

## Research on Mathematics Education in China: A Review of Doctoral Theses<sup>1</sup>

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This paper presents a survey study aiming to systematically review research on mathematics education in China and identify important variables that should be considered in future research. The literature surveyed is selected from doctoral theses. The study reveals that important progress has been made over the last two decades. Following the review and discussion, the study proposes five needed directions for advancing research on mathematics education in China.

*Keywords:* mathematics education; research on mathematics education; review of doctoral theses

*MESC Classification:* D10

*MSC2010 Classification:* 97D10

### 1. INTRODUCTION

In China, many scholars such as Shan & Yu (2001) and Zheng (2005) pointed out that it is very essential to review research on mathematics education in China. In particular, a special academic conference to look forward to Mathematics Education in China in the Next Decade, sponsored by East China Normal University, was held in Shanghai in 2013. Obviously, the

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analysis and assessment of the past achievements should be a prerequisite to the prospect in the next decade. In such a context, the review of research on mathematics education in China has been carried out.

In the wider context, the world is becoming more and more interested in mathematics education in China due to the outstanding performance of Chinese students and scholars in mathematics (Xu & Lee, 2009). The three Forums of All Chinese Mathematics Educators separately were given at the China National Exhibition of Mathematics Education of ICME-9 (9th International Conference of Mathematics Education in Tokyo, Japan; July 31–August 6, 2000), ICME-11 (11th ICME in Monterrey, Mexico; July 6–13, 2008), and ICME-12 (12th ICME in Seoul, Korea; August 8–15, 2012). The fact that international scholars are paying closer attention to mathematics education in China motivates Chinese scholars to paint a clearer picture of mathematics education in China so as to get better understood internationally.

The study presented here is part of a large research effort which aims to review research on mathematics education in China. More specifically, this study aims to:

- 1) Paint a clearer picture of research on mathematics education in China; and
- 2) Identify the important variables that should be considered in future research.

## 2. RESEARCH MECHODS

The Ph. D. thesis contains new ideas, new methods and new trends. And to a large extent, it reflects the research facts and the research level of a specific period at a high altitude in the academic fields. This paper, based on the statistical analysis of Ph. D. theses<sup>2</sup>, describes the research status of mathematics education and tries to look forward to future research.

### 2.1. Selection of Doctoral Theses

Si (2013) produced a catalog of doctoral theses on mathematics education in China, which much facilitated this study. However, Si Haixia's job is incomplete, with some important papers missing. This study adds 18 Ph. D. theses of Gu (1993), Liu (2012), Shen (2011), and other authors, and eventually includes 195 doctoral theses.

### 2.2. Conceptual framework

A conceptual framework about doctoral theses was established for the study.

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<sup>2</sup> The doctoral theses in this paper mean all the doctoral theses about mathematics education, in all the units that confer doctor degree and in the majors including Theory of Education and Developmental and Educational Psychology, etc.

### ***2.2.1. Statistics and analysis based on the completion years of the Ph. D. theses***

Statistical analysis based on the completion years of the Ph. D. theses may present a chronological image of the research status of mathematics education in China, which may show the general development trend and direction of mathematics education in China.

### ***2.2.2. Statistics and analysis based on the Ph. D. conferring institutions***

Statistical analysis based on the Ph. D. conferring institutions may show the geographical distribution of research teams of mathematics education in China and mirror the strength and level of the research units of mathematics education in China.

### ***2.2.3. Statistics and analysis based on the research directions of the Ph.D. theses***

Statistical analysis based on the research directions of the Ph. D. theses may illustrate the distribution of the research directions of research on mathematics education in China. Taking the 195 theses as its study cases, the dimensional range of this paper covers mathematics education and other two research directions. The former refers to the direction of mathematics education under the discipline of theory of curriculum and teaching, which in different universities may have different names, such as theory and practice of mathematics education, mathematics curriculum and teaching theory and mathematics curriculum and teaching research, and mathematics discipline teaching theory, and the latter consists of curriculum theory and educational psychology, etc., other than those of mathematics education.

### ***2.2.4. Statistics and analysis based on the disciplinary distribution of the Ph. D. theses***

Statistical analysis based on the secondary disciplinary levels of the Ph. D. theses may show the disciplinary distribution and origins of research on mathematics education in China.

