

A Study on the Relationship between Temperament and Mathematics Academic Achievement¹

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Based on a survey on 1620 students in primary school and secondary school, by adopting Eysenck Personality Questionnaire (EPQ), we got the following findings:

1. There is close relationship between emotionality characteristics of temperament and mathematics academic achievement of the subjects at Grade 5 (Primary 5), Grade 8 (Junior Secondary 2), and Grade 10 (Senior Secondary 2). Also there is close relationship between internal-external directivity characteristics of temperament and mathematics academic achievement at Grade 5 and Grade 8. While there is not close relationship between internal-external directivity characteristics of temperament and mathematics academic achievement at Grade 10;
2. There is close relationship between temperament types and mathematics academic achievement of the subjects from the three grades. Superior temperament, which benefit learning mathematics, are sanguine, sanguine-phlegmatic and phlegmatic; While inferior temperament types, which don't benefit learning mathematics, are choleric, melancholic and choleric-melancholic. With the rising of grade, temperament types of benefiting learning mathematics converts from external directivity emotion balance to balance of internal-external directivity emotion stability. While temperament of no benefiting learning mathematics converts from internal directivity emotion balance to balance of internal-external directivity emotion instability;
3. In mathematics education, students' temperament difference, which affects learning mathematics, should be recognized. Mathematics teachers should find out the best

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teaching ways, forms and methods which are suitable for student's temperament type, so that the students with different temperament types can gain better mathematics academic achievement

Keywords: Eysenck Personality Questionnaire (EPQ), temperament, internal-external directivity characteristics of temperament, temperament types, mathematics academic achievement

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INTRODUCTION

To explore relationship between psychological factors and mathematics academic achievement has become one of important tasks which study modern mathematics education. Through understanding and observing education, with summarizing experience, transplanting theory and rational thinking methods, many mathematics education researchers, with modern pedagogy and psychology theories, have made a series of achievements after they analyze correlation between a series of psychological factors and mathematics academic achievement (M. Li, 1994a; M. Li, 1994b; M. Li, 1996; Qiao & Fu, 2003; X. Li & W. Li, 2004). These results have certain significance to study mathematics education.

Temperament is a kind of important psychological factor. After carrying on qualitative analysis of the relationship between academic achievement and it, some scholars think that temperament, which influences individual learning way, has not great impact on academic achievement of students (Gao, 1994, pp. 165–170). While Lin (1992, pp. 446–448) thinks that temperament plays role in restraining nature and efficiency of intelligence and ability directly. The intelligence and capability are some important factors which inference academic achievement. Including professor Zhang (1995), Some people point out that temperament is decisive factor which affects a person's future achievement and that what kind of temperament one has, what kind of learning ability one has. Shen (2004) thinks that some temperament types are related to learning disabilities. In foreign, some research show that students' temperament affect their academic achievement (*cf.* Burger, 2004, pp. 176–186). Some others point that there is difference between temperament types of students that have learning disabilities (*cf.* Bender, 1998, 281–283). From above, although the relationship between temperament and academic achievement remains disputed, it has been approved by many scholars.

With questionnaire investigation-statistical analysis method, we had investigated and analyzed the relationship between temperament types and student's mathematics thinking

quality (M. Li, 1995). The result indicates that the subjects with different temperament types have different characteristics of mathematics thinking quality. The characteristics of mathematics thinking quality is the expression of mathematics thinking ability, and different mathematics thinking quality is sure to show different mathematics thinking ability which is one of the important factors that influence mathematics academic achievement. Therefore, there possibly exists inherent relationship between temperament and mathematics academic achievement. In view of this, with quantitative analysis method, this essay proposes the real material for the relationship between temperament and mathematics academic achievement, and offer enlightenment for practice of mathematics education.

METHODOLOGY

Subject

Firstly we choose five primary schools and five middle schools in Guiyang City, Guizhou Province. Then, in the same grade, subjects from Grade 5 (Primary 5th year), Grade 8 (Junior Secondary 2nd year), and Grade 11 (Senior Secondary 2nd year) are orderly arranged from high to low, according to mathematics academic achievement of terminal examination in the city. We regard the first 27%, the middle 46%, and the final 27% as excellent, moderate and backward group. Finally, we randomly choose 1620 subjects who respectively come from three grades, and each grade has three groups and each group has 180 subjects.

Instrument

We examine temperament characteristics of subjects through *Eysenck Personality Questionnaire* (EPQ)²: emotion (N) and internal-external (E). We change primitive scores of N and E into standard T scores; and then determine temperament types of subjects according to evaluating table of temperament types (see Table 1) (Zhang, 1995, p. 61).

