The Correlation Study of Mathematics Self-Concept and Learning Strategies of Junior High School: Based on the Analysis of Compound Multiple Mediation Effect based on the Analysis of Compound Multiple Mediation Effect

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Introduction

Since the 21st century, educators have realized the essential role of mathematics in the education of teenagers. Government and many of them have made great efforts to improve students' abilities to solve mathematics problems, but many students in secondary school still feel stressful and fearful because of their poor mathematics grades. Many mathematics scholars blame to the mathematics itself, like mathematical symbols and special language, which they think cannot be well-acquired by less talented mathematics learners. When the mathematics problems become complicated, some students will lose confidence, interest and finally the motivation to learn.

As the "ruler" of the learning effects, professional tests like TIMSS and PISA have been designed and promoted, hoping to evaluate and improve the mathematics education in different countries or areas. For example, some scholars have used TIMSS as the analytical tool to compare mathematics and science subjects from the perspectives of curriculum, school's teaching systems, and relationship between students' grades and their attitudes, whose results show that the mathematics terms, symbols and sentences have effect on students' mathematics grades to some extent (Robitaille, Taylor & Orpwood, 1996). However, the key factors are their attitude, faith, self-efficacy and learning experience that distinctly influence their study efficiency (Papanastasiou, 2000). Some scholars have provided convincing evidence to support the hypothesis that cognition and motivation can affect students' mathematics learning achievement directly or indirectly. Moreover, this research also reveals how these factors function to affect students' mathematics learning methods and academic achievements (Muis, 2004).

In a word, the mathematics educators have worked a lot on the relationship of students' psychological factors and mathematics learning. After reviewing the literate, we found that the teaching method, learning materials, students' different cognitive mode, mathematics learning strategies, mathematics self-concept, mathematics learning motivation, efficacy and other related variables have been studied as a key factor, but the researchers mainly focused on one factor each time (Robitaille, Taylor &Orpwood, 1996; Papanastasiou, 2000; Muis, 2004). Therefore, this study takes mathematics self-concept, self-efficacy and learning motivation together to identify their structural relations with learning strategies, to test and integrate nine hypotheses among them, especially to explore the mediation effect in the model of the self-efficacy and learning motivation, which we hope can provide some inspirations to improve mathematics education and study.

Theoretical Background and Hypotheses

The relationship between self-concept and learning motivation

An individual's self-concept means someone observes and evaluates his own ability (including cognitive ability, athletic ability, and interpersonal skills and so on) (Harter & Connell, 1984). Houston defines learning motivation as the key factor that pushes people to learn (Houston, 2013). Guthega's research shows that the students' mathematics self-concept (MSC) and mathematics learning motivation (MLM) have linear relationship. The students' MSC explains 63.0% mathematics learning motivation variance (Githua&Mwangi, 2003). Hemke's similar research in high-grade primary school in Germany, reveals that there is a relationship between pupils MSC and their mathematics learning achievements and motivation (Helmke, 1990). Heckhausen thinks students' attitudes towards their achievement and the family background are the key factors. His research also confirms that the change of MSC can affect students' academic grade and learning motivation (Heckhausen, 1998). Therefore, we promote our first hypothesis that mathematics self-concept (MSC or SC) positively affects mathematics learning motivation (MLM or LM) (Hypothesis 1).

The relationship between self-concept and self-efficacy

Bandura (1977) states that self-efficacy is the self-evaluation for someone's operation ability in a certain field. Ferla and others confirm that students' academic self-concept will strongly affect their academic self-efficacy (shown in Fig. 1). In their study, self-concept is believed as a rather complex structure which adds cognition and feelings to the self and is strongly influenced by the social comparison. However, self-efficacy is based on the cognitional judgment of someone's mastery criterion (Ferla, Valcke&Cai, 2009). Lopez and Lent (1992) research indicates that mathematics self-efficacy (MSE) has the significant correlations with normal learning self-concept and practical mathematics course score, and that the academic self-concept's prediction to one's self-efficacy can be interfered by the mathematics learning experience. Some Chinese scholars suppose self-concept and self-efficacy have positive statistical on the level of significance (Lu, Tang, Xie, Deng & Liu, 2015). Therefore, we suppose the second hypothesis: mathematics self-concept (MSC or SC) positively affects mathematics self-efficacy (MSE or SE) (Hypothesis 2).

The relationship between learning motivation and self-efficacy

Zimmerman and his partners' study has shown that students' self-efficacy has significant influence on learning strategy regulation when they motivate themselves and there are obvious causation among self-regulated learning efficacy, academic achievement efficacy and academic achievement. Students who think himself or herself to be more capable of adjusting their activities always have more confidence in mastering the subject and get higher scores (Zimmerman, Bandura & Martinez-Pons, 1992). Some scholars confirm that self-efficacy is the mediating variable as learning motivation affects learning strategies (Peng, Pan, Wang, 2008). Ausubel (Kong, 2015) believes that achievement motivation is students' main learning motivation and academic self-efficacy plays the role of complete mediation in achievement motivation and learning grades. An empirical study also shows students' mathematics learning motivation affect their mathematics grades through self-efficacy as mediation (Liu, 2014). Therefore, the third hypothesis of our research is that mathematics learning motivation(MLM or LM) positively affects mathematics self-efficacy(MSE or SE) (Hypothesis 3).

