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The Influence of Constructivist Classroom Environment on High School Students' Mathematics Grades: The Mediating Role of Learning Motivation

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ABSTRACT

Constructivist classroom environment scale, mathematics learning motivation scale and mathematics grades were used to investigate 319 students from a high school in a city of Jilin province. The results show that: (1) There is a significant positive correlation between the four dimensions of constructivist classroom environment, such as personal relativity, collaboration, teacher's support and task orientation, and the constructivist classroom environment can significantly predict mathematics grades. (2) Learning motivation plays an intermediary role between constructivist classroom environment and mathematics grades, and the intermediary role of each path is different.

KEYWORDS

Constructivist Classroom Environment; Mathematics Grades; Learning Motivation.

1. INTRODUCTION

In 2019, the Ministry of Education of the people's Republic of China issued the opinions of the CPC Central Committee and the State Council on deepening Education and Teaching Reform and comprehensively improving the quality of compulsory Education and the guidance of the General Office of the State Council on promoting the Reform of Educational methods in ordinary Senior High Schools in the New era. "strengthen the role of the classroom as the main position, earnestly improve the quality of classroom teaching" and "optimize curriculum implementation" General high school education is an important part of the national education system, which plays a key role in personnel training. Running ordinary high school education well is of great significance to consolidate the popularization and achievements of compulsory education, enhance the staying power of the development of higher education and further improve the overall quality of the people.

The classroom is the main place for students to learn, and the classroom environment is an important variable that affects learning. According to the subjective meaning theory of social construction, each student takes his own experience as the background, combines the students' past life experience, and constructs their own cognitive understanding of the classroom environment and knowledge according to their interaction with teachers and classmates [1]. Cognitive psychology also believes that new knowledge requires learners to construct themselves, learners do not simply store new knowledge in the brain, but must establish a relationship between new knowledge and their own experience, this process is the essence of learning [2]. As far as mathematics is concerned, mathematics learning is based on past experience and cooperation with classmates to construct mathematical knowledge in various situations created by teachers. Therefore, it is very important to create a good classroom

environment for students. Constructivist classroom environment helps to promote individual knowledge construction, social interaction, negotiation, conversation and other classroom activities, and promote students' meaning construction of new knowledge. The research on the current high school students' perception of constructivist mathematics classroom environment and the relationship between learning motivation and academic achievement has a certain reference significance for how to improve the weak aspects of classroom environment and improve students' mathematics grades. And it can promote the improvement of classroom teaching quality and the development of students' mathematics learning.

2. LITERATURE REVIEW

2.1. Learning Motivation and Mathematics Grades

Learning motivation is an internal process or internal psychological state, which urges individuals to participate in learning activities, maintain the status quo of ongoing learning activities, and further guide students' behavior towards specific learning goals. Mathematics learning motivation is the sum total of learners' needs, interests, motivation and other internal factors in the process of mathematics learning, which enables students to coordinate internal mathematics learning needs with external mathematics learning stimuli, forming a driving force and maintaining their own mathematical learning behavior, which is a key factor in gaining a sense of satisfaction and achievement in mathematical learning.

Most scholars have found that There is a positive correlation between learning motivation and academic achievement. Liang Haocui believes that students with good grades tend to have a higher motivation for learning mathematics, while poor students are relatively low. The achievement level and motivation level of students are positively correlated, and students with high achievement levels will also have relatively higher motivation levels [3]. Zuo Bin makes an investigation on the learning motivation of primary and secondary school students, and the results show that there is a very significant positive correlation between their learning motivation and their achievement. Amrai, Zalani and Arfai also found that there was a significant positive correlation between learning motivation and academic achievement, suggesting that students' learning motivation plays a key role in promoting their academic achievement. Students' learning motivation can directly affect their academic achievement [4], and the influence of students' internal motivation on academic achievement is greater than external motivation [5]. Therefore, in mathematics teaching, teachers should pay attention to the role of non-intellectual factors and pay attention to students' learning motivation in order to improve students' learning efficiency and achievement. However, some scholars believe that the relationship between motivation strength and learning efficiency will be affected by the level of task difficulty. Yerkes and Dodson found that when the task difficulty is low, the higher motivation level can improve the learning efficiency, while when the task difficulty increases, the high motivation level will have a negative effect and reduce the learning efficiency. When the intensity of learning motivation is lower than the optimal level, students may feel bored or have no interest, resulting in a decline in learning efficiency. Therefore, students need to appropriately adjust the intensity of learning motivation according to the difficulty of the task and their own ability level, in order to obtain the best learning effect.

