Journal of Mathematics Education
December 2008, Vol. 1, No. 1, pp. 172-181

Analysis of Principal Non-Intellectual Factors Influencing Senior Middle School Students' Mathematicsematics Achievement

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This study focused on a questionnaires research on the learning experience of 199 senior high school students in learning mathematics. The results showed (1) senior students had comparatively high scorers in learning attitude and low in learning anxiety; (2) remarkable differences existed between gender in the aspect of mathematics learning anxiety; (3) there existed significant differences in the Academic Achievement of the students among different senior students from different anxiety groups; (4) significant correlations were found among senior students' learning anxiety, learning attitude and motivation, and between the above three factors and mathematics achievement; (5) Senior students' learning anxiety, learning motivation and learning attitude served as a predicator of their mathematics achievement.

***Key words*:** senior students; learning anxiety; learning attitude; learning motivation; achievement

Introduction

"Mathematics is the gymnastics of thinking." At the senior middle school stage, mathematics is a difficult course as well as an important foundation course to foster students' abstract thinking ability. The mathematics teachers' fundamental object is to make students have a better command of the basic mathematics knowledge and cultivate their basic ability thus to lay a solid foundation on the learning of other courses. In order to accomplish this, above all, we should find the various factors affect students' mathematics achievement, based on targeted teaching.

Many researches have shown that individual factors influencing students' mathematics achievement can generally be divided into two categories: intellectual and non-intellectual factors. In the latter, mathematics learning anxiety, learning motivation and learning attitude may all affect mathematics achievement.

Mathematics learning anxiety is a kind of special anxiety formed in learning and applying mathematics. It targets mathematics activities and influences the efficiency and effect of mathematics activities. Kong (2002) concluded from his research that on

the relation between mathematics anxiety and mathematics achievement among second-year junior middle school students, the significant negative correlation exists not only between various layers of mathematics anxiety and mathematics achievement but also between total score of mathematics anxiety and mathematics achievement. He indicated that there exists close relationship between mathematics anxiety and mathematics achievement.

Mathematics learning attitude defines the learner's cognition, emotion and behavior inclination to mathematics study objects. Cognition refers to the learner's value judgment to mathematics study objects; emotion refers to the learner's emotional reflection such as love, hatred, liking and loathing to mathematics study objects; behavior inclination is the learner's outward behavior of cognition and emotion to mathematics study objects. The influence of learning attitude on learning effect has been conformed by experiments and researches.

Mathematics learning motivation is the internal drive to inspire students to learn mathematics. Li (2004) showed that there exists notable difference in mathematics achievement among students with different achievement motivation. Students with higher achievement motivation tend to get better mathematics achievement and vice versa. Difference in achievement motivation level affects students' mathematics academic achievement.

Taking an overall view of literature, we can found that there are many researches on the relationship between mathematics learning anxiety, learning attitude, learning motivation and mathematics achievement. However, many of those studies were carried out based on the single-factored researches. Moreover, to what extend those factors have influence on mathematics achievement; whether it is positive or negative; whether they are independently functionary or inter-functionary, the previous researches have not solved those problems, and our current research is tried to give answers for these problems. The present research can provide a theoretic guidance for the senior middle school mathematics teachers to improve teaching methods, supervise students correctly, explore students' potential and inspire students' interest in mathematics.

Methods

Subject

The subject consists of 199 second-year senior middle school students in some cities from a northeast province in China. Among the participants, 107 are male students and 92 are female students.

Instrument

A learning experience questionnaire was adopted as the measuring instrument for this research. The questionnaire included 3 subscales made up of 71 items. The first subscale consisted of 27 items including 4 dimensions: fear of pressure, emotional concern, test anxiety and class anxiety; the second subscale 30 items, 4 dimensions: learning confidence, utility, success attitude and research motivation; the third subscale

14 items, 2 dimensions: work devotion and self devotion. This questionnaire originally adopted five points self-report inventory: from "totally disagree" to "totally agree" respectively marked with numbers from one to five.