The relationship between learning motivation and learning strategies

Sternberg (1983) believes that learning strategy is the combination of learners' learning monitoring and learning methods and it consists of the executive and non-executive skills. Ames and Archer have found that students with clear achievement goal in class tend to use effective learning strategies, to choose the challenging tasks, to be more positive in class performance and to believe firmly that they will succeed if trying their best (Ames & Archer, 1988). After investigating 283 high-school students' using of achievement motivation (capability perception, expectation and perceptive value) and learning strategies (meta-cognition, general cognition, and special geometry and effort), and analyzing the relationship between usage and achievement, Pokay and Blumenfeld have discovered that at the beginning of the term, both expectations and values forecast the use of learning strategies; while in the end, they use learning strategies to forecast the perceptive value (Pokay&Blumenfeld, 1990). Elliot and other scholars find that achievement goals can predict achievement strategies and proves their theory that learning strategies became the predictor between achievement goals and learning grades in the well-classified college classes (Elliot, McGregor & Gable, 1999). Therefore, we suppose the hypothesis that mathematics learning motivation (MLM or LM) affects mathematics learning strategies (MLS or LS) positively (Hypothesis 4).

The relationship between self-efficacy and learning strategies

Some scholars conducted empirical research and found that the predictability of self-efficacy is high in the usage of learning strategies (Wang &Liu, 2000). Zimmerman and other scholars suppose that students' language and mathematical efficacy is significantly related to strategy using. Students' efforts of strategic adjustment are related to their higher self-awareness of mathematics and language efficacy. According to the regression analysis, they also find that languages and mathematics efficacy will forecast students' strategy using in self-regulation separately (Zimmerman & Martinez-Pons, 1990).

Some scholars think learning self-efficacy has positive prediction on learning strategies, like distance learners' learning efficacy (Peng et al., 2008). Moreover, there is a further study reveals that the teacher-student relationship not only affects self-efficacy and autonomous learning strategies directly, but also affects autonomous learning strategies through the self-efficacy indirectly (Shan, 2012). Therefore, we suppose the hypothesis that mathematics self-efficacy (MSE or SE) positively affects mathematics learning strategies (MLS or LS) (Hypothesis 5).

The relationship between self-concept and learning strategies

After evaluating students' academic self-concept, results expectation and the two's effect to learning strategies through test model, Rodriguez has discovered that academic self-concept and expectation affect students' choice of learning methods of commercial education (Rodriguez, 2009). McInerney and his teammates also raise and prove a hypothesis that self-concept has significant influence on learning strategies by a survey of 8,354 students from 16 middle schools in Hong Kong on mathematics and English learning (McInerney, Cheng &Mok, 2012). In addition, there is a study shows that academic self-concept has a direct influence on students' academic achievements, goal orientation and efforts. Furthermore, they also find that efforts and learning strategies have mediate effect between academic goals and the final achievements, and academic self-concept indirectly affects students' learning strategies and academic achievements through efforts (Pérez, Costa &Corbí, 2012). Therefore, we suppose a hypothesis: mathematics self-concept (MSC) positively affects mathematics learning strategies (MLS) (Hypothesis 6).

The mediated effect of learning motivation and self-efficacy between self-concept and learning strategies

From the six hypotheses above, we can achieve three conclusions: self-concept affects learning motivations and self-efficacy; learning motivation and self-efficacy both affect learning strategies; and learning motivation affects self-efficacy. Therefore, we promote three more hypotheses: (1) mathematics self-concept (MSC or SC) affects mathematics learning strategies (MLS or LS) positively through mathematics learning motivation (MLM or LM) (Hypothesis 7); (2) mathematics self-concept (MSC) affects mathematics learning strategies (MLS or LS) positively through mathematics self-efficacy (MSE or SE) (Hypothesis 8); (3) mathematics self-concept (MSC or SC) affects mathematics learning strategies (MLS or LS) positively through mathematics learning motivation (MLM or LM) and mathematics self-efficacy (MSE or SE) (Hypothesis 9).

Research Model

From the research of the documents, we found that learning strategies (LS) is closely related to learning motivation (LM), self-concept (SC) and self-efficacy (SE), which indicates that learning strategies may be influenced by these internal factors directly or indirectly. Therefore, we listed the research structure as Fig. 2 and all the hypothesis in Table 1.

Methods

Questionnaire design and Participants

we chose the parts of self-efficacy, learning strategies, self-concept, learning motivation dimensions from student's questionnaire of PISA2003, and recomposed some to adapt to Chinese students. This article's mathematics self-efficacy dimension (SE1-SE6), mathematics learning strategy dimension (LS1-LS5), mathematics self-concept dimension (SC1-SC5), mathematics learning motivation dimension (LM1-LM5) were based on it. We also adopted 5-point Linker scale to test (Responses on a scale from1-strongly disagree to 5-strongly agree).

607 junior high school students from Grade 7 to Grade 9 at three schools in Qinzhou and Guilin of Guangxi responded the questionnaire. Participants were selected randomly by cluster sampling. After checking, we exculpated the invalid questionnaires, having 560 valid questionnaires (=0.9).

Data Collection

The data of this study was collected and analyzed by *SPSS13.0*. Then, we summarized the relationship of SC, CM, SE and LS dimensions to structure the dimension of Correlation model in *AMOS 24.0*. At last, we tested the model fitting and mediating effect based on path analysis.