### ***2.2.5. Statistics and analysis based on the research themes of the Ph. D. theses<sup>3</sup>***

Statistical analysis based on the research themes of the Ph. D. theses may demonstrate the focus and hot spots of research on mathematics education in China. But it's a challenge to categorize the themes. For the current knowledge about the themes of research on mathematics education has not been well unified. Based on the existing research results and pointing to the 195 cases, this paper classifies the themes as theory and practice of mathematics curriculum, mathematics classroom teaching research, mathematics learning theory, mathematics teacher

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<sup>3</sup> When encoding the research subjects of the doctoral theses, we found that some of the theses refer to two subjects. To ensure the integrity of the statistical information, we encoded by means of repeated assignment to the theses. For instance, the doctoral thesis *A Case Study on Tibetan Junior Middle School Mathematics Teachers' PCK Development in Lhasa* (Chen, 2010) referred to two subjects of both mathematics teachers' education and mathematics education of ethnic minorities; therefore, we encoded the two subjects separately.

education, mathematics education evaluation and mathematics education technology, etc.

### **2.2.6. Statistics and analysis based on the research methods of the Ph. D. theses**

Statistical analysis based on the research methods of the Ph. D. theses may reveal the applications of methods in research on mathematics education in China. Yao Jihai and Wang Guangming explored at different levels into mathematics education research methods. This statistical study adopts Yao Jihai's classification to analyze the 195 cases and classified them as speculative research, quantitative research, qualitative research and mixed-method research. Speculative research refers to the researches that take philosophical approaches such as dialectics in their logical analysis of the object or phenomenon and presentation of their own ideas or theories. Quantitative research measures, calculates and analyzes the quantifiable parts of the object and their relations, in order to reveal the essence of the object. In a qualitative research, the researcher forms a comprehensive explanatory understanding of the essence of the object by undergoing a deep, detailed and long-term experience with the object in the interaction between the researcher and the object. And mixed-method research uses the quantitative and qualitative methods alternatively in the study for pragmatic purposes.

### **2.3. Data collection and analysis**

Using the above conceptual framework, we examined and coded all the selected doctoral theses. After all, all of the coding results were analyzed using both quantitative and qualitative methods.

## **3. RESULTS AND DISCUSSION**

### **3.1. Statistics and analysis based on the completion years of the Ph. D. theses**

The completion years of the 195 Ph. D. theses span from 1993 to 2012. For the detailed distribution, see Figure 1.

Figure 1 shows an unsteady curve and a general increasing trend in regard to the number of doctoral theses completed from 1993 to 2012.

In 1993, Gu Lingyuan completed his doctoral thesis on mathematics education, a theoretical summary of Qingpu experiment (cf. Gu, 1993) which was the first one completed in China. Six years later, Professors Gu Lingyuan and Wang Jianpan co-founded the first doctoral training base of mathematics education, quite a contribution to research on mathematics education in China.

From 1993 to 2001, only a few Ph. D. theses came up in the field of research on mathematics education in China. In some of the years in that period, there was not any doctoral thesis at all. The reason might be the simple fact that there had been no mathematics doctoral training

base before 1999, and some scholars could only turn to majors such as comparative education, and developmental and educational psychology to study mathematics education at doctoral level.