In this research, variables such as mathematics achievement and Sex and so force were listed in the questionnaire as the subjects' basic information. The mathematics achievement was their achievement in the city's unified middle term exam for second-year senior middle school students in 2004-2005 school year.

Analysis and Results

Reliability Analysis of Scale (Alpha coefficient)

Internal consistency reliability **(**Alpha coefficient) analyses have been made to all the general scales, subscales and dimensions. Results are shown in Table 1.

Table 1

Reliability Analysis of Scale of Learning Experience Questionnaire

	Learning Anxiety				Learning Attitude				Learning Motivation	
	Fear of Pressure	Emotional Concern	Test Anxiety	Class Anxiety	Learning Confidence	Utility	Success Attitude	Research Motivation	Work Devotion	Self Devotion
Dimensions	0.668	0.823	0.692	0.802	0.879	0.793	0.840	0.783	0.782	0.783
Subscales		0.944					0.900			0.742

Table 1 reveals that subscales and dimensions both have relatively high reliability. Moreover, reliability of general scales is 0.824 which is also relatively high. Therefore, the measuring results are reliable.

Basic Information about Mathematics Learning Anxiety, Learning Attitude and Learning Motivation

Table 2

The Descriptive Statistics of Learning Experience

	Mean	*SD*	Items	Score
Fear of Pressure	15.64	5.70	6	2.61
Emotional Concern	22.61	6.59	8	2.83
Test Anxiety	22.68	7.18	8	2.84
Class Anxiety	15.08	4.45	5	3.01
Learning Anxiety	75.95	20.40	27	2.82
Learning Confidence	30.97	7.32	10	3.10
Utility	26.08	5.12	7	3.73
Success Attitude	25.34	5.12	7	3.62
Research Motivation	21.22	4.95	6	3.54
Learning Attitude	103.70	16.04	30	3.46
Work Devotion	24.11	5.21	7	3.44
Self Devotion	18.53	5.16	7	2.65
Learning Motivation	42.64	7.74	14	3.05

Contrast of Mathematics Learning Anxiety, Learning Attitude, Learning Motivation and Academic Achievement between gender.

Table 2 shows that senior students have comparatively high scorers in learning attitude and low in learning anxiety. In the aspect of learning anxiety, classroom anxiety ranks the highest and test anxiety is the next. In the aspect of attitude, confidence is the lowest and utility is the highest. In the aspect of motivation, work devotion is significantly higher than self devotion. The t-test conducted for further correlated samples of work devotion and self devotion reveals that work devotion is significantly different from self devotion with 11.41 as *t* value and 0.000 as *p* value.

Table 3

Contrast of Mathematics Learning Anxiety, Learning Attitude, Learning Motivation and Academic Achievement between Sex

Items	Sex	*N*	Mean	*SD*	*t*	*p*
Learning Anxiety	Male	107	72.91	19.02	2.297	0.023
	Female	92	79.50	21.47		
Learning Attitude	Male	107	105.02	15.98	1.254	0.211
	Female	92	102.16	16.07		
Learning Motivation	Male	107	43.85	7.55	2.399	0.017
	Female	92	41.24	7.78		
Academic Achievement	Male	107	102.07	22.08	2.088	0.038
	Female	92	95.40	22.86		

Table 3 shows that remarkable differences exists between sex in the aspect of mathematics learning anxiety, learning motivation and achievement but in the aspect of learning attitude, difference does not exist.

According to the degree, Learning anxiety has been divided into three groups which include High Anxiety Group (total score of anxiety ranking the first 27%), Medium Anxiety Group (total score of anxiety ranking the middle 46%), Low Anxiety Group (total score of anxiety ranking the last 27%). The analysis of variance has been made with mathematics achievement as a dependent variable. Results are such as shown in table 4.

