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Comparison Study on High School Students' Mathematics Belief Systems between Han and Chaoxian Nationality

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This paper attempts to study Chinese high school students' belief systems about mathematics in the Han and Chaoxian nationality. Through comparisons, the results reveal that both Han and Chaoxian nationality high school students hold multiple beliefs and their belief systems are not constant. In addition, there are some differences between these two nationalities.

Key words: Han nationality, Chaoxian nationality, high school students, mathematics belief systems.

Background

On the development of cognitive psychology, there is an increasing interest in the study of students' belief systems about mathematics. Students' belief systems about mathematics are made up of one's views of the nature about mathematics, its teaching and learning, as well as beliefs about self in mathematics and learning contexts (Jin et al., in press).

The beliefs about mathematics are the views about the nature and the value of mathematics (Ernest, 1989). The beliefs about mathematics learning refer to the views about students' ability and the methods of learning (Ernest, 1991). The beliefs about mathematics teaching refer to the views about the purpose of teaching, teaching methods, resources and assessment (Ernest, 1991). The beliefs about self in mathematics involve individual self-confidence, task values, goal orientation and attributions (Op't Eynde et al., 2006). The beliefs about learning contexts refer to the views about the class context, family context and social context (McLeod, 1992).

Students' belief systems about mathematics are an important component of the students' experience. It gradually developed since the day that the students began to learn mathematics, and it has a major influence on the activities of mathematics learning as well as mathematics achievement. Students' learning outcomes are strongly related to their belief systems about mathematics, thus assessment or evaluation of students' mathematical knowledge must be made in an awareness of their beliefs (Trygve Breiteig et al., 2004), and it helps teachers cultivate the student's creativity in mathematics teaching. (Lin, 2007) .

In recent years, scholars researched students' mathematics belief systems extensively, and achieved remarkable results. McLeod (1992) found that the social context provided by schools and families would influence students' beliefs. Wong (2002) studied students' beliefs about mathematics from multiple angles. Markku (2006) studied the students' self-confidence levels from 5th through 8th grades; the results suggested that the levels of self-confidence moved downward with the grade, and the level of self-confidence could predict the students' future development. Jin, Dai, and Guo (2008) investigated middle school students' beliefs about mathematics, mathematics learning and teaching.

Although there have been so many important findings about students' mathematics belief systems thus far, and the general agreement among researchers is that students' beliefs have an important influence on mathematical learning and problem solving, yet the research on this topic has not resulted in a comprehensive model of students' mathematics-related beliefs. As a matter of fact, most of the studies are situated in relative isolation from other beliefs. The research considering cross-cultural studies are few. Indeed, the beliefs of the system are interrelated to each other, and influenced by each other (Jin, 2001; Thompson, 1992), so we must study students' mathematics-related beliefs from a systemic rather than an isolated perspective.

So, this paper investigated and compared Han and Chaoxian nationality high school students' mathematics-related beliefs. Specifically, which mathematics belief systems do the students from different nationalities hold? What is the difference between the two nationalities? Based on Han and Chaoxian nationality, this paper compared high school students' belief systems, including the beliefs about mathematics, learning and teaching, self and learning contexts.

Theoretical Framework

Ernest (1991) summarized five ideologies of mathematics education: industrial trainers, technological pragmatist, old humanist, progressive educator, and public educator. Each group has its own beliefs about mathematics, mathematics learning and teaching, see table 1.

Table 1

Five Ideologies of Mathematics Education: An Overview of Mathematics, Mathematics Learning, and Mathematics Teaching

	Mathematic	Mathematic learning	Mathematic teaching
Industrial Trainers	Set of Truths and Rules	Hard work, effort, practice, rote	Authoritarian transmi-ssion, Drill, no 'frills'
Technologi cal Pragmatist	Unquestioned body of useful knowledge	Skill acquisi-tion, practical experience	Skill instructor, motivate through work-relevance
Old Humanist	Body of structured pure knowledge	Understanding and application	Explain, motivate pass on Structure
Progressiv e Educator	Personalized mathematics	Activity, play, exploration	Facilitate personal explo-ration, prevent failure
Public Educator	Social constructi-vism	Questioning, decision making, negotiation	Discussion, conflict questioning of content and pedagogy

Students' beliefs about the self refer to self-efficacy, intrinsic and extrinsic goal orientation beliefs related to mathematics, task value, and attribution.