2.2. Constructivist Classroom Environment and Learning Motivation

Constructivist classroom is different from the traditional teacher-centered learning environment, it is a student-centered classroom environment where students cooperate in the construction of knowledge. Teachers promote students to achieve their learning goals, and knowledge construction has the characteristics of situation, interaction, induction and cooperation[6].

Most scholars believe that students' perception of constructivist classroom environment is related to learning motivation and learning performance. When students get the opportunity to receive education in their favorite learning environment, their learning interest and achievement will be significantly improved. The classroom environment is also related to students' academic efficacy, and the "student-centered" classroom environment is conducive to the improvement of students' learning motivation and academic achievement[7]. Ding Rui, Huang Yiying, Lin Zhizhong and Ma Yunpeng divided the primary school mathematics classroom environment into different types, and found that in different types of mathematics classroom environment, there are significant differences in students' mathematics learning attitude, mathematics learning orientation and students' learning view. The characteristics of English classroom environment perceived by senior high school students also have a significant impact on students' English learning attitude and achievement [8]. In addition, teachers' teaching methods, the difficulty level of teaching content, teachers' concern and support for students and other factors will also affect students' mathematics learning motivation [9]. Shernoff, Kelly, Tonks, Anderson, Cavanagh, Sinha and Abdi take senior high school students as subjects, and the quality of classroom learning environment is measured by environmental support and environmental challenges (complexity of learning environment). It is considered that the complexity of learning environment can significantly positively predict students' learning input, in which environmental support can significantly positively predict students' input, and environmental challenges can significantly positively predict students' academic intensity. Based on the social ecology theory of Bronfenbrenner, Watt, Carmichael and Callingham divided students' input in mathematics learning into three types: input type, obedience type and non-input type, and found that different input types have no significant difference in the classroom environment of perceived achievement orientation, but students' perception of the goal structure of mastery orientation in mathematics classroom environment has an important impact on their mathematics learning input.

According to the above research, this study holds that there may be a positive correlation between constructivist classroom environment and mathematics grades of high school students; there may be a positive correlation between constructivist classroom environment and learning motivation; there may be a positive correlation between learning motivation and mathematics grades of high school students; learning motivation can play an mediating role in the relationship between constructivist classroom environment and mathematics grades. Based on the above analysis, this study explores the influence of constructivist mathematics classroom environment on high school students' mathematics performance through a questionnaire survey, and further explores the mediating role of learning motivation between the two to provide guidance for mathematics teachers to effectively improve classroom teaching quality and optimize teaching methods.

3. METHOD

3.1. Subjects

Table 1. quantifying the object of study

Valid sample	sexuality		grade			total
	boy	girl	one	two	three	
Number of people	138	181	80	128	111	319
percentage (%)	43.26	56.74	25.08	40.13	34.8	100

Students from a senior high school in a city of Jilin Province were selected by random sampling, 345 questionnaires were collected and unreasonable samples were removed. The final valid samples were 138 boys, 181 girls, 80 senior one students, 128 senior two school students and 111 senior three

students. And all the measurements were completed within one month, and the composition of the quantitative study is shown in Table 1.

3.2. Research Tools

Constructivist Classroom Environment Scale: based on the characteristics of mathematics in China and the teaching reality of Jilin Province, the Constructivist Classroom Environment Scale (Secondary Chemistry Constructivist Learning Environment Survey, SCCLES) compiled by Ding Yun and Qin Chunsheng was adapted or adjusted, and the constructivist mathematics classroom environment questionnaire was obtained. It includes five dimensions: task orientation, personal reletivity, collaboration, teacher's support and student voice, a total of 22 items, using the Likert five-level score, "never like this", "rarely like this", "sometimes like this", "often like this" and "always like this" score 1 to 5 respectively.

Mathematics Learning Motivation Scale: using the high school mathematics learning motivation scale compiled by Wang Guangming et al in 2015 on the basis of his predecessors, focusing on the uneven number of items and the large number of questions in the whole research questionnaire, this study cut and retouched the items to get the mathematics learning motivation scale, including three dimensions: cognitive motivation, external motivation and achievement needs, a total of 14 items. The Likert five-level scoring method was used to score 1 to 5 points from "very non-conforming", "non-conforming" to "general" and "very consistent" respectively.