² (Added by Editors) The *Eysenck Personality Questionnaire* (EPQ) is a reliable research tool that is validated by criterion analysis. Disadvantages of the questionnaire are that it asks yes/no questions which forces a sometimes inaccurate response, and it can be psychometrically inferior. The questionnaire measures the three traits described in the personality theory of Hans Eysenck. These are extraversion, psychoticism and neuroticism. It was published, in revised form, by Eysenck, Eysenck & Barrett (1985) in the journal *Personality and Individual Differences*. A different approach to personality measurement developed by Eysenck, which distinguishes between different facets of these traits, is the Eysenck Personality Profiler. From http://en.wikipedia.org/wiki/Eysenck_Personality_Questionnaire

Table 1. Evaluation of temperament types

Scale of <i>N</i> interval of <i>T</i>	Scale of <i>E</i> interval of <i>T</i>		
	<i>T</i> < 43.3	43.3 < <i>T</i> < 56.7	<i>T</i> > 56.7
<i>T</i> < 43.3	phlegmatic	sanguine-phlegmatic	sanguine
43.3 < <i>T</i> < 56.7	phlegmatic-melancholic	multi-temperament	sanguine-choleric
<i>T</i> > 56.7	melancholic	choleric-melancholic	choleric

Data analysis

We choose 1620 subjects with each grade having 540 subjects who include excellent, moderate and backward, then, 15 years old forms the boundary between the two groups. One group has 762 subjects, and the other one has 858 subjects.

We respectively test subjects aged less than 15 years old and over 16 with juvenile edition and adult edition of EPQ, and we change primitive scores of *N* and *E* into standard *T* scores respectively, and sort out the temperament characteristic of each subject according to interval of *T*. Depending on the two kinds of temperament characteristics of each subject, we evaluate temperament type of each subject (see Table 1).

Table 2. Relationship between emotionality characteristics of temperament and mathematics academic achievement (unit: person-time)

grade	levels	stability	balance	instability	Significance test
Grade 5	excellent	<i>n</i> 81 % 45	58 32.22	41 22.78	$\chi^2 = 39.05$ <i>df</i> =4 <i>p</i> < 0.001
	moderate	<i>n</i> 48 % 26.67	78 43.33	54 30	
	backward	<i>n</i> 40 % 22.22	56 31.11	84 46.67	
Grade 8	excellent	<i>n</i> 74 % 41.11	52 28.89	54 30	$\chi^2 = 19.97$ <i>df</i> =4 <i>p</i> < 0.001
	moderate	<i>n</i> 52 % 28.89	72 40	56 31.11	
	backward	<i>n</i> 45 % 25	53 29.44	82 45.56	
Grade 11	Excellent	<i>n</i> 76 % 42.22	55 30.56	49 27.22	$\chi^2 = 19.96$ <i>df</i> =4 <i>p</i> < 0.001
	Moderate	<i>n</i> 51 % 28.33	73 0.56	56 30.11	
	backward	<i>n</i> 52 % 28.89	49 27.22	79 43.89	

We count the numbers and proportion of subjects, whose mathematics academic

achievement vary in the two kinds of temperament characteristics and nine kinds of temperament types. And then, with inference statistical method, we study the relationship between mathematics academic achievement and temperament characteristics and types.

RESULTS

Table 2 shows that there are significant differences between emotionality characteristics of temperament and mathematics academic achievement. For each grade, excellent students with high mathematics academic achievement are inclined to possess stability emotionality characteristics of temperament, moderate to balance and backward to instability. This indicates that there are close relationship between emotionality characteristics of temperament and mathematics academic achievement.

Table 3 demonstrates that there are significant differences between internal-external directivity characteristics of temperament and mathematics academic achievement from Grade 5 and Grade 8. For each grade, the excellent students are inclined to possess internal directivity characteristics of temperament, the moderate students to balance of internal-external and the backward students to external.

Table 3. Relationship between internal-external directivity characteristics of temperament and mathematics academic achievement (Unit: person-time)

grade	levels	stability	balance	instability	Significance test	
Grade 5	excellent	<i>n</i>	55	54	71	$\chi^2 = 13.756$ <i>df</i> =4 $p < 0.01$
		%	30.56	30	39.44	
	moderate	<i>n</i>	60	68	52	
		%	33.34	37.78	28.89	
	backward	<i>n</i>	74	60	46	
		%	41.11	30	25.56	
Grade 8	excellent	<i>n</i>	56	50	74	$\chi^2 = 12.116$ <i>df</i> =4 $p < 0.05$
		%	30.11	27.78	41.11	
	moderate	<i>n</i>	50	66	64	
		%	27.78	36.67	35.56	
	backward	<i>n</i>	74	56	50	
		%	41.11	30.11	27.78	
Grade 11	excellent	<i>n</i>	56	52	72	$\chi^2 = 8.98$ <i>df</i> =4 $p < 0.05$
		%	31.11	28.89	40	
	moderate	<i>n</i>	55	66	59	
		%	30.56	36.67	32.78	
	backward	<i>n</i>	73	58	49	
		%	40.56	32.22	27.22	

This indicates that there are close relationship between internal-external directivity characteristics of temperament and mathematics academic achievement, and Grade 5 is more significant than Grade 8. There exists no significant difference between them from Grade 11.

