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A Survey and Research on Mathematical Metacognition among Mathematics Normal Students in Local Universities

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Abstract: Mathematical metacognition is an important topic in the research field of Mathematics education. Good mathematical metacognition can promote the efficiency of mathematical learning. This article uses questionnaire survey and mathematical statistics to analyze the current situation of mathematical metacognition and dimensions among mathematics normal students in Qinghai Province, as well as differences in grade and gender. The results show that: (1) The mathematical metacognition and dimensions of mathematics normal students in Qinghai Province are at a moderate level; (2) There are significant grade differences in mathematical metacognition, mathematical metacognition experience dimension, and mathematical metacognition monitoring dimension, while there is no significant grade difference in mathematical metacognition knowledge dimension; (3) There is no significant gender difference in mathematical metacognition and dimensions.

1. Introduction

The goal of high-quality development of universities in the new era is to prioritize the guiding ideology of cultivating first-class talents, serving national strategic needs, and striving for world-class development, providing strong support for the comprehensive construction of a socialist modernized country [1]. This requires college students to form and develop the core qualities needed for future social and personal development in the process of mathematics learning, and learn to learn efficiently. Mathematical metacognition, as an important component of the efficient mathematical learning psychological structure model [2], cannot be ignored for its impact on the formation of students' core mathematical literacy and mathematical learning performance. Professor Guangming Wang[3-5] and his team believe that mathematical metacognition is the embodiment of metacognition in the process of mathematics learning, and it is the planning, adjustment, evaluation and monitoring of mathematical cognitive activities, which can reflect the ability of individuals to monitor and regulate mathematical thinking activities. Mathematical metacognition includes three main dimensions: mathematical metacognitive knowledge, mathematical metacognitive experience, and mathematical metacognitive monitoring. Among them, mathematical metacognition knowledge contains three sub-dimensions: knowledge about individuals, knowledge about tasks, and knowledge about strategies. The dimension of mathematical metacognition experience includes two sub-dimensions: cognitive

experience and emotional experience. The monitoring dimension of mathematical metacognition specifically includes five sub-dimensions: orientation and planning, organization and management, monitoring and adjustment, feedback and inspection, reflection and evaluation. This paper analyzes the status quo and difference of the three main dimensions. Mathematical metacognition plays an important role in mathematics learning activities, and good mathematical metacognition has a certain impact on the improvement of mathematical academic performance, mathematical learning efficiency and mathematical problem-solving ability [6].

Through literature review [7-12], it was found that current research on mathematical metacognition is mainly focused on primary and secondary school students, and there is relatively little research on college students, especially mathematical normal students. This article will conduct a survey on mathematical metacognition among mathematics normal students in local colleges and universities, explore the current situation and gender differences in mathematical metacognition among mathematics normal students in Qinghai Province, in order to further enrich the research content of mathematical normal students' mathematical metacognition.

2. Research Design

2.1. Research Object

This article takes mathematics normal students from freshmen to seniors in universities in Qinghai Province as the survey subjects. A total of 520 questionnaires were distributed. After statistical analysis and organization of the questionnaires, 470 valid questionnaires were obtained, including 112 in freshmen, 114 in sophomores, 124 in juniors, and 120 in seniors. The sample validity rate was 90.38%.

2.2. Research Tool

Based on the research results of Professor Guangming Wang [3-4] and his team, the “Questionnaire on Mathematical metacognition of Mathematics normal students in local universities” was modified and compiled according to the reality and actual situation of local students. The questionnaire includes 38 test questions of three main dimensions and ten sub-dimensions of mathematical metacognition. Likert five-point scoring method is adopted to allow students to judge according to their own answers. The higher the score, the higher the level of mathematical metacognition.

2.3. Research Process

SPSS 26.0 is the software used to process the questionnaire data. Through analysis, the reliability and validity of the “Questionnaire on Mathematical metacognition of Mathematics normal students in local universities” are 0.8943 and 0.8792, indicating that the questionnaire has high consistency, stability and reliability, and the results obtained from the survey are consistent with the investigation content. The measurement of mathematical metacognition of mathematics normal students has good reliability and validity.

3. Data Analysis

3.1. Analysis of the Current Situation of Mathematical Metacognition

3.1.1. Analysis of the Current Situation of Mathematical Metacognition and Dimensions

By organizing 470 valid questionnaires, the descriptive statistical results of mathematical

metacognition and dimensions of mathematics normal students in local universities are shown in Table 1.