Results

Test on reliability and validity

Confirmative factor analysis (CFA) was applied to test the questionnaire and we deleted the items whose factor loading is under 0.60 and cross loading is above 0.40 (Jöreskog&Sörbom, 1989). Finally, the items are settled as shown in Table 2. After the second-round factor analysis, we ensured that Total Variance Explained is 63%, achieving the standard 60%, which means this is a proper academic questionnaire.

Reliability test.

As Table 2 shows, in this questionnaire, the standardized factor loading of every item is mainly over 0.600, Grenache's α is mainly between 0.757 and 0.821, and the corrected item-total correction are all over 0.350, which means the internal consistency is good. In addition, this questionnaire has satisfied Hair's standard (Hair, Black &Babin, 2010) and proved to be reliable because square multiple correlation (SMC) are mainly over 0.360, composite reliability is between 0.761 and 0.824 and the average variance extracted (AVE) value is between 0.446 and 0.54.

Validity test.

The average variance extracted (AVE) method was applied to analyze the convergence and discrimination validity of this questionnaire. First, as the result shows in Table 2, AVE of each dimension (0.446~0.554), composite reliability (0.761~0.824) both fit the standard(AVE>0.36, CR>0.70) that Hair and Fornell have set (Hair, Anderson & Tatham, 1998; Fornell & Larcker, 1981). Therefore, we can say that the convergence validity is good. Second, according to Forenell, the way to prove the discrimination validity among dimensions is to ensure the square root of dimension's AVE is over other dimension's correlation coefficient (Fornell&Larcker, 1981). From Table 3, we can see that Pearson related coefficient between each dimension (0.3~0.7) is obviously less than the square root of AVE in each dimension, which indicates that the questionnaire has a good discrimination validity.

Common method deviation test

This study used common CFA to test the influence of common method bias, which analyzed the Chi-square value's change between the Single-Factor and multiple-factor CFA (McFarland, & Sweeny, 1992). The results in Table 4 show that the Chi-square value increases significantly ($\triangle\chi^2$=1199.785, △df=6, p <0.01) after the analysis of single-factor CFA and multiple-factor CFA in Fig. 3 and Fig. 4. That is to say, this research doesn't cause estimation coefficient bias because of CMV.

Model fit test

According to Bollen-stine, when the sample size is over 200, the structural equation model's Chi-square value may get inflated and the data will not fit the multivariate normal distribution (Bollen & Stine, 1992). Considering this study tested 560 students, Bollen-stine bootstrap was applied to correct the Model Fit (p<0.001) and then the Bollen-stine P-value to correct model Chi-square value. The result of Table 5 shows that each model fitting index has reached the standard of structural equation model, which means the new model fitting is very ideal. Therefore, the mathematics learning strategies model in this study can be used to explain the actual observation data.

H1~H6 hypothesis test

We used the path analysis to test the estimated value of the conceptual hypotheses H1~H6 in Fig.5 and the results in Table 6 shows the values are 0.456 (self-concept to learning motivation), 0.512 (self-concept to self-efficacy), 0.159 (learning motivation to strategies), 0.158 (earning motivation to self-efficacy), 0.361(self-concept to learning strategies), and 0.205 (self-efficacy to learning strategies), which indicates the six hypotheses are all true.

Mediation effect test

Mediation effects of learning motivation and self-efficacy between self-concept and learning strategies are analyzed in Table 7 from four perspectives, which are the significance analysis of indirect effect, direct effect, comparing analysis of specific mediating effect and, comparing analysis of specific and distal mediation effect.

Significance analysis of indirect effect.

The analysis of indirect effect contains the total effect, total indirect effect and specific mediating effect. According to the data of first group, the estimated value of mathematics self-concept to learning strategies' total effect is 0.577, standard error is 0.07, and product of coefficients is 7.397(>1.96). At the same time, both the Bias-corrected's and Percentile's 95% Confidence Intervals do not include zero from 2000 times of bias-corrected with the P-value under 0.05. These data altogether indicate that there are mediation factors between self-concept and learning strategies. The total indirect effect from self-concept to learning strategies also establishes because the estimated value (0.371), standard error (0.062), product of coefficients (5.984>1.96), 95% CI (≠0) and P-value (<.05) are all fit.

In this study, learning motivation and self-efficacy are two specific mediation factors that self-concept affects learning strategies and there are three paths: ①self-concept→ learning motivation→learning strategies;② self-concept→self-efficacy→learning strategies; ③self-concept→learning motivation→self-efficacy→learning strategies. From the data of specific mediation effect and distal mediation effect in Table 7, we can see that all the CI 95% do not include zero with the P-value under 0.05, which means the mediation effects function and the three paths are all in existence.

Significance analysis of direct effect.

In the mediation effect analysis, the direct effect between self-concept and learning strategies was tested as well. We can see the estimated value (0.206), standard error (0.079), product of coefficients (2.608>1.96), 95% CI (≠0) and P-value (<.05) in Table 7, which indicates the direct effect is tenable.

To sum up, the effect analysis reveals that Hypotheses 7 to 9 are all true, which means self-concept has effect on the learning strategies in four routes: (1) indirectly through learning motivation; (2) indirectly through self-efficacy; (3) through learning motivation and then self-efficacy; (4) directly from self-concept to learning strategies. In addition, the existence of direct effect decides that the three indirect effect paths are partial mediations.