From Table 4, the test between temperament types and mathematics academic achievement of the subjects shows significant difference. This indicates that there is close relationship between temperament types and mathematics academic achievement.

Table 4. Relationship between temperament types and mathematics academic achievement

Tempera- ment Types	Primary 5				Junior Secondary 2				Senior Secondary 2			
	Exe.	Mod.	Bac.	χ^2	Exe.	Mod.	Bac.	χ^2	Exe.	Mod.	Bac.	χ^2
choleric	12	15	12	0.462	7	10	19	6.5 *	12	10	26	9.5**
sanguine	18	10	4	9.247 **	30	12	8	16.477 ***	25	14	9	8.375*
phlegmatic	16	22	20	0.966	19	8	7	7.846 *	21	8	7	10.167*
melancholic	7	9	22	10.471 **	12	15	33	12.9 ***	9	13	23	6.933*
sanguine- choleric	34	15	11	15.1** *	8	16	9	3.455	13	20	9	4.72
sanguine- phlegmatic	21	13	7	7.218 *	24	11	8	9.306 **	36	16	11	16.667 ***
choleric- melancholic	9	13	24	7.87 *	14	10	27	9.294 **	8	15	31	15.444 ***
phlegmatic- melancholic	9	17	29	11.057 ***	8	18	11	4.282	9	16	9	2.891
multi- temperament	54	66	51	2.211	58	80	57	5.2	4.8	68	55	3.614
χ^2	64.542***				75.23***				78.311***			

So the subjects, from Grade 5, with sanguine-choleric, sanguine-phlegmatic and sanguine temperament, are inclined to be more excellent in mathematics study, and the subjects, with phlegmatic-melancholic, choleric-melancholic and choleric-melancholic temperament, to be more backward: The subjects, from Grade 8, with sanguine, sanguine-phlegmatic and phlegmatic temperament, to be more excellent, and the subjects, with melancholic, choleric-melancholic and choleric temperament, to be more backward: The subjects, from Grade 11, with sanguine-phlegmatic, sanguine and phlegmatic temperament, to be more excellent, and the subjects, with choleric-melancholic, choleric and melancholic temperament, to be more backward. Above-mentioned differences reach the significant or extremely significant level.

It is obvious, with the rising of the grade, the temperament types, which benefit or don't benefit learning mathematics, have changes in some degrees. There is one obvious tendency that with the rising of grade, temperament of benefiting learning mathematics converts from external-emotionality balance to balance of internal-external directivity-emotionality stability. While temperament of no benefiting learning mathematics converts from internal-emotionality balance to balance of internal-external directivity-emotionality instability. This corresponds with some research (*cf.* Zhang, 1995, p. 61).

Entwistle (2005) indicates that achievement of external directivity temperament students, with 7–13 years old, is more outstanding than that of internal directivity temperament students, with the same age. But with the rising of age, the situation is opposite (Zhang, 1995, p. 61). In order to make it obvious, the superior temperament types and the inferior temperament types are made as Table 5.

Table 5. Superior temperament types and inferior temperament types

Grades	Superior temperament types	Inferior temperament types
Grade 5 (Primary 5)	sanguine-choleric sanguine-phlegmatic sanguine	phlegmatic-melancholic choleric-melancholic melancholic
Grade 8 (Junior Secondary 2)	sanguine sanguine-phlegmatic phlegmatic	melancholic choleric-melancholic choleric
Grade 8 (Senior Secondary 2)	sanguine-phlegmatic sanguine phlegmatic	choleric-melancholic choleric melancholic

CONCLUSION AND DISCUSSION

There is close relationship between emotionality characteristics of temperament and mathematics academic achievement

Learning mathematics activities, which are a kind of process that includes the tight thinking activity, demand a kind of good environmental condition of psychology and require that students study mathematics under a kind of balance and stability emotionality state. The subjects with unstable emotionality characteristics of temperament are often anxious, easy to be excited, often be state such as being bad of sleep. And they often show strong response to the various kinds of stimulates, and it is difficult to resume balance. So, unstable emotionality characteristics of temperament, which does not suit

with psychological environment which learning mathematics activities require, do not benefit learning mathematics.