Relationship between Learning Anxiety and Academic Achievement

Table 4

One-Way ANOVA of Learning Anxiety

Source	*SS*	*Df*	*MS*	*F*	*p*
Between Groups	17308.21	2	8	20.168	0.000
Within Groups	84104.75	196	654.10		
Total	101413.00	198	429.11		

As is shown in Table 4, there exist significant differences in the Academic Achievement of the students among the three groups. Descriptive statistic and back testing indicates that Medium Anxiety Group get the best achievement while High

Anxiety Group the worst achievement; notable difference exists between Medium Anxiety Group and High Anxiety Group while no obvious difference between High Anxiety Group and Low Anxiety Group.

Correlation Analysis between Learning Anxiety, Attitude, Motivation and Academic Achievement

Table 5

Correlation Analysis between Learning Anxiety, Attitude, Motivation and Academic Achievement

	Learning Anxiety	Learning Attitude	Learning Motivation
Learning Attitude	–0.474**		
Learning Motivation	–0.183**	0.552**	
Academic Achievement	–0.376**	0.595**	0.563**

Note：*$P \leq 0.05$, $P \leq 0.01$.

Table 5 shows that significant correlations are found among senior students' learning anxiety, learning attitude and motivation, and between the above three factors and mathematics achievement. Among them, learning anxiety and learning attitude, learning anxiety and academic achievement, learning anxiety and learning motivation are all in a significant negative correlations; learning attitude and learning motivation, learning attitude and academic achievement, learning motivation and academic achievement in a significant positive correlation; Learning attitude and academic achievement have the highest correlations.

Regression Analysis of Learning Anxiety, Attitude and Motivation for Academic Achievement

Multiple regression analysis has been made with learning anxiety, learning attitude and learning motivation as independent variables and academic achievement as dependent variable by using setwise regression analysis method. Results are such as shown in table 6.

Table 6

Regression Analysis of Learning Anxiety, Attitude and Motivation for Academic Achievement

	Beta	*SE*	*t*	*R*	R^2	*F*
Learning Attitude	0.324	0.101	4.530**	0.672	0.444	53.641**
Learning Motivation	0.356	0.187	5.569**			
Learning Anxiety	–0.157	0.067	-2.594*			

Table 6 shows that regression model validity has reached a significant level. Academic achievement is affected by three factors including learning anxiety, learning attitude and learning motivation. Senior students' learning anxiety, learning motivation and learning attitude can serve as a predicator of their mathematics achievement.

Combined predicting power of the three variables is 44.4%. Standardized regression equation goes as the following: academic achievement=0.324×learning attitude＋0.356×learning motivation–0.175×learning anxiety.

Discussion

Basic Information of Mathematics Learning Anxiety, Learning Attitude and Learning Motivation

This research indicates that learning attitude scores relatively high and learning anxiety relatively low. In the aspect of learning anxiety, class anxiety ranks the highest and test anxiety comes the next. In the aspect of learning attitude, utility scores the highest and learning confidence the lowest. In the aspect of learning motivation, work devotion scores significantly higher than self devotion. In other words, senior middle school students can correctly treat mathematics learning but mostly with a utilitarian trend and lack of confidence and intrinsic motivation. Causes to this effect are complicated. Perhaps it is due to the lack of elicitation for mathematics teacher's teaching methods, students' much failure sense, school's frequent exams, great pressure brought by entering a higher school or incorrect attitude to exam results and so on.

Contrast of Mathematics Learning Anxiety, Learning Attitude, Learning Motivation and Academic Achievement Between gender

This research indicates that there exists notable difference between Sexs in mathematics learning anxiety and learning motivation of senor middle school students, which is basically consistent with previous related researches. Hembree's research indicates that girl students' mathematics anxiety is significantly higher than boy students in the same grade. However before entering colleges, boy students' mathematics anxiety is generally related with low achievement and escaping from mathematics. Causes to this effect are complicated. First, mathematics study results may have counteractive effect to learning motivation and mathematics anxiety. Because girl students have experienced much mathematics failure, they get low devotion motivation and high anxiety. What's more, it is possibly affected by the traditional idea which holds that mathematics is suitable for boys while it is quite difficult for girls to study mathematics well. Therefore, when girl students meet obstacles in mathematics, influenced by the sex prejudice they always think that they can not study mathematics well no matter how hard they have tried. Thus their inferiority complex and learning anxiety are strengthened, which causes their low learning motivation and severe learning anxiety. Moreover, it is related to the attitude taken by teachers to students and parents to children.