Comparing analysis of specific mediating effect.

The data that differences value (0.078), standard error (0.064), significance test value of parameter (1.219<1.96) , 95% CI of Bias-corrected and Percentile excluding 0 and P-value(<0.05) shows that the two specific mediating effect (learning motivation and self-efficacy) have no difference.

Comparing analysis of specific mediating and distal mediation effect.

According to Table 7, when comparing path 1 (self-concept→learning motivation→learning strategies) with path 3 (self-concept→learning motivation→self-efficacy→learning strategies), path 2 (self-concept→self-efficacy→learning strategies) with path 3, we found that the 95% CI of Bias-corrected and percentile don't include 0, and P-value is all less than 0.05. That is to say, the two specific mediation effects have significant difference with the distal mediation effect and the two are greater.

Model stability test

During the model test, the structural equation model may exist the heterogeneity sometimes and cross-validation can be used to test the model stability of the results (MacCallum, Roznowski& Mar, 1994). In theory, if one of the three norms ($P>0.05$ or $\Delta CFI \leq 0.01$ or $\Delta TLI \leq 0.05$) is meet, one can tell that the model is stable (Cudeck& Browne, 1983; Little, 1997). Therefore, we divided the 560 students randomly into two groups to test the cross-validation and listed the results in Table 8, from which we can see that the P-value of two groups' measurement weights, structural weights, structural covariance, structural residuals, measurement residuals are all over 0.05, ΔCFI are not over 0.01 and ΔTLI not over 0.05. That can fully prove this research's consistency and stability, and the recomposing do not cause significant changes and remain the homogeneous with the original questionnaire and model.

Discussion

In this study, we investigated junior high school students to test the model about mathmatics self-concept (MSC), math learning strategies (MLS) and another two factors, self-efficacy (MSE) and learning motivation (MLM) and made 9 hypotheses. The main findings based on the hypotheses are discussed in the following 7 sections.

MSC positively affects MLM

Consistently with the study of hypothesis and others' studies (Helmke, 1990; Heckhausen, 1998; Githua&Mwangi, 2003), we found that mathematics self-concept can predict junior high school students' learning motivation, which means the more self-concept they have, more motivated they are, and vice versa. The reason is that when students' satisfaction to math is fulfilled or their learning capacity is respected, they will gain more self-concept, which gives rise to higher achievements and more confidence. As a result, their motivation will be enhanced (Biehler & Snowman, 1986).

MSC positively affects MSE

The hypothesis 2 that mathematics self-concept can affect self-efficacy is also proved true, which has agreement with some researchers' conclusions (Lopez & Lent, 1992; Ferla et al., 2009; Lu et al., 2015). Based on our teaching experience and daily communication with students, we believed the reason is that more positive students' self-cognition is, better self-evaluation they may have. Since they have better self-concept, the learners will have more confidence and more self-efficacy when facing learning stress. Otherwise, the negative self-concept will result in less self-efficacy. According to Rodriguez's research, the students with better self-concept tend to participate in complex cognitive activities and have better self-reflection. When observing the clues, understanding and reflecting what they have learned, they can relate the phenomena to reasons behind them more easily and effectively, which will help them to get more recognition from teachers and improve their self-efficacy (Rodriguez, 2009).

MLM positively affects MSE

In line with the hypothesis 3 and previous researches (Zimmerman et al., 1992; Peng et al., 2008; Kong, 2015), we proved that learning motivation can affect self-efficacy positively. The more motivated students are always those who have realized the importance of learning mathematics and are more positive to judge their learning ability and efficiency. Therefore, these students will be more capable of dealing with their difficulties, and the achieving of their expectations will increase their interest and satisfaction, which will improve their mathematics self-efficacy. For those who are less motivated, mathematics can be harder if they do not push themselves to solve problems and the self-efficacy will decrease with time going by.

MLM positively affects MLS

This study certified the hypothesis 4 that mathematics learning motivation has significant positive impact on learning strategies. Others (Ames & Archer, 1988; Pokay&Blumenfeld, 1990; Elliot et al., 1999) who have achieved to this result as well also agreed on the reason that students with higher motivation will have higher possibility to realize the strategies' promotion to mathematics learning, which inspires their desire to master and apply the proper strategies in mathematics study. If the positive effects of using the strategies are strengthened, they will be more successful and the virtuous circle will be formed between strategies' application and mathematics achievements (Pang &Deng, 2011).

MSC positively affects MLC

As other researchers have shown, we found that mathematics self-concept has significant positive impact on learning strategies (Zimmerman & Martinez-Pons, 1990; Wang &Liu, 2000; Peng et al., 2008; Shan, 2012). According to the self-regulation theory, people's cognition, personality and their behavior are influenced by the self-managing systems. Most of the junior high school students are not mature enough and external stimulation can easily affect their self-cognition and judgement, which play a significant part in forming their self-concept. Once in high level of self-concept, they will build up strong self-identification and are more likely to choose suitable learning strategies.

MSE positively affects MLS

In conformity with some studies (Rodriguez, 2009; McInerney et al., 2012; Pérez et al., 2012), hypothesis 6 that mathematical self-efficacy has significant positive effect on learning strategies proves to be right in this study. In their study, it is obvious that proper use of self-efficacy determines mathematics learners learning strategies acquisition, adjustment and learning outcomes' development. Therefore, to some standard, the students with higher self-efficacy can master learning strategies more effectively and will achieve higher in mathematics study. On the contrary, students whose self-efficacy is limited cannot build a good connection between learning strategies and mathematics acquisition. Thus, mathematics teachers should focus more on improving students' self-efficacy when guiding them to acquire strategies.