Mathematics grades: select the final math test results of the second semester of the 2023-2024 academic year (full score of 150 points).

3.3. Reliability and Validity Test

The measured results show that the internal consistency reliability (α coefficient) of each dimension of the scale is greater than 0.7, indicating that the whole scale has a certain reliability. The confirmatory factor analysis results of the scale are shown in Table 2, the chi-square degree of freedom ratio is less than 3, the absolute fitness index RMSEA is less than 0.08, and other indexes also meet the requirements of the fitness model, indicating that the model has a good fitness, and the structural validity of the scale is acceptable. In addition, the factor load of each item of the scale is greater than 0.6 and is significant, indicating that each item can better reflect the measured factors.

Table 2. confirmatory factor analysis model indicators (N=319)

Fitting index	CMIN/DF	GFI	AGFI	RMSEA	NFI	IFI	TLI	CFI	PNFI	PCFI
Actual value	1.243	0.894	0.876	0.028	0.907	0.98	0.978	0.98	0.815	0.881

3.4. Data Processing

Use SPSS25.0 and Amos23.0 software to count and analyze the collected data. Correlation analysis, structural equation model and intermediary effect are used to explore the relationship between constructivist classroom environment, learning motivation and mathematics grades of senior high school students.

4. RESEARCH RESULTS

4.1. The Correlation between Constructivism Classroom Environment, Learning Motivation and Mathematics Grades of Senior High School Students

In order to explore the relationship between constructivist mathematics classroom environment, learning motivation and senior high school students' mathematics performance, taking students' voice, task orientation, teacher's support, collaboration, personal relativity dimensions, learning motivation and mathematics grades as variables, correlation analysis is used, and the results are detailed in Table 3.

The correlation coefficients R among students' voice, personal relativity, collaboration, teacher's support, task orientation and learning motivation are 0.332, 0.599, 0.583, 0.603 and 0.542 respectively. It means that there is a significant positive correlation between students' voice, personal relativity, collaboration, teacher's support, task orientation and learning motivation. The correlation coefficients R between students' voice, personal relativity, collaboration, teacher's support, task orientation and mathematics grades are 0.435, 0.705, 0.673, 0.711 and 0.645 respectively. It means that there is a significant positive correlation between students' voice, personal relativity, collaboration, teacher's support, task orientation and mathematics grades. There is also a significant relationship between learning motivation and mathematics grades, and the correlation value R is 0.73, indicating that there is a positive correlation between learning motivation and mathematics grades.

Table 3. correlation analysis table

	students' voice	personal relativity	collaboration	teacher's support	task orientation	learning motivation	mathematics grades
students' voice	1						
personal relativity	0.32**	1					
collaboration	0.354**	0.485**	1				
teacher's support	0.36**	0.614**	0.501**	1			
task orientation	0.317**	0.483**	0.457**	0.476**	1		
learning motivation	0.332**	0.599**	0.583**	0.603**	0.542**	1	
mathematics grades	0.435**	0.705**	0.673**	0.711**	0.645**	0.73**	1

4.2. Structural Equation Model Analysis

Amos23.0 constructs the structural equation model and analyzes the factors that affect the constructivist mathematics classroom environment, the relationship between learning motivation and mathematics grades. The structural equation model diagram is shown in figure 1, and the fitting index of the model is shown in Table 4.