Self-efficacy is defined as personal judgments of one's capabilities to organize and execute courses of action to attain designated goals. Research sought to assess its level, generality, and strength across activities and contexts (Bandura, 1997). The intrinsic goals of the students are the desire for

knowledge acquisition and self-improvement; the extrinsic goals of the students are the desire for gaining recognition from others and earning good grades (Robert, 2004). Task value refers to the students' understanding and view about the task value of themselves. Attribution theory deals primarily with explanations for success and failure in achievement situations: ability, effort, and task difficulty. Ability and effort attributions are internal to the individual; task difficulty attribution is external (Robert, 2004).

Students' beliefs about their learning contexts refer to beliefs about the role and the functioning of the students in their own class, beliefs about the role and the functioning of their parents, and the sociological view about mathematics.

There are two kinds of mathematics classroom context. One is traditional mathematics classroom context, and the other one is the new classroom context. The characteristic of traditional mathematics classroom context is that the teachers play the main role in teaching activities. The characteristic of the new classroom context is that the students are the center of the classroom, and teachers occupy the leading position.

There are two kinds of beliefs about family context. One is positive beliefs. Students with these beliefs have a positive recognition about parents' role in offering help in their mathematics learning. The other one is negative beliefs. Students with these beliefs are unwilling to be understood by their parents; they don't let their parents help them learn mathematics, either. They hold a negative recognition about their parents' help and support.

The sociological views about mathematics mainly contain two aspects, the beliefs about gender stereotypes and the beliefs about mathematics superiority.

Based on the Ernest's five ideologies, we identify and compare students' beliefs about mathematics, mathematics learning and teaching. From self-efficacy, goal orientation, task value, attribution and learning contexts, the study identified the students' beliefs about self in mathematics and learning contexts.

Methods

Participants

613 Chinese high school students from 6 cities in Liaoning Province and Jilin Province participated in the study. The number of validated questionnaires was 546. The effective percentage was 89%. See table 2.

Table 2
The Number of the Participants

	Han Nationality				Chaoxian Nationality			
Gender	Male	Female	Total		Male	Female	Total	
Senior One	72	72	144	288	53	96	149	278
Senior two	77	67	144		62	67	129	

Instruments

This paper used a questionnaire based on multiple related literature and theory analysis to investigate high school students' belief systems about mathematics in Han and Chaoxian nationality. We developed a 180-item questionnaire to investigate students' belief systems about mathematics. The questionnaire consisted of five scales that are beliefs about mathematics, mathematical teaching and learning, self in mathematics, and environment of learning. Beliefs about mathematics scales were developed to survey their beliefs about nature and epistemology of mathematics, and its values, including 26 items. Beliefs about mathematical learning scale were developed to survey beliefs about views of students' learning ability and their learning methods, including 34 items. Beliefs about teaching mathematics scales were developed to investigate their beliefs about purposes, methods, resources, and assessment of teaching mathematics, including 47 items. Beliefs about self in mathematics were developed to investigate their beliefs about self, internal and external causes, including 31items. The survey used 5 points of Likert scale: strongly disagree, disagree, undecided, agree, and strongly agree. Numerical values of 1, 2, 3, 4, and 5, respectively, were assigned to the responses to facilitate data analyses.

Following the exploratory analysis, the internal consistency estimates of reliability (Cronbach's alpha coefficient) were computed for the scales representing the five factors. The scale on students' beliefs about mathematics teaching had a very high alpha (.800), as did the scale on the beliefs about the mathematics (.791) and mathematics learning (.742), the self (.723), mathematics learning contexts (.758). The alphas suggest that the five-factor model is a reasonable representation of the data and that an adjusted version of the questionnaire can provide us with an instrument to measure students'

mathematics-related belief systems reliably.

Data Analyses

We used the statistical SPSS 16.0 software to analyze the data. We used mean value, cluster analysis, an independent sample *t*-test to identify the beliefs that students held, and evaluate whether there is difference between Han and Chaoxian nationality high school students' beliefs about mathematics, its teaching and learning, and self and learning contexts.

To identify Han and Chaoxian students' beliefs about mathematics, mathematical learning and teaching, we first used Ernest's five ideologies of mathematics to classify these three beliefs, and according to the average score, we identified which beliefs the students may hold. That is to say, we believe that students hold a belief when its average score is higher than 3. The higher the average score were, the stronger the beliefs they held. Then, a synthetic method of cluster analysis is presented to evaluate and classify students holding beliefs, and determine the central beliefs or peripheral beliefs that students may hold; the classificatory criteria should display a distance between 15~20 at the middle position.