This research indicates that there exists significant difference between sex in mathematics academic achievement of senior middle school students. Mathematics is a course which requires high logic thinking of senior middle school students and possesses preciseness and abstractness. Sex difference psychology indicates that boys are better at logic thinking and space ability. Metacognition researches in the past 40

years discovered that in computing ability, girls are better than boys in primary and junior middle school period but in senior middle school and university period, boys show advantages. Others think that boys are better at standardized tests or competitive mathematics activity, while girls are better at grading honor awarded by schools or cooperative mathematics activity. According to the conclusions, that in senior middle school, boy students get better academic achievement than girls is understandable.

Correlation Analysis between Learning Anxiety, Learning Attitude, Learning Motivation and Academic Achievement

Significant correlations exist both among learning anxiety, learning attitude and learning motivation and between the three factors above and academic achievement. Learning anxiety and learning attitude, learning anxiety and academic achievement, learning anxiety and learning motivation all have a significant negative correlations; learning attitude and learning motivation, learning attitude and academic achievement, learning motivation and academic achievement have a significant positive correlation; learning attitude and academic achievement have the highest correlations.

For the mathematics academic achievement of different groups, the medium group obtained the best achievement, while the high anxiety group had the lowest achievement. There exists a significant difference between the high anxiety group and the medium anxiety group, but no significant difference between the high anxiety group and low anxiety group. This further illustrates that learning anxiety is an important factor influencing students' academic achievement. When he was making a researching the cause to the interaction between anxiety level and mathematics achievement, Ashcraft（2001) thought that when the anxiety of individual with high anxiety is activated, then he takes the mode of "double tasks": mathematical manipulation and anxiety experience. Taken as a task, anxiety experience draws an individual's attention and increases the burden of memory, thus the memory capacity originally for mathematical manipulation is lessened. Besides, mathematics anxiety may have an influence on the long-term memory. Most mathematics anxiety first appears at the early stage of a junior middle school period when individual is studying difficult mathematics problems. As the disturbance which is made to the perceiving task, mathematics anxiety may create influence on individual in mathematics class and reduce the working memory capacity for learning and grasping knowledge. It is because of the indirect influence by mathematics anxiety on the cognition process that mathematics anxiety directly causes the negative effect to mathematics achievement. Related analysis results in this research have further proved this view that mathematics learning anxiety and learning attitude are in significant negative correlation. That is to say, too high anxiety will result in negative learning attitude. The research also indicates that learning attitude and mathematics achievement, learning motivation and mathematics achievement, and learning attitude and learning motivation are all in significant positive correlation. It indicates that learning attitude and devotion motivation support each other. Generally speaking, individual with positive learning attitude and high devotion motivation will get a good academic achievement;

otherwise, they will affect academic achievement.

Mathematics learning motivation and learning anxiety are in significant negative correlations, which is inconsistent with previous research conclusions. It is probably related to the fact that mathematics is a difficult subject. Because of the difficulties in mathematics study, many students especially those with low mathematics achievement create a psychology on mathematics learning which result in low learning motivation. Therefore, it requires teachers to properly improve teaching methods and set up cooperative class environment. Mutual help and cooperation between teacher and classmates and among classmates should be stressed and students' learning enthusiasm, initiative and participation should be effectively motivated. Attention should be paid to the students, especially those with low scores to minimize their failure sense and maximize their sense of achievement. Students' subject consciousness and self-study ability should be cultivated deliberately to strengthen their learning motivation.