MLM and MSE as mediation factors

Not only affect the learning strategies directly, mathematical learning motivation and self-efficacy are also the mediation factors that bridge self-concept and learning strategies separately and together in this study (Table 7). This section discusses how they function as mediation factors.

MLM as the mediation factor.

According to Biehler and Snowman, high self-concept has positive correlation to high academic achievements and self-satisfaction, and then inspires high motivation (Biehler& Snowman, 1997). Githua and Mwangi (2003) suppose that students' self-concept will stimulate their interest of learning mathematics, improve the possibility of their success and learning satisfaction, and then enhance their learning motivation, which drives students to be more aware to master and use their learning methods. As gathering enough learning experience, students gradually summarize and accumulate strategies to instruct their mathematics learning. To sum up, we can see that self-concept affects students' learning strategies through the mediation, learning motivation.

MSE as the mediation factor.

According to Giddens' self-identification theory, personal experience and social demand form oneself through subjective initiative (Jia, 2003). That is to say, if students have more positive self-cognition, their self-evaluation and self-acceptance will be better, and this will be helpful for them to develop positive academic self-concept. Therefore, when facing academic stress, students will be more confident to their own abilities and gain more self-efficacy. Bong and Clark (1999) also held the opinion that positive people are more likely to be more successful and confident to overcome the obstacles. While those with low self-concept cannot tap their potential fully and put their real competence into performance effectively. As is known to all, self-efficacy is one's confidence and self-experience that derive from the effect of learning activities, and students' self-efficacy has a close relationship with their efforts, motivation, attitudes towards difficulties and cognition to failures, which influence the improvement and application of learning strategies in a way. Therefore, we can say that self-concept will affect learning strategies and the mediating is self-efficacy.

Distal mediation effect.

The investigation of our study demonstrated that high self-concept affects students' academic achievements positively, and then improve their beliefs and satisfactions to themselves, which motivate students to learn mathematics. Moreover, as Ersanli's research has shown, students with high motivation usually possess better awareness and practise more actively in mathematics learning. They are more willing to challenge themselves in difficult exercises so that they can be more confidence and be praised by others like teachers and parents, which definitely contributes to their self-efficacy that inspires them to predict their leaning and evaluate the learning results more actively (Ersanli, 2015). Furthermore, positive expectation and judgement can involve students to stimulate their cognitive strategies, which can prompt their deep learning together with learning strategies. Also, in the process of arousing potentials, students' confidence and capacity is improved and adjusted with the accumulating of their learning experience and achievements, from which higher level of strategies are inspired (Rodriguez, 2009). All in all, based on our and others' study, we can come to the conclusion that self-concept has influence on learning strategies through learning motivation and self-efficacy successively.

Conclusion

In this study, we mainly took five steps. Firstly, we used CFA to test CMV influence and the result shows that common method variation does not exist and the research result is reliable. Secondly, we applied the well-measured questionnaire to survey and analyze the results to ensure that mathematics self-concept, learning motivation and self-efficacy all have positive influence on mathematics learning strategies. Thirdly, we evaluated the compound multiple mediation model by the maximum likelihood method and the fitting index are all up to the standard, which means this model can be used to analyze and explain the mediation effects. Finally, we used bootstrap to analyze compound multiple mediating effect, calculated 95% CI of Bias-Corrected and Percentile and got three result. First, total effect, direct effect, total indirect effect, and distal mediation effect are all significant between self-concept's influences on learning strategies. Second, two specific mediation effects of learning motivation and self-efficacy are all significant, while there is no significant difference between the two effects. Third, when comparing the two specific mediation effects with distal mediation effect respectively, we found specific effects are signally greater than distal mediation effect, which contains both learning motivation and self-efficacy as mediation factors. All in all, the four steps' investigation, analysis and evaluation confirm the nine hypotheses and proves the mediation model is tenable to explain how mathematics self-concept influences learning strategies.

Contributions, Limitations and Directions for Future Researches

First, there are two contributions of our study. On one hand, we used *AMOS* as the main tool to structure mathematical learning strategy models and discussed the influence path on how mathematics self-concept, learning motivation and self-efficacy affect junior high school students' mathematical learning strategies. Comparing the study of other researchers(Wang &Liu, 2000) who used SPSS multiple linear regression, our study involved more talent variables and had lower probability to result in estimation bias. On the other hand, this research discussed three mediation hypotheses, which are mathematics learning motivation's specific mediating effect, mathematics self-efficacy's specific mediating and both of them as distal mediation. The literature review and investigation proved that the hypotheses are all true. That is to say, mathematics self-concept not only affects learning strategies directly, but also indirectly through learning motivation, self-efficacy separately and together, which is a breakthrough, for the former researches that were mainly about direct impact of variables (Peng et al., 2008). Apart from the value of revealing the mechanism of self-concept's effect to mathematics learning strategies, this study will inspire teachers and schools to pay more attention to stimulating students' learning motivation, self-efficacy and other psychological elements.

There are mainly two limitations in this study. First, although group stratification sampling was used to choose the participants and students' mathematics levels differ from good, medium and weak to weaken the sampling errors and ensure the reliability, the three city schools are relatively intensive in one province. Future study may therefore expend to schools in towns and village schools and will cover more provinces to see if there are different results after considering more factors like teaching style, culture and local economy.

Otherwise, there may be more interfering factors in learning strategies, such as family background, learning experience, career expectations and so on. Therefore, in further study, we will add more factors into study to structure more complete and specific models.

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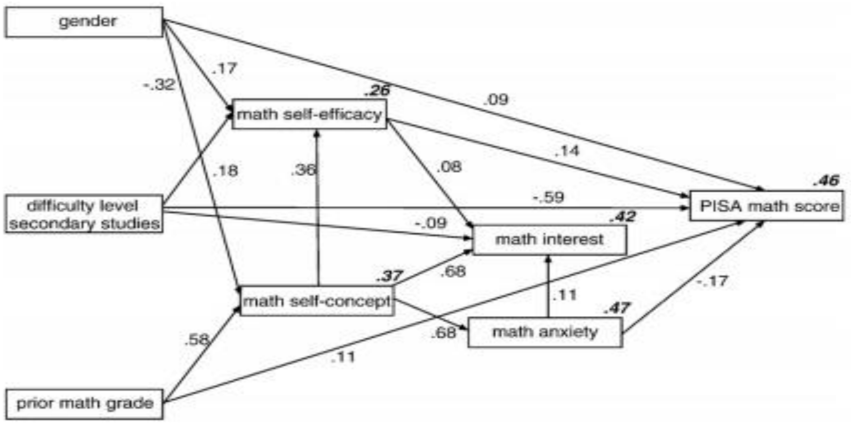

Fig. 1 Ferla Analysis result of mathematical self-concept affects self-efficacy

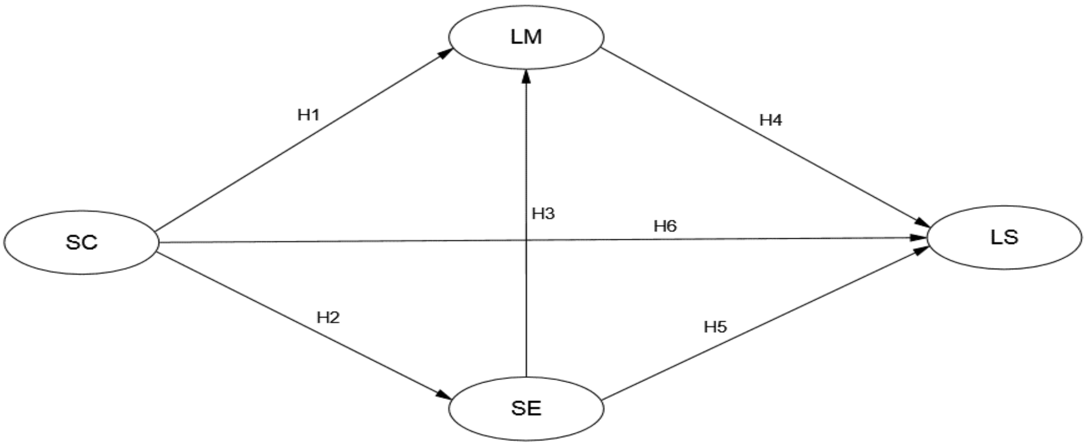

Fig. 2 Research framework

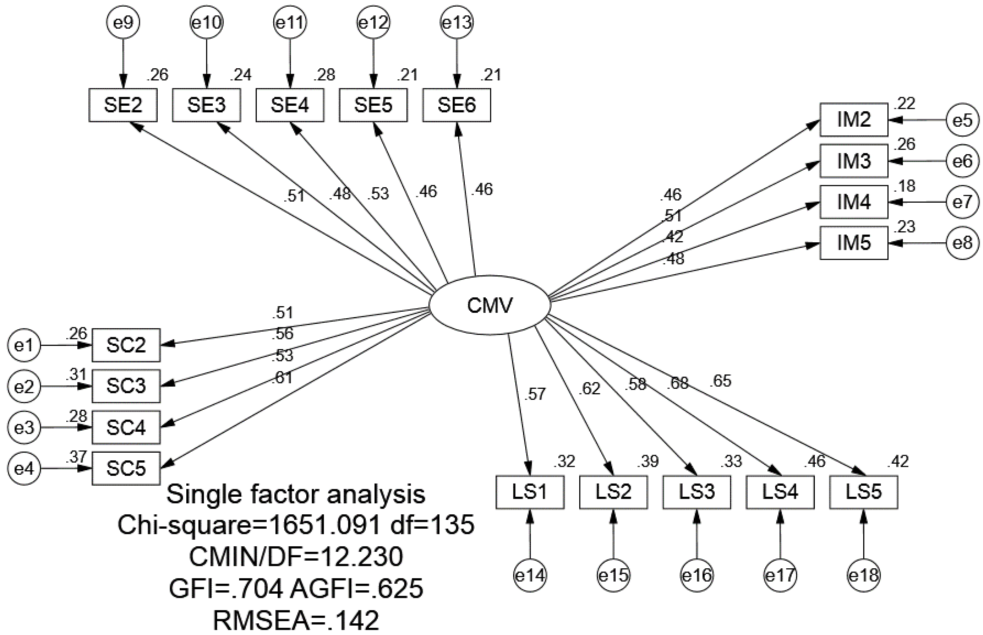

Fig. 3 Single factor CFA model

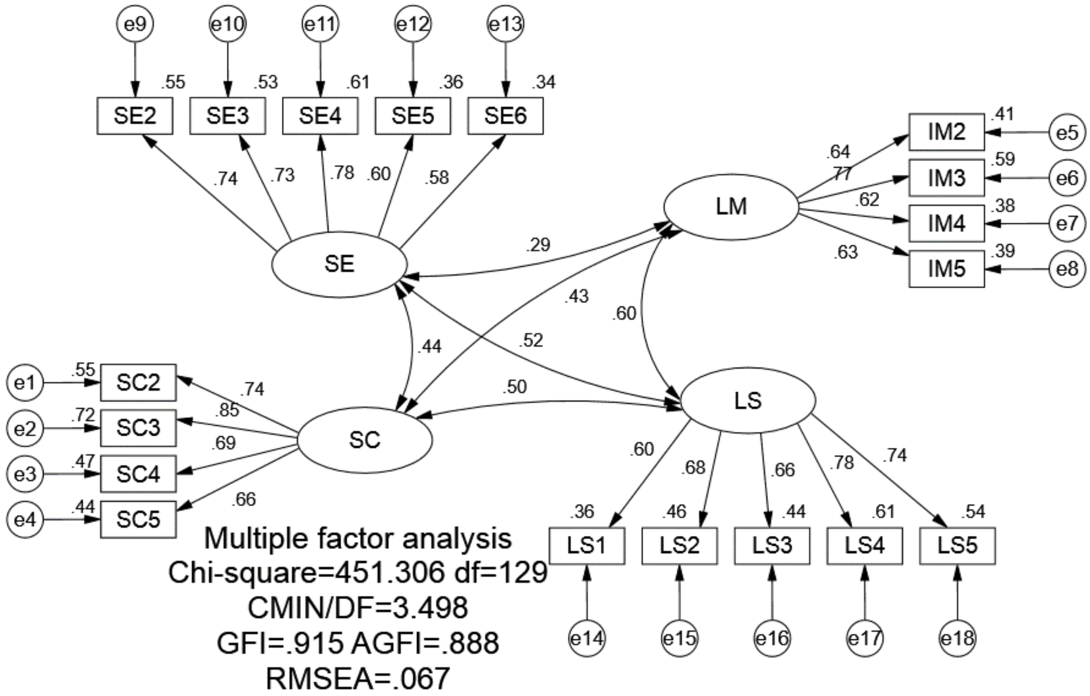

Fig. 4 Multi-factor CFA model

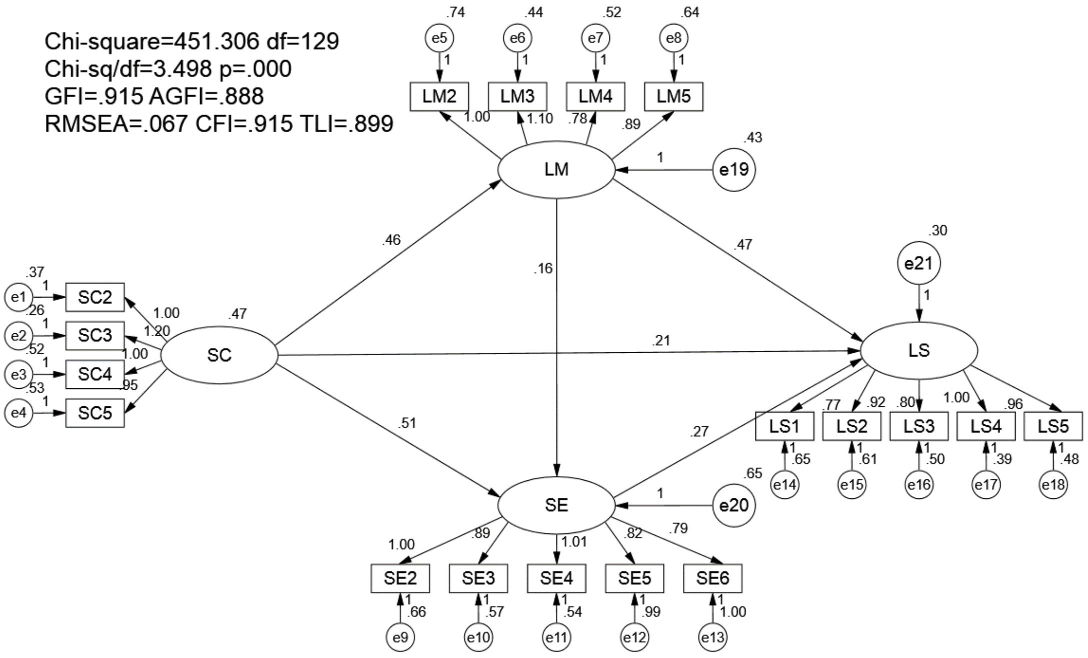

Fig. 5 Path coefficient diagram of the model

Table 1 Hypothesis of Research

Hypothesis	Content
H1	MSC positively affects MLM
H2	MSC positively affects MSE
H3	MLM positively affects MSE
H4	MLM positively affects MLS
H5	MSE positively affects MLS
H6	MSC positively affects MLS
H7	MSC affects MLS positively through MLV
H8	MSC affects MLS positively through MSE
H9	MSC affects MLS positively through MLM, MSC