To establish Han and Chaoxian nationality students' beliefs about self in mathematics and learning contexts, we use average scores as the standards. We believe that students hold one belief when its average score is higher than 3. The higher the average score, the stronger the beliefs they held.

Data Analysis

Beliefs about Mathematics

In both the Han and Chaoxian nationality high schools, the average scores of students' mathematics beliefs are higher than 3, except for the industrial trainer. This indicates that they might hold mathematics beliefs of technological pragmatist, old humanist, progressive educator, and public educator. The Dendrogram of hierarchical cluster analysis of the students' beliefs about mathematics in Han and Chaoxian nationality indicates that there are two kinds of beliefs about mathematics held by Han and Chaoxian nationality students. One kind involves the beliefs of the technological pragmatist, old humanist, progressive educator, and public educator. The industrial trainer's belief about mathematics belongs to the other kind. It can be concluded that Han and Chaoxian nationality students hold technological pragmatist, old humanist,

progressive educator, and public educator mathematics beliefs as their peripheral beliefs. There is no core belief. The results of t-test show that there are significant differences between Han and Chaoxian nationality high school students' beliefs in the old humanist, progressive educator, and public educator. Han students held stronger mathematics beliefs of the old humanist, progressive educator, and public educator than did Chaoxian nationality students.

In conclusion, Han and Chaoxian nationality students hold mathematics beliefs of technological pragmatist, old humanist, progressive educator, and public educator as their peripherial beliefs .There is no core belief. Compared with Chaoxian nationality, students in Han hold stronger mathematics beliefs of the old humanist, progressive educator, and public educator.

Beliefs about Mathematics Learning

The data show that the means of students' beliefs about mathematics learning in Han exceeded 3.5, industrial trainer excluded. This indicated that students in Han may hold mathematics learning beliefs of technological pragmatist, old humanist, progressive educator, and public educator. The average scores of students' beliefs about mathematics learning in Chaoxian are higher than Han's 3 points. Therefore, it illustrates that students in Han may hold industrial trainers, technological pragmatist, old humanist, progressive educator, and public educator beliefs about mathematics learning.

The dendrograms of hierarchical cluster analysis on the students' beliefs about mathematics learning in Han and Chaoxian nationality reflects that technological pragmatist, old humanist, progressive educator, and public educator beliefs about mathematics learning belong to one kind, belief of industrial trainers belongs to the other one. It can be concluded that Han and Chaoxian nationality students take technological pragmatist, old humanist, progressive educator, and public educator beliefs about mathematics learning as their peripheral belief. There is no core belief.

The p-value obtained from this test shows that there are significant differences between Han and Chaoxian nationality students' beliefs in technological pragmatist, old humanist, progressive educator, and public educator. Han students hold stronger beliefs about mathematics learning in old humanist, progressive educator, and public educator than Chaoxian nationality students.

In conclusion, in both Han and Chaoxian nationality high schools, students adhere to the technological pragmatist, old humanist, progressive educator, and

public educator beliefs about mathematics learning as their peripheral beliefs. There is no core belief. Compared with Chaoxian, students in the Han have stronger mathematics learning beliefs of the technological pragmatist, old humanist, progressive educator, and public educator.

Beliefs about Mathematics Teaching

The data show that only the average score of industrial trainer beliefs about mathematics teaching is lower than 3. All the means of the other four groups exceed 3 points in the Han and Chaoxian nationality. It is possible that students in the Han and Chaoxian nationality hold mathematics teaching beliefs of technological pragmatist, old humanist, progressive educator, and public educator.

The dendrograms of hierarchical cluster analysis on the students' beliefs about mathematics teaching reflect that Han and Chaoxian students have two kinds of beliefs about mathematics teaching. One involves the beliefs of technological pragmatist, old humanist, progressive educator, and public educator. The industrial trainer's beliefs belong to the other kind. It can be concluded that, students of Han and Chaoxian nationality take technological pragmatist, old humanist, progressive educator, and public educator beliefs about mathematics teaching as their peripheral beliefs. There is no core belief.