Table 1: Descriptive statistics on mathematical metacognition and dimensions of mathematics normal students

mathematical metacognition and dimensions	sum	minimum	maximum	mean	standard error	standard deviation
mathematical metacognition	470	2.1579	4.8947	3.3553	0.0208	0.4558
mathematical metacognitive knowledge	470	1.9091	4.6364	3.4159	0.0224	0.4898
mathematical metacognitive experience	470	2.0001	4.9999	3.3651	0.0241	0.5254
mathematical metacognitive monitoring	470	2.1053	4.9998	3.3161	0.0229	0.4999

From Table 1, it can be seen that the average score of mathematical metacognition is 3.3553, indicating that the mathematical metacognition of mathematics normal students is at a moderate level. In terms of each dimension, the order from high to low is: mathematical metacognitive knowledge dimension, mathematical metacognitive experience dimension, and mathematical metacognitive monitoring dimension. The average scores of the three dimensions are also at a moderate level.

3.1.2. Analysis of the Current Situation of Mathematical Metacognition and Dimensions among Mathematics Normal Students of Different Grades

The descriptive statistical results of mathematical metacognition and dimensions for mathematics normal students of different grades are shown in Table 2.

Table 2: Descriptive statistics on mathematical metacognition and dimensions of mathematics normal students of different grades

mathematical metacognition and dimensions	grade	sum	mean	standard deviation	standard error
mathematical metacognition	freshman	112	3.3079	0.5386	0.0505
	sophomore	114	3.4519	0.4847	0.0451
	junior	124	3.2918	0.3854	0.0343
	senior	120	3.3732	0.3947	0.0357
mathematical metacognitive knowledge	freshman	112	3.3445	0.5335	0.0501
	sophomore	114	3.4624	0.5118	0.0475
	junior	124	3.3961	0.4235	0.0377
	senior	120	3.4593	0.4863	0.0442
mathematical metacognitive experience	freshman	112	3.2807	0.5909	0.0553
	sophomore	114	3.5065	0.5083	0.0472
	junior	124	3.3413	0.4545	0.0405
	senior	120	3.3342	0.5251	0.0475
mathematical metacognitive monitoring	freshman	112	3.2982	0.5806	0.0544
	sophomore	114	3.4229	0.5332	0.0495
	junior	124	3.2105	0.4491	0.0401
	senior	120	3.3399	0.4107	0.0372

From Table 2, it can be seen that the average scores of mathematical metacognition, mathematical metacognition knowledge dimension, mathematical metacognition experience dimension, and mathematical metacognition monitoring dimension for four grades of mathematical normal students

are within the range of 3.2 to 3.7. This indicates that mathematical normal students generally have a good grasp of mathematical metacognition and dimensions, and most of them have certain mathematical metacognition knowledge.

3.1.3. Analysis of the Current Situation of Mathematical Metacognition and Dimensions among Mathematics Normal Students of Different Genders

The descriptive statistical results of mathematical metacognition and dimensions for mathematics normal students of different genders are shown in Table 3.

Table 3: Descriptive statistics on mathematical metacognition and dimensions of mathematics normal students of different genders

mathematical metacognition and dimensions	gender	sum	mean	standard deviation	standard error
mathematical metacognition	boy	227	3.3735	0.4683	0.0308
	girl	243	3.3382	0.4441	0.0283
mathematical metacognitive knowledge	boy	227	3.4360	0.5166	0.0341
	girl	243	3.3971	0.4635	0.0295
mathematical metacognitive experience	boy	227	3.3977	0.5214	0.0343
	girl	243	3.3345	0.5283	0.0336
mathematical metacognitive monitoring	boy	227	3.3272	0.5141	0.0338
	girl	243	3.3056	0.4871	0.0311

From Table 3, it can be seen that the average scores of boys in mathematical metacognition and dimensions are higher than the average scores of girls. This indicates that after the mental development of boys and girls is relatively stable in college, boys have a relatively stronger grasp of cognitive activities than girls.

3.2. Analysis of Differences in Mathematical Metacognition

3.2.1. Analysis of Grade Differences in Mathematical Metacognition

Table 4 shows the results of one-way ANOVA using grade as the factor and mathematical metacognition and dimensions as the dependent variables for mathematics normal students.