Table 2 Analysis of Reliability and Convergent Validity of Dimensions

Dim	Item	Parameters of Significant Test				Item Reliability		Cronbach's Alpha	Composite Reliability	Convergence Validity
		Est.	SE	Est./SE	P	Std.	SMC		CR	AVE
SC	SC2	1.000				.748	.560	.821	.824	.544
	SC3	1.237	.070	17.752	***	.879	.773			
	SC4	.967	.065	14.919	***	.669	.448			
	SC5	.893	.064	14.039	***	.630	.397			
LM	LM2	1.000				.649	.421	.757	.761	.446
	LM3	1.110	.089	12.416	***	.780	.608			
	LM4	.771	.069	11.242	***	.615	.378			
	LM5	.864	.077	11.208	***	.612	.375			
SE	SE2	1.000				.745	.555	.816	.819	.478
	SE3	.897	.057	15.659	***	.735	.540			
	SE4	1.013	.062	16.407	***	.783	.613			
	SE5	.817	.064	12.860	***	.596	.355			
	SE6	.773	.063	12.353	***	.572	.327			
LS	LS1	1.000				.586	.343	.821	.822	.482
	LS2	1.205	.102	11.830	***	.668	.446			
	LS3	1.081	.091	11.899	***	.674	.454			
	LS4	1.350	.104	13.018	***	.794	.630			
	LS5	1.272	.102	12.520	***	.733	.537			

Table 3 Convergence and Discriminant Validity Analysis

Dimension	Convergence validity	Discriminate validity			
	AVE	LS	SC	SE	LM
LS	.482	**.694**			
SC	.544	.503	**.738**		
SE	.478	.516	.439	**.691**	
LM	.446	.603	.428	.292	**.668**

Table 4 Common Method Deviation Test

Model	χ^2	df	$\Delta\chi^2$	Δdf	P
Single Factor	1651.091	135	1199.785	6	.000
Multiple Factors	451.306	129			

Table 5 The Modified Model Fitting Degree is Compared with the Standard

Model Fit Index	Criterion	Bootstrap Correction model	Fit
Bollen-Stine $\square^2$	The Smaller The Better	164.280	Ideal
DF (Degree of Freedom)	The Bigger The Better	129	Ideal
Normed Chi-sqr ($\square^2$/DF)	1<$\square^2$/DF<3	1.273	Ideal
GFI	>0.9	0.958	Ideal
AGFI	>0.9	0.938	Ideal
RMSEA	<0.08	0.022	Ideal
SRMR	<0.08	0.051	Ideal
TLI (NNFI)	>0.9	0.989	Ideal
CFI	>0.9	0.991	Ideal
IFI	>0.9	0.991	Ideal
Hoelter's N (CN)	>200	440.445	Ideal

Table 6 Verification Results of the Research Hypothesis (N=560)

Hypothesis	Path			Estimate	S.E.	Parameters of Significant Test	Std.Est.	R^2	P	Result
H1	SC	→	LM	.456	.060	7.543	.428	.184	***	Support
H2	SC	→	SE	.512	.077	6.665	.385	.206	***	Support
H5	LM	→	SE	.159	.071	2.241	.127		.025	Support
H6	SC	→	LS	.158	.046	3.421	.180	.513	***	Support
H3	LM	→	LS	.361	.050	7.220	.436		***	Support
H4	SE	→	LS	.205	.035	5.934	.310		***	Support

Table 6 Verification Results of the Research Hypothesis (N=560)

Hypothesis	Path	Estimate	S.E.	Parameters of Significant Test	Std.Est.	R^2	P	Result

Note. *p<0.05, **p<0.01, ***p<0.001

Table 7 Mediation Effect Analysis

	Point Estimate	Product of Coefficients		Bootstrap 2000 Times 95% CI					
				Bias-corrected			Percentile		
		SE	Est./S.E.	Lower	Upper	P	Lower	Upper	P
				Total Effect					
SC→LS	.577	.078	7.397	.435	.749	.001	.429	.741	.001
				Total indirect effect					
SC→LS	.371	.062	5.984	.270	.521	.001	.260	.504	.001
				Specific mediating effect					
①SC→LM→LS	.215	.052	4.135	.132	.343	.001	.127	.330	.001
②SC→SE→LS	.137	.033	4.152	.080	.216	.001	.077	.208	.001
				Distal mediation effect					
③SC→LM→SE→LS	.019	.010	1.900	.003	.046	.020	.001	.042	.048
				Direct effect					
SC→LS	.206	.079	2.608	.060	.379	.005	.055	.372	.007
				Contrast					
① VS ②	.078	.064	1.219	-.036	.222	.168	-.042	.212	.201
① VS ③	.195	.050	3.900	.114	.317	.001	.111	.309	.001
② VS ③	.118	.036	3.278	.060	.202	.001	.056	.196	.001

Note. 2000 bootstrap samples。

Table 8 Model Stability Analysis

Model invariance comparison	ΔDF	ΔCMIN	P	ΔTLI	ΔCFI
Measurement weights	14	17.128	.249	-.005	-.001
Structural weights	6	7.564	.272	-.002	-.001
Structural covariances	1	.166	.684	-.001	.001
Structural residuals	3	1.842	.606	-.001	.000
Measurement residuals	18	21.607	.250	-.005	-.001