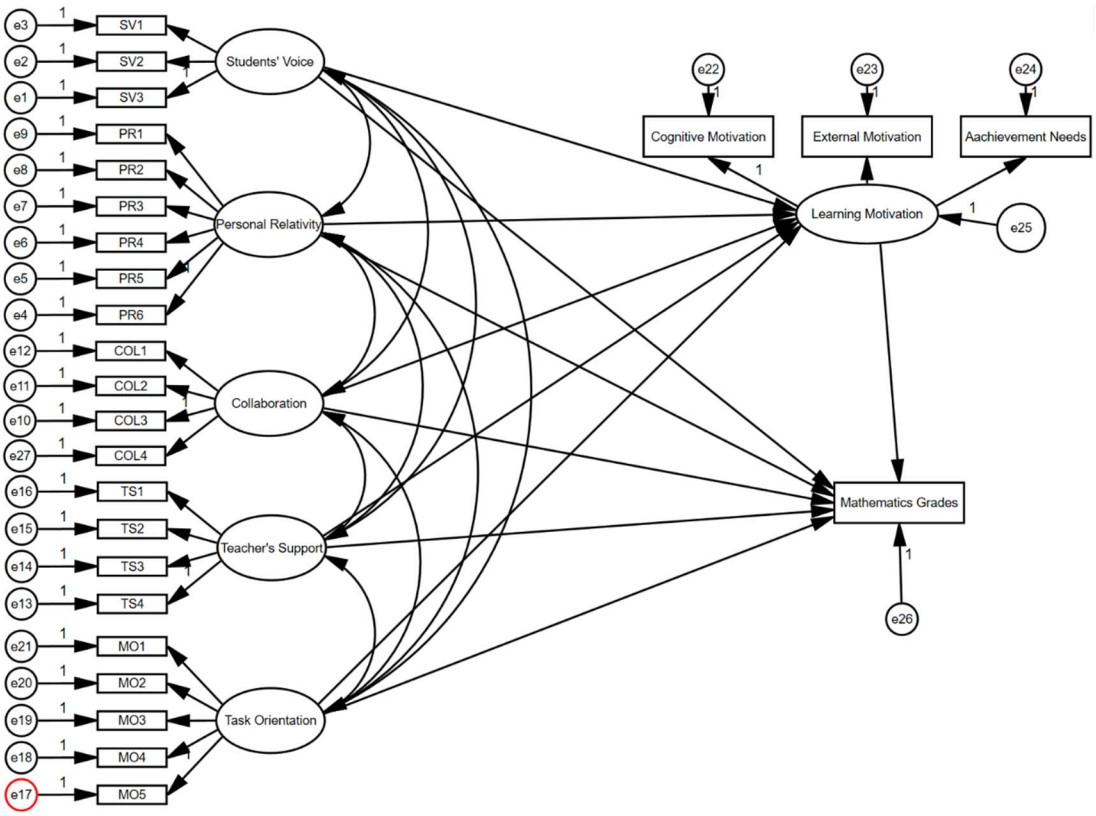

Fig. 1 structural equation model

Table 4. fitting index of theoretical model (N=319)

Fitting index	CMIN/DF	GFI	AGFI	RMSEA	NFI	IFI	TLI	CFI	PNFI	PCFI
Actual value	1.393	0.917	0.896	0.035	0.926	0.978	0.974	0.978	0.795	0.839

The results showed that the CMIN/DF was 1.393, less than 3, and the AGFI was greater than 0.8. The RMSEA was 0.035. The relative fitting indices such as NFI and IFI are all more than 0.8, indicating that the model fits well. Both PNFI and PCFI are greater than 0.5, indicating that the model has a good degree of fit while keeping simplicity.

According to the research model, firstly, personal relativity, collaboration, teacher's support and task orientation play a significant positive role in predicting learning motivation. In the classroom, teachers connect mathematics knowledge more closely with students' daily life, and students can use what they have learned to solve practical problems, the stronger their learning motivation; the more cooperative learning between students, their negative emotions towards mathematics learning will be reduced, and their interest in mathematics learning will be enhanced. The higher the degree of teachers to help, care, trust and love students, the more serious students can learn mathematics, the stronger their sense of self-efficacy, and then enhance their self-confidence to succeed in the field of mathematics; the higher the score of students' task orientation, the higher their importance and understanding of mathematics, and the higher their belief in mathematics learning. However, the influence of students' voice on learning motivation is not significant, which may mean that students' participation or expression of opinions has no direct impact on their learning motivation, or this influence may be disturbed by other factors. Secondly, the four dimensions of personal relativity, collaboration, teacher's support and task orientation play a significant positive role in predicting mathematics performance. Students' personal interests and related experiences can improve their mathematics grades to a certain extent, and personal related factors will affect students' ability to

understand and apply mathematics; cooperative learning will promote knowledge sharing and mutual help among students, so as to improve their mathematics grades. Teachers' support can effectively improve students' mathematics performance, teachers' guidance, feedback and resource support have a positive effect on students' academic performance; focus on learning tasks and goal setting help to improve students' performance in mathematics. However, the direct influence of students' voice on mathematics performance is not significant, which may be due to the limited effect of students' participation and expression on the direct improvement of mathematics performance. Last, learning motivation has a significant positive predictive effect on mathematics performance. The improvement of learning motivation significantly improves students' mathematics performance, which reflects the importance of students' learning motivation in mathematics.

4.3. Test of Mediating Effect of Learning Motivation

Table 5. intermediary test

	Parameter	Estimate	Lower	Upper	P	Hypothesis test results
“Students' voice"→learning motivation→"mathematics grades"	direct effect	0.063	-0.018	0.14	0.115	Refuse
	indirect effect	0.006	-0.049	0.083	0.773	
	total effect	0.069	0.004	0.139	0.039	
"personal relativity"→learning motivation→"mathematics grades"	direct effect	0.156	0.029	0.266	0.032	Support
	indirect effect	0.093	0.022	0.244	0.005	
	total effect	0.249	0.155	0.342	0	
" collaboration "→learning motivation→"mathematics grades"	direct effect	0.149	-0.023	0.264	0.07	Support
	indirect effect	0.129	0.049	0.306	0.001	
	total effect	0.278	0.186	0.355	0.001	
"teacher’s support"→learning motivation→"mathematics grades"	direct effect	0.167	0.008	0.282	0.044	Support
	indirect effect	0.113	0.035	0.291	0.001	
	total effect	0.28	0.18	0.377	0	
"task orientation"→learning motivation→"mathematics grades"	direct effect	0.144	0.013	0.236	0.041	Support
	indirect effect	0.089	0.029	0.227	0.003	
	total effect	0.234	0.157	0.305	0	

According to the analysis of the intermediary effect, from the perspective of the path "students' voice"→learning motivation→"mathematics performance", the direct effect of students' voice on mathematics performance (Estimate=0.063,95%CI [- 0.018] 0.14, Prun0.115) does not reach the significant level of statistics. Similarly, there was no significant difference in the interactive effect of learning machine (Estimate=0.006,95%CI [- 0.049, 0.773). Therefore, the mediating effect of students' voice on mathematics performance is not significant. From the perspective of path "personal relativity"→learning motivation→"mathematics grades", path "teacher’s support"→learning motivation→"mathematics grades" and path "task orientation"→learning motivation→"mathematics grades", the direct effects of personal relativity, teacher’s support and task orientation on mathematics

grades (Estimate=0.156,95%CI [0.029d0.266], Prun0.032; Estimate=0.167,95%CI [0.008d0.282], Prun0.044). Estimate=0.144,95%CI is significant, and so are the indirect effects of learning motivation (Estimate=0.093,95%CI, 0.022, 0.005; Estimate=0.113,95%CI, 0.035, 0.291; Estimate=0.089,95%CI, 0.029, 0.227, 0.003). Therefore, the total effects of personal relativity, teacher's support and task orientation on logarithmic achievement were highly significant (Estimate=0.249,95%CI [0.155, 0.342), Estimate=0.28,95%CI [0.18, 0.377], Estimate=0.234,95%CI [0.157, 0.305], respectively. This shows that personal relativity, teacher's support and task orientation have a significant impact on mathematics performance, including both direct effects and learning motivation. From the perspective of the path " collaboration "→learning motivation→"mathematics grades", the direct effect of cooperation on mathematics grades is not significant (Estimate=0.149,95%CI [- 0.0230.264], Prun0.07), but it is significant through the indirect effect of learning motivation (Estimate=0.129,95%CI [0.049meme0.306], Prun0.001). The total effect of collaboration on mathematics grades (Estimate=0.278,95%CI [0.186, 0.355], Prun001) also reaches the level of statistical significance. It shows that the influence of collaboration is reflected in that it plays an important role by enhancing learning motivation.

5. CONCLUSION

This study examines the relationship between constructivist classroom environment, learning motivation and mathematical grades, and finds that constructivist classroom environment can significantly predict mathematical performance in four dimensions (personal relevance, cooperation, teacher's support and task orientation). And learning motivation plays an intermediary role between constructivist classroom environment and mathematical achievement. This result has important implications for mathematics teaching in senior high school, indicating that constructivist classroom environment plays a positive role in promoting students' academic achievement. The integration of middle school mathematics teaching and life situation should be strengthened, and students' life experience should be used as a support in mathematics teaching to reduce students' learning difficulty and promote the cultivation of life-related mathematical literacy. Teachers can cultivate students' thinking habits of thinking independently and daring to question, so as to better help students establish clear learning goals, learn to use their mathematical knowledge to solve problems in life, and then improve the efficiency of self-learning. Teachers can also pay attention to the positive influence of classroom environment on learning motivation and academic achievement can also help teachers to reflect on teaching according to students' awareness of classroom environment and further understand the individual differences in non-intellectual factors such as interest and attitude. Formulating personalized teaching strategies to improve the effectiveness of classroom teaching is as well as a key point.

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