Table 4: Analysis of grade differences in mathematics metacognition and dimensions among mathematics normal students

mathematical metacognition and dimensions	statistic	sum of squares	df	mean square	F	significance P-value
mathematical metacognition	inter group	1.8859	3	0.6294	3.0654	0.0283
	within group	97.2123	466	0.2053		
	total	99.0982	469			
mathematical metacognitive knowledge	inter group	1.1082	3	0.3691	1.5446	0.2019
	within group	113.3116	466	0.2394		
	total	114.4201	469			
mathematical metacognitive experience	inter group	3.3119	3	1.1073	4.0862	0.0073
	within group	128.3521	466	0.2714		
	total	131.6722	469			
mathematical metacognitive monitoring	inter group	2.8323	3	0.9444	3.8453	0.0096
	within group	116.3863	466	0.2462		
	total	119.2191	469			

From Table 4, it can be seen that the significance levels Sig. values of mathematical metacognition,

mathematical metacognitive experience dimension, and mathematical metacognitive monitoring dimension between grades are 0.0283, 0.0073, and 0.0096, respectively, all lower than 0.05, indicating significant differences between grades in mathematical metacognition, mathematical metacognitive experience dimension, and mathematical metacognitive monitoring dimension; the significance level Sig. value of grade on the dimension of mathematical metacognitive knowledge is 0.2019, which is greater than 0.05, indicating that there is no significant difference in the dimension of mathematical metacognitive knowledge between grades.

3.2.2. Analysis of Gender Differences in Mathematical Metacognition

The independent sample T-test results of male and female mathematical metacognition and dimensions are shown in Table 5.

Table 5: Independent sample T-test on mathematical metacognition and dimensions of male and female students

mathematical metacognition and dimensions	hypothesis	Levene test for variance equation		T-test of the mean equation			
		F	Sig.	t	Sig (bilateral)	mean difference	Standard deviation error value
mathematical metacognition	assuming equal variance	0.0831	0.7733	0.8479	0.3969	0.0354	0.0417
	assuming unequal variances			0.8464	0.3978	0.0354	0.0418
mathematical metacognitive knowledge	assuming equal variance	0.3961	0.5294	0.868	0.3858	0.0389	0.0448
	assuming unequal variances			0.8648	0.3876	0.0389	0.045
mathematical metacognitive experience	assuming equal variance	0.334	0.5636	1.3155	0.1890	0.0632	0.0481
	assuming unequal variances			1.3161	0.1888	0.0632	0.048
mathematical metacognitive monitoring	assuming equal variance	0.0009	0.9762	0.4721	0.6371	0.0216	0.0458
	assuming unequal variances			0.4712	0.6377	0.0216	0.0459

From Table 5, it can be seen that the P-values corresponding to mathematical metacognition and dimensions under the Levene test are 0.7733, 0.5294, 0.5636, and 0.9762, respectively, which are greater than 0.05. Therefore, the results of the T-test should be based on the data in the "assuming equal variance" row. The results showed that the corresponding P-values of mathematical metacognition and dimensions under T-test were 0.3969, 0.3958, 0.1890, and 0.6371, respectively, which were higher than 0.05, indicating that there was no significant gender difference in mathematical metacognition and dimensions among mathematics normal students.

4. Research Conclusion

From the investigation of the research subjects and the analysis of research data, the following preliminary results can be obtained:

(1): The overall level of mathematical metacognition among mathematics normal students in

Qinghai Province is at a moderate level. Through descriptive statistical analysis of mathematical metacognition and its three dimensions, it was found that students scored higher in mathematical metacognition and its dimensions, indicating that mathematics normal school students in Qinghai Province performed better in mathematical metacognition and its dimensions, with the best performing being in the knowledge dimension of mathematical metacognition.

(2): By analyzing the differences in mathematical metacognition and dimensions by grade, it was found that there were significant differences in mathematical metacognition, mathematical metacognitive experience dimension, and mathematical metacognitive monitoring dimension among different grades, while there was no significant difference in mathematical metacognitive knowledge dimension between grades.

(3): The difference analysis of mathematical metacognition and dimension is carried out according to gender, and the conclusion is drawn: the difference of male and female in mathematical metacognition and dimension is not obvious, but the result of descriptive statistical analysis shows that the average score of male in mathematical metacognition and dimension is slightly higher than that of female.

5. Discussion

The conclusions of this paper provide some ideas for us to further understand the grasp of mathematics metacognition of mathematics normal students. At the same time, relevant research on mathematics metacognition in the teaching process is helpful to cultivate the learning ability of mathematics normal students, stimulate the autonomy and initiative of mathematics learning, enable them to learn and improve learning efficiency. So as to promote the overall improvement of mathematics core literacy.

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