On the contrary, the subjects with stable emotionality characteristics of temperament are hardly too excited, very apt to resume balance, often relatively calm and steady, and good at controlling and hardly anxious. So, stable emotionality characteristics of temperament suits with psychological environment, which learning mathematics activities require, benefit learning mathematics. Shen (2004) thinks stable emotionality is important and unstable emotionality may be a factor that leads to learning disability.

There is close relationship between internal-external directivity characteristics of temperament and mathematics academic achievement from Grade 2 (Primary 5) and Grade 8 (Junior Secondary 2), but there is not close relationship between them from Grade 11 (Senior Secondary 2).

The students with external directivity characteristics of temperament are sociable person. It is easy for them to get help from teachers, higher grade students and their companions, etc. And because of their lower thinking level and independently studying abilities, the students from lower grade often need others to guide and help during learning mathematics. With the rising of the grade, their abilities have developed and been improved accordingly, and also they have possessed the ability of analyzing and solving the mathematics problem independently. Therefore, under the normal teaching conditions, the subjects who possessed internal directivity characteristics of temperament like independent thinking which remedied their deficiency that they were less likely to ask to help. So we can to conclusion that there is no close relationship between internal-external directivity characteristics of temperament and mathematics academic achievement of students from higher grade.

There is close relationship between temperament types and mathematics academic achievement

Superior temperament types, which benefit learning mathematics, are sanguine, phlegmatic and sanguine-phlegmatic; while inferior temperament types, which don't benefit learning mathematics, are choleric, melancholic and choleric-melancholic. Why? We think we can make explanations from the following two.

First, the modern research of the temperament psychology indicates that temperament is the reflection of behavior characteristics of advanced nervous system activity, and mixing reflection of typical and steady motive characteristics of intensity, speed and flexibility of individual psychological activity (Strelau, 1987). Learning mathematics activities take mathematics thinking as main activities. Its physiological foundation of

mathematics thinking activity is the advanced nervous system of the brain. And the characteristics of some advanced nervous system activity will help develop certain mathematics thinking quality which will influence mathematics thinking activity. Our research indicated temperament types are closely related to student's mathematics thinking quality. And phlegmatic temperament benefits criticize deep and creativity of mathematics thinking. Sanguine temperament benefits flexibility, agility and creativity. Sanguine-phlegmatic temperament has some corresponding superior of the two temperament types. Choleric temperament does not benefit deep and creativity. Melancholic temperament does not benefit the flexibility and agility. And choleric-melancholic temperament has some corresponding inferior of the two temperament types (M. Li, 1995). To sum up, through corresponding thinking quality of mathematics, temperament types influence their mathematics thinking activity, and then will influence their mathematics academic achievement.

Second, learning mathematics activities take mathematics thinking as main activities. Therefore students should have good psychological environments and stable emotionality state. And sanguine temperament, sanguine-phlegmatic temperament, and phlegmatic temperament, which possess stable emotionality characteristics of temperament, benefit learning mathematics. But choleric temperament, melancholic temperament and choleric-melancholic temperament, which possess unstable emotionality characteristics of temperament, do not benefit learning mathematics. Shen (2004) thinks students with sanguine temperament and phlegmatic temperament respectively have stability, flexibility and stability, persistence which all benefit learning mathematics, but students with choleric temperament have impulse which does not benefit learning mathematics, and melancholic temperament have not any superiority of learning mathematics.

Certainly, the reason for close relationship between temperament types and mathematics academic achievement probably includes whether temperament adapts to requirement of class, that teacher explains and reflects behavior difference which is lead by temperament difference of students and that teacher and student act each other (Burger, 2004, pp. 176–186).

Enlightenment for mathematics education

There are close relationship among temperament characteristics, temperament types and mathematics academic achievement. Some temperament types are superior temperament types, and the others are inferior temperament types. Mathematics teachers should grasp methods of identifying temperament types, take corresponding scientific measure according to the temperament types and characteristics, and take use of the positive aspect of all kinds of temperament types and suppress the passive aspect, so that

the students with different temperament types can get better mathematics academic achievement. According to the research (Shen, 2004), students can perform best learning state if teachers take learning style of students into consideration, and when the temperament of students is in accordance with the expectation and demands of teachers, students can achieve good academic achievement (Burger, 2004, pp. 176–186).

According to psychological research, we should not promote to change the temperament types in the educational course. This is because the transformation of traits of nervous system is very slow, and we do not completely know how to transform it (Ye & Kong, 1993, p. 132). So, it is impossible to change the temperament types in practice. In fact, temperament depends largely on heredity (Burger, 2004, pp. 176–186).

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