The results of the t-test show that there are significant differences between Han and Chaoxian nationality students' beliefs in technological pragmatist, old humanist, progressive educator, and public educator. Han students hold stronger beliefs about mathematics teaching in the old humanist, progressive educator, and public educator than do Chaoxian students.

In conclusion, both Han and Chaoxian nationality high school students take mathematics beliefs of the technological pragmatist, old humanist, progressive educator, and public educator as their peripheral beliefs. There is no core belief. Compared with Chaoxian nationality, Han students have stronger beliefs of the technological pragmatist, old humanist, progressive educator, and public educator.

Beliefs about Self in Mathematics

The average scores of Han students' self-confidence are between 3.5 and 4.5. In the area of internal causes, the means of intrinsic goals, success-effort, and failure- effort are between 3 and 3.5. This indicates that Han high school's

students' self-confidence is on a high-level. Their learning goals belong to intrinsic goals, and they partly attribute success and failure to effort. The average scores of students' self-confidence in Chaoxian were between 3 and 3.5. The means of intrinsic goals, success-effort, and failure- effort in internal cause are also between 3 and 3.5. This indicates that self-confidence of Chaoxian nationality has reached a certain level. Their learning goals correlate with intrinsic goals, and they attribute students' success and failure to effort to a certain degree.

The results of the t-test show that there are significant differences between Han and Chaoxian nationality students' beliefs in self-confidence and intrinsic goals in internal cause. That is to say, students in Han high schools hold higher levels of self-confidence, and the intrinsic goals they hold are more explicit than Chaoxian students.

Briefly in a short word, the learning goals of Han and Chaoxian students are connected to intrinsic goals. The self-confidence of Han students is on a high-level when compared to the students in Chaoxian high schools. They both attribute success and failure to effort. However, there are significant differences in self-confidence and intrinsic goals, Students in Han have higher levels of self-confidence, and the intrinsic goals they hold are more explicit than Chaoxian students.

Beliefs about learning contexts

The means of Han students' beliefs about progress learning contexts are higher than 3.5. This indicates that students in Han hold a higher level of beliefs about progressive learning contexts. The average scores of beliefs about progressive learning contexts are between 3 and 3.5 in the Chaoxian nationality. This illustrates that the belief of students in the Chaoxian is on a certain level.

The results of the t-test show that there are significant differences between Han and Chaoxian nationality high school students' beliefs in progressive learning contexts. That is to say, students in Han have higher levels of beliefs about progressive learning contexts when compared with Chaoxian nationality students.

Results

Beliefs about Mathematics

Students in both the Han and Chaoxian nationality high schools consider that mathematics is a hierarchical body of truths in which the higher level the knowledge is, the stricter the logic is, and the more abstract the content is; the

truth or false of the mathematics knowledge can only be determined by logical reasoning and proofs; mathematics knowledge consists of two parts, one is pure knowledge, the other is applied knowledge. In addition, they believe that the value of mathematics can promote people's development; the producing and judging of mathematics depends on communication and negotiation; mathematics is central to the culture, that is to say, mathematics is formed in society and it has social value; mathematics is a tool, and people have different understandings of mathematics.

However, students in the Han schools preferred to regard mathematics as a tool, as a hierarchical truths body; mathematics needs improvement and a complement; they tend to consider that mathematics is a kind of language which is used to communicate and negotiate with other people; everyone has his or her own idea about it; mathematics knowledge is created when people communicate and negotiate with each other. They usually think that mathematics is closely related with culture, and it is value-laden.

Beliefs about Mathematic Learning

Both Han and Chaoxian nationality students feel that they could obtain mathematics knowledge, skills, and one's own development of potentialities through practical experiences and autonomic learning. Culture and social context play an important role. Mathematics ability is not innate; it is acquired by learning. When learning mathematics, they are willing to communicate and negotiate with others. However, students in Han hold stronger beliefs than Chaoxian nationality students.

Beliefs about Mathematics Teaching

Students in both the Han and Chaoxian nationality high schools consider that mathematics teaching should help students obtain mathematics applied knowledge and master the skills. Mathematics teachers should teach them how to perceive the beauty in mathematics, cultivate in them the abilities of solving social problems about mathematics, and guide them to understand the relationships of mathematical concepts. Mathematics teaching should provide enough opportunities and chances for discussing mathematics problems. Teaching resources should not only be able to help students gain practical experience and skills, but also help them understand mathematical knowledge as well as social problems which were designed by teachers. The assessment

of mathematics learning should be diversified, and it should contain the evaluation of students' knowledge as well as the attainment of applied skills. The process of mathematics learning should be paid more attention. Students in Han hold stronger beliefs than Chaoxian nationality students.

Beliefs about Self in Mathematics

Students in both Han and Chaoxian nationality high schools attribute their success and failure to effort. They believe that mathematics learning should promote students' integrated development. Mathematics learning provides the foundation for students' career development in the future. They perceive the beauty in mathematics, so they are interested in mathematics, and learn mathematics.

However, Han students have higher agreement with the views than Chaoxian nationality students. Students in Han have a higher level of self-confidence.

Beliefs about Learning Contexts

Students in both Han and Chaoxian nationality high schools hold the belief of progressive context. They consider that classroom atmosphere should be active. Students can open the floor for discussion; and they should strengthen cooperation with the other students. Teachers who guide them in learning play an important role. They also think that parents should provide help, encouragement and support in the process of learning. However students in Han high schools hold stronger beliefs in the area of learning contexts.

In all, the points provide us basic components about students' mathematics belief systems in the Han and Chaoxian nationality. Specifically, both of them possess no core belief about mathematics, mathematics learning, and teaching, and they both hold technological pragmatist, old humanist, progressive educator, and public educator as their peripherial beliefs. Han students' mathematics belief systems are stronger than those of Chaoxian students in the areas of belief about mathematics, mathematics learning and teaching, self and learning contexts

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Conclusion

This study mainly analyzes Han and Chaoxian nationality high school

students' mathematics belief systems. The conclusions are as follow:

1. Han and Chaoxian nationality students' belief systems about mathematics are unstable. According to the study, students' mathematics belief system consists of mathematics beliefs, mathematics learning beliefs and mathematics teaching beliefs. They have only peripheral beliefs but no core beliefs. This indicates that the students' mathematics belief systems of Han and Chaoxian nationality are unstable. This may be caused by dynamicity and reconfigurability. So the mathematics beliefs, mathematics learning beliefs and mathematics teaching beliefs in the Han and Chaoxian nationality can easily change as time passes. That is to say, the peripheral beliefs may be gone or may turn to become core beliefs.

2. The students' belief systems about mathematics in the Han and Chaoxian nationality are compound. Han and Chaoxian nationality students simultaneously have diverse beliefs of mathematics, mathematics learning and mathematics teaching which possibly contradict each other. So the students' belief systems about mathematics in the Han and Chaoxian nationality are compound being in agreement with the view of Green (1971). When studying the relationships among peripheral beliefs, Green clearly stated "Beliefs are developed in clusters and affect each other." Each group of beliefs cannot be affected by the beliefs of other groups; instead they may be affected by other beliefs in the same group.

3. There are ethnic differences in the students' mathematics belief systems in the Han and Chaoxian nationality. Specifically, compared with Han students, Chaoxian high school students have stronger mathematics teaching beliefs of the progressive educator. But compared with the students in the Chaoxian nationality, students in Han have higher confidence and stronger beliefs of progressive education beliefs with more specific intrinsic goals.

Recommendation

1. Use reasonable teaching to promote the establishment of scientific belief systems about mathematics. The instability of middle school students' belief systems about mathematics has both positive and negative effects on teaching. Teachers can change the unscientific and unreasonable beliefs students hold through a reasonable teaching method, but some reasonable and scientific beliefs students originally hold will be easy to change at the same time. What's more, the beliefs in high school students' belief system about mathematics are positively correlated. It provides favorable conditions for the

teachers to change the students' beliefs; for example, if a teacher wants to improve the confidence level of students, he or she can realize it by improving the students' intrinsic goals.

2. Schools shall provide a teaching exchanges platform to facilitate cross-cultural exchange. According to the differences of high school students' belief systems about mathematics, schools should enhance exchanges in cross-cultural teaching. Each ethnic group has its own cultural features. Carrying out more exchange activities, such as teaching demonstrations, is favorable for different ethnic groups to draw on the strong points of others to offset their own weakness and enhance their cooperation as well. The exchange activities can also improve the teaching level and qualities, optimize the allocation of teaching resources, improve teaching theories, and benefit students' progress and development. Providing as many exchange opportunities as possible between undeveloped districts and developed districts is an effective way to improve teachers' quality, promote the self development of teachers, learn advanced teaching theories and ideas, and raise the teaching level.

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