Influence of Mathematics Learning Anxiety, Learning Attitude and Learning Motivation on Academic Achievement

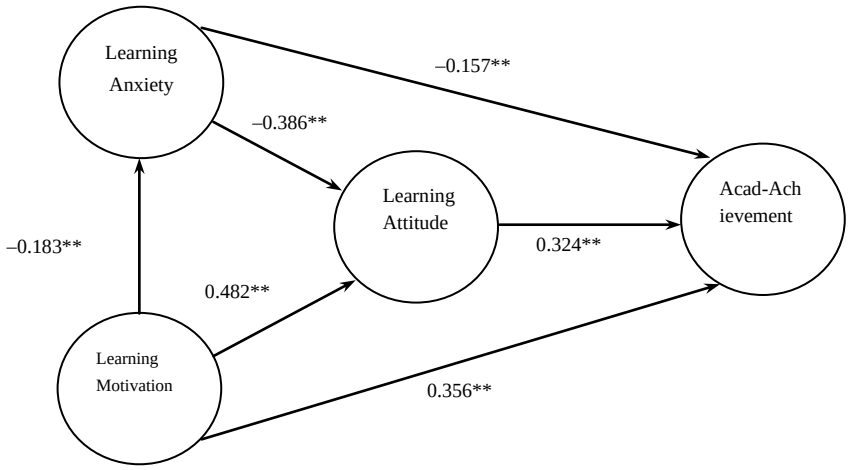

Figure 1. **Path Analysis of Influence of Learning, Attitude and Devotion Motivation on Mathematics Achievement**

Learning anxiety, learning attitude and learning motivation all have predicative roles on academic achievement. Literature indicates that the influence of factors such as learning anxiety, learning attitude and learning motivation on academic achievement does work independently but also sophisticatedly and mutually. To make a better understanding of the relationship, we repeatedly adopt a stepwise multiple regression method to work out mathematics learning experience model (as is shown in Figure 1).

The model in Figure 1 indicates that there are three paths directly influencing test achievement including learning attitude, learning anxiety and learning motivation. Besides the three direct paths, four indirect paths influencing test achievement are also included, which are learning anxiety influencing academic achievement through learning attitude, learning motivation influencing academic achievement through learning anxiety, learning motivation influencing academic achievement through

learning attitude and learning motivation influencing learning attitude through influencing learning anxiety and then influencing academic achievement. The last path reaches test achievement through two variables, which is perhaps the effect caused by the three variables together.

In all, research results indicated that factors such as mathematics learning anxiety, learning attitude and learning motivation all influence senior middle school students' mathematics achievement to various extent. Too high learning anxiety goes against improving students' achievement, which may be an important factor influencing mathematics academic achievement. From the aspect of individual's internal factors, students should properly adjust their anxiety in class and exam. From the aspect of external factors, teachers should try to create a loose class and exam environment, especially take more care of the students with low academic achievement minimizing their learning pressure and anxiety in class and exam. Moreover, attention should be paid to lead students to keep an active learning attitude and high learning motivation and increase their interest in this course, which is the driving force for them to get good academic achievement.

Conclusions

In conclusion, (a) Senior students are comparatively high scorers in learning attitude and low in learning anxiety. In the aspect of learning anxiety, classroom anxiety ranks the highest and test anxiety is the next. In the aspect of attitude, confidence is the lowest and utility is the highest. In the aspect of motivation, work devotion is significantly higher than self devotion. (b) Remarkable differences exist between sex in the aspect of mathematics learning anxiety, learning motivation and achievement but in the aspect of learning attitude, difference do not exist. (c) There exist significant differences in the Academic Achievement of the students among different senior students from different anxiety groups. Senior students from Medium Anxiety Group get the best achievement while senior students from High Anxiety Group the worst achievement. (d) Significant correlations are found among senior students' learning anxiety, learning attitude and motivation, and between the above three factors and mathematics achievement. (e) Senior students' learning anxiety, learning motivation and learning attitude can serve as a predicator of their mathematics achievement.

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