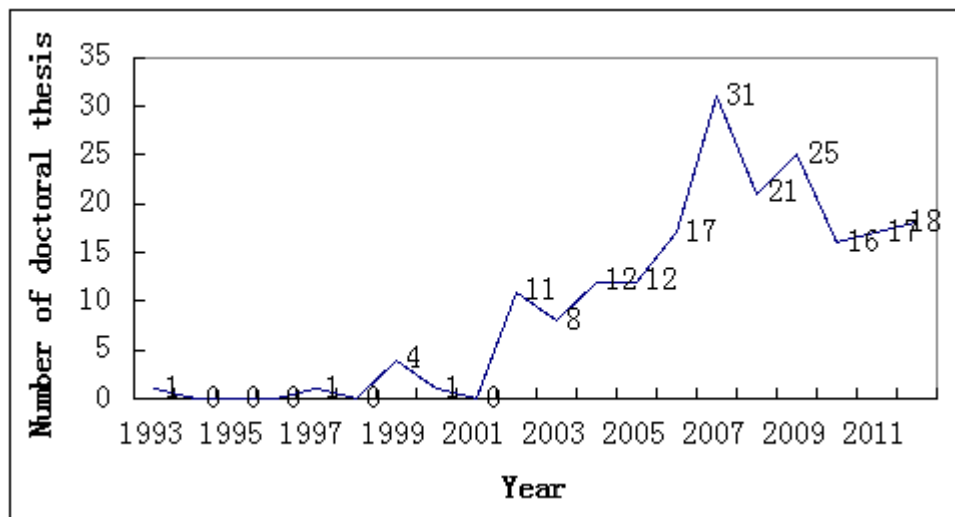


Figure 1. Distribution of research time

From 2001 to 2009, the figure of doctoral theses on mathematics education was gradually increasing, as a number of doctoral training bases were opened since 1999 in universities such as East China Normal University and the number of doctoral students increased. The Ph. D. theses on mathematics education amounted to 31 in 2007, including 11 theses completed by doctoral students in other professional directions than the direction of mathematics education, such as developmental and educational psychology, and educational technology.

From 2009 to 2012, the figure of doctoral theses on mathematics education in China decreased first and then reached a steady state. The reason for the halt in increasing was that doctoral tutors of the older generation in the direction of mathematics education gradually retired in the universities such as East China Normal University and Northeast Normal University, thus leading to the result of fewer theses produced on mathematics education in these universities.

### 3.2. Statistics and analysis based on the Ph. D. conferring units

Referring to Table 1, there were 19 universities in China that conferred doctoral degree for theses on mathematics education from 1993 to 2012. 166 of them, 85.1% of the total, were awarded by East China Normal University, Southwest University, Nanjing Normal University, Beijing Normal University, and Northeast Normal University. That shows the advantage of the top five universities in the area of doctoral research on mathematics education. In East China

Normal University, the Department of Mathematics offered the first doctoral program of mathematics education in China, and a few years later, the Department of Curriculum and Teaching began to recruit doctoral students of mathematics education. Southwest University, Nanjing Normal University and Northeast Normal University successively set up doctoral training bases of mathematics education in this period. Though the doctoral program of mathematics education in Beijing Normal University was a rather late occurrence, a considerable number of doctoral students (such as Zhang (1999) and Kang (2003)) of other research directions, developmental and educational psychology for instance, produced doctoral theses on mathematics education, accounting for 88.9% of the theses turned out in Beijing Normal University.

**Table 1.** Distribution of research units

Name	Theses	Percent (%)
East China Normal University	54	27.7
Southwest University	40	20.5
Nanjing Normal University	27	13.8
Beijing Normal University	27	13.8
Northeast Normal University	18	9.2
Northwest Normal University	5	2.6
Nanjing University	4	2.1
Northwest University	3	1.5
Central China Normal University	3	1.5
Liaoning Normal University	3	1.5
Huazhong University of Science and Technology	2	1.0
Inner Mongolia Normal University	2	1.0
South China Normal University	1	0.5
Capital Normal University	1	0.5
Shandong Normal University	1	0.5
Tianjin Normal University	1	0.5
Jiangxi Normal University	1	0.5
Jilin University	1	0.5
Chinese Academy of Social Science	1	0.5

The 14 universities below the top five, though a percentage of 74% of all the included statistical units produced a number of theses which is only 14.9% of the total production in the calculated years. That is a significant sign of serious difference in research ability among different doctoral training units of mathematics education.

### 3.3. Statistics and analysis based on the research directions of the Ph. D. theses

It is graphically shown in Figure 2 that, 126 doctoral theses, 64.6% of the total, were produced by the students of mathematics education under the discipline of theory of curriculum and teaching, which indicates mathematics education under the discipline of theory of curricu-

lum and teaching played a dominant role in the field of mathematics education in China. And although the doctoral programs for mathematics education under the discipline of theory of curriculum and teaching began to be offered very lately (in 1999), they had a fast development and, in the ten years, the number of Ph. D. theses on mathematics education under the discipline of theory of curriculum and teaching was more than the total production by students in all the other research directions.

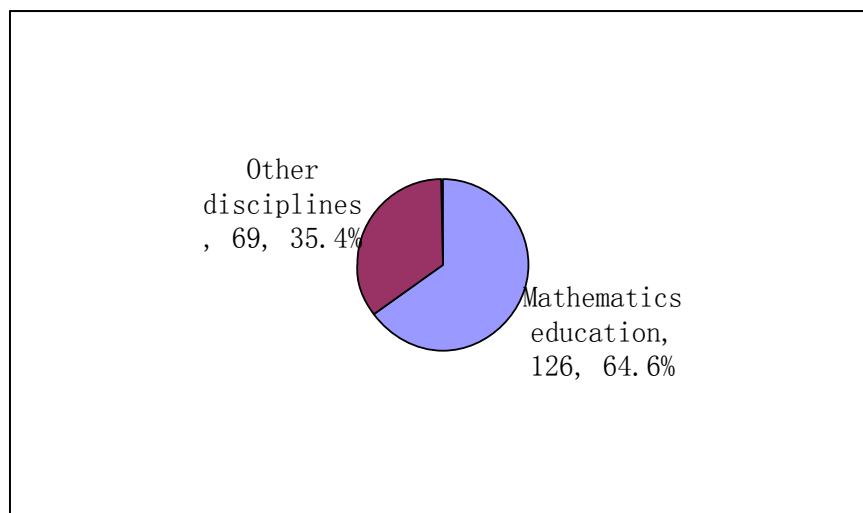


Figure 2. Distribution of research directions

#### 3.4. Statistics and analysis based on the disciplinary distribution of the Ph. D. theses

As Figure 3 shows, a total of 15 second level disciplines are involved in the research on mathematics education in the 195 doctoral theses. In the 15 second level disciplines, mathematics education, a third level discipline under curriculum and teaching theory and thus less importance attached to in the vast majority of Chinese universities, is promoted to the second level first time by Capital Normal University, which enhances practically the academic status of mathematics education.

In the 15 second level disciplines, theses on mathematics education produced by the students of theory of curriculum and teaching are 65.5% of the total, which indicates a dominant role of this discipline in the field of mathematics education in China. 31 theses are produced by the students of developmental and educational psychology, basic psychology and general psychology, a percentage of 15.9 of all the doctoral theses, suggesting a certain discourse power in research on mathematics education. Of principles of education, pre-school education, comparative pedagogy and other three

disciplines, the students turn out 24 doctoral theses, accounting for 12.3% of all the doctoral theses, which points to the fact that mathematics education has become interdisciplinary of mathematics, pedagogy and psychology.

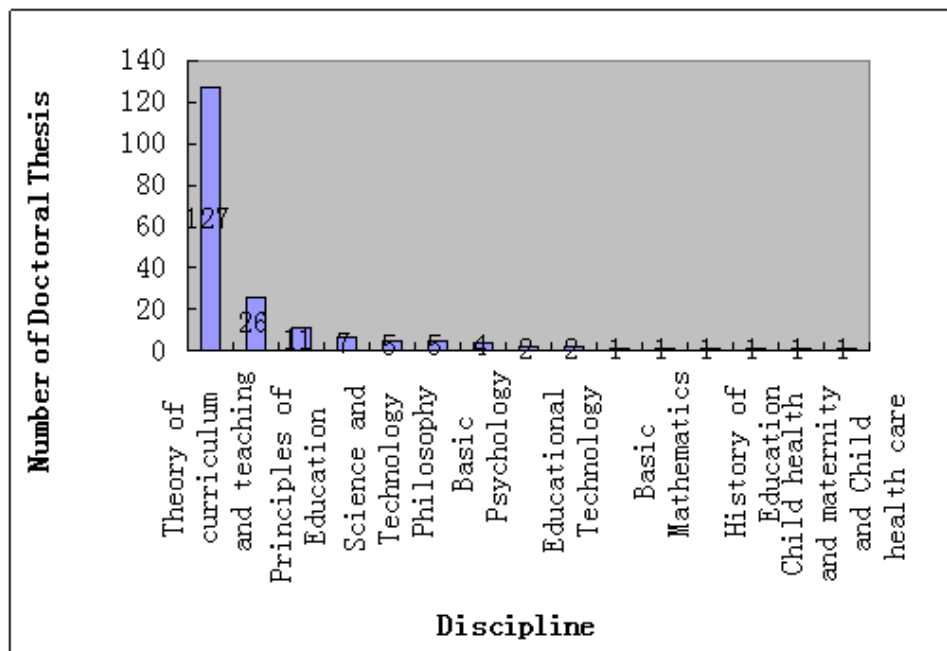


Figure 3. Discipline distribution of the Ph. D. theses

### 3.5. Statistics and analysis based on the research themes of the Ph. D. theses

Table 2 shows that the themes of Ph. D. theses may be roughly divided into three categories. The first category includes mathematical theory of learning and research on classroom teaching of mathematics. The number of doctