's overall score is utilized as an independent variable via SPSS, and the college entrance exam's mathematics score is employed as the outcome of a linear predictive analysis' variable of dependence. Table 2 exemplifies an example formula, which is as follows: math score on college entrance exam = 0.588 + 0.040*self-efficacy. The whole self-efficacy score (complete score: 110) is consistent with the algorithm's R-square rating of 0.226, which is determined by the overall score in the table and may account for 22.6% of the variation in your math performance on the college entrance exam. When the model was put to use, it passed the F test (F=34.512, p=0.0000.05), proving that self-efficacy is certain to have an effect on the mathematics test scores for college admission. Particulars thorough analysis's final results show that: self-efficacy regression coefficient equals 0.040 (t=5.875, p=0.0000.01), illustrating that self-efficacy will significantly improve test-taker performance on the mathematics portion of the college admission exam. The summary analysis demonstrates that all levels of self-efficacy will significantly improve test-taker mathematics scores.

Table 2: Results of linear regression analysis (n=120).

	Inconsistent coefficient		consistent coefficient	t	p	collinearity diagnosis	
	B	standard error	*Beta*			VIF	tolerance
constant	0.588	0.483	-	1.218	0.226	-	-
Total Self-Efficacy Score	0.040	0.007	0.476	5.875	0.000**	1.000	1.000
R^2	0.226						
Adjustment R^2	0.220						
F	$F(1,118)=34.512$, $p=0.000$						
D-W value	2.082						

dependent element: College Entrance Examination Mathematics Results.
* p<0.05 ** p<0.01

Therefore, regarding what was originally the study question, the team found that self-efficacy is positively correlated with Chinese high school students' college entrance examination scores and self-efficacy has a significant impact on college entrance examination scores.

4.2. Analysis of the RQ2

RQ2 is: Do males or females have a higher sense of self-efficacy in learning mathematics?

The analysis suggestions are: paired t-test to study the differential relationship between paired data;

Firstly, analyze whether there is a significant difference (p-value less than 0.05 or 0.01) between each pair of paired items through p-value analysis. Secondly, if there are significant differences in the selected data, the specific differences can be described by comparing the average (or difference) size. Finally, summarize the analyzed data. The following content will analyze eight issues separately.

From Table 3, it can be seen that the paired t-test method was used to study the differences in experimental data, and a total of 6 paired data sets showed differences (p<0.05).

The analysis result is that if the difference is significant (p<0.05), the average value may be used to compare the difference in detail, and the effect size can be used to investigate the size of the difference.;

Firstly, use Cohen's d value to represent the magnitude of the effect (the magnitude of the difference), and the larger the value, the greater the difference;

Secondly, the paired sample t-test uses Cohen's d-value to represent the critical points for distinguishing small, medium, and large effects, which are 0.20, 0.50, and 0.80, respectively;

Thirdly, the difference's absolute value divided by its standard deviation is used to get Cohen's d-value.

By analyzing the paired t-test analysis results using SPSS, it can be concluded that: The two paired quantitators are gender and representative questions selected. A total of 6 paired data sets will all show differences. Regarding the issue of whether men or women have higher self-efficacy when learning mathematics, this survey found that: Similarly, when learning mathematics, men's self-efficacy is higher than that of women. The p-values of a total of 6 paired data sets are all less than 0.05, indicating differences. The average value of gender is significantly higher than the average value of the six questions. Therefore, research shows that men have a higher sense of self-efficacy when learning mathematics [9].

Table 3: Paired t-test analysis results.

name	Pairing (mean ± standard deviation)		Difference (pair 1- pair 2)	t	p
	pair 1	pair 2			
1. Your gender: Paired 25. Even if the teacher does not require it, I will consciously do exercises at the end of each chapter in the book to test my mastery of knowledge.	1.50±0.50	2.67±1.30	-1.17	-8.753	0.000**
1. Your gender: Paired 24. When doing homework, I always strive to recall what the teacher said in class in order to do the homework well.	1.50±0.50	3.05±1.16	-1.55	-13.042	0.000**

Table 3: (continued).

1. Your gender: Paired 18. When reading a book, I am able to connect the content I have read with my own mathematical knowledge for thinking.	1.50±0.50	3.19±1.09	-1.69	-13.704	0.000**
1. Your gender: Paired 5. I believe I have the ability to solve problems encountered in mathematics learning.	1.50±0.50	3.30±1.16	-1.80	-14.801	0.000**
1. Your gender: Paired 16. When I am thinking about a certain question, I am able to connect the knowledge I have learned before and after.	1.50±0.50	3.46±1.18	-1.96	-15.144	0.000**
1. Your gender: Paired 3. How confident are you in the process of learning mathematics that you believe you can easily complete math learning tasks?	1.50±0.50	0.56±0.27	0.94	16.538	0.000**

* p<0.05 ** p<0.01

4.3. Analysis of the RQ3

RQ3 is: How do Chinese high-student feel about their self-efficacy when learning the math?

To address this issue, in the questionnaire, the respondents were first asked to investigate their confidence in learning mathematics, and then they were asked to fill out a professional academic self-efficacy scale to conduct a correlation analysis of the obtained data. The analysis results are shown in Table 4.

Table 4: The correlation between respondents' confidence assessment and actual self-efficacy.

		confidence assessment
actual self-efficacy score (Full score of 110)	correlation coefficient	0.638**
	p	0.000
	sample size	120

* p<0.05 ** p<0.01

Table 4 sets forth the important fact that the correlation coefficient value between the respondents' evaluation of their confidence in learning mathematics and their final self-efficacy score is 0.638 at the 0.01 significance level. Therefore, it indicates a significant positive correlation between learners' self-assessment of confidence and their actual self-efficacy in the process of mathematics learning. It is easy to see that the respondents have a relatively accurate assessment of their confidence in learning mathematics.

In addition, based on the data, the following conclusions can be drawn:

Overall, 120 respondents believe they have 56% confidence in learning mathematics well, and their average self-efficacy score is 67.97. The full mark of self-efficacy is 110. The highest score among the respondents is 110, while the lowest score is 22. Among them, 75% and 50% of respondents chose the most options: 40.83% of respondents believed they had a great chance of learning mathematics well, while 31.67% of respondents believed they had only a half chance of learning mathematics well. This indicates that the respondents' confidence in learning mathematics is relatively objective, but there is still a lot of space for improvement.

From the perspective of gender, the following conclusions can be drawn:

For one thing, males have higher self-efficacy when learning math than females. The average score for females who believe they can easily complete math learning tasks is 63%, compared to 50% of females. This means that males are more confident that they can successfully complete math learning tasks.

For another, in terms of self-efficacy, males scored an average of 73.35 overall, compared to 62.58 for females. From this point of view, males have a higher sense of self-efficacy than females. This may reflect sociocultural influences on gender roles, leading to men being more confident in mathematics.

Therefore, teachers should try their best to enhance students' confidence in the process of mathematics teaching, which can enable them to perform better [10].

5. Conclusions

To conclude, the authors have drawn the following conclusions through their research: (1) Self-efficacy is positively correlated with Chinese high school students' college entrance examination scores and self-efficacy has a significant impact on college entrance examination scores, which means the more students believe that they can learn mathematics well, the higher their math grades will be. (2) Males have a stronger sense of self-efficacy in learning mathematics than females. (3) The respondents have a relatively accurate assessment of their confidence in learning mathematics. Therefore, there are still many measures that need to be further improved to enhance the self-efficacy of Chinese high school students in learning mathematics. For example, teachers need to use reasonable teaching methods to stimulate students' interest in learning.

However, there are still some shortcomings in this study. It can be seen that there are only 120 respondents in this survey, and the data collected may have certain limitations. Therefore, in future further research, it is necessary to invite as many participants as possible to make the data more reliable and representative.

In addition, the group did not study the differences in self-efficacy among high school students in each grade, nor did it study the effects of other factors (such as family atmosphere and teachers' attitude) on self-efficacy or math grades. The object of the research is not to investigate high school students but the survey of college students is flawed. These issues should be further addressed and improved in future research.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

References

[1]   Bandura, A. (1997). Self-efficacy: the exercise of control. New York: W. H. Freeman and Company.
[2]   Neda Noorollahi. (2021) On the Relationship between Iranian English Language Teaching Students' Selfefficacy, Self-esteem, and their Academic Achievement Language Teaching Research Quarterly.

[3]   Cui Kaiwen. (2022) The impact of middle school students' academic self-efficacy on Test anxiety: the role of negative evaluation fear and core self-evaluation (master's Thesis, Guangxi University for Nationalities) https://epub2.yyttgd.top/KCMS/detail/detail.aspx?dbname=CMFD202202&filename=1022547018.nh

[4]   Gao Huan and Chen Kesheng. (2017) Research Status and Prospects of Mathematics Self-Efficacy. Journal of Mathematics Education (01), 76-81.

[5]   Du Shuqin (2012) Research on Strategies for Improving Students' Self efficacy in Middle School English Teaching New course (mid-year) (06), 50-51.

[6]   Su Xingyu. (2022) Research on the Relationship between Mathematics Teacher Support, Mathematics Self-efficac y and Mathematics Academic Performance of High School Students (Master's Thesis, Tianjin Normal University). Retrieved from https://epub2.yyttgd.top/KCMS/detail/detail.aspx?dbname=CMFD202202&filename=102255469 7.nh

[7]   Song Binbin. (2021) A survey of high school students' self-efficacy in mathematics learning (master's Thesis, Hebei   Normal   University) https://epub2.yyttgd.top/KCMS/detail/detail.aspx?dbname=CMFD202102&filename=1021586919.nh

[8]   Peng Li & Lihua Cao. (2021) A Study on the Relationship between "Learning Interest", "Self efficacy", "Learning Anxiety" and "Learning Motivation" of College Students in Further Mathematics. journal of mathematics education (04),97-102.

[9]   Wang Zhixiang,&Zhang Jiaming. (2021) A Model and Empirical Study on the Evaluation of High School Students' Self efficacy in Mathematics Learning. Advances in Applied Mathematics, 10, 291.

[10] Dianshun Hu, Zhanlin Zhu& Ping Zhang. (2021) The Influence of Mathematics Learning Motivation, Mathematics Failure Attribution, and Mathematics Learning Reflectivity on Mathematics Self efficacy. Educational Measurement and Evaluation (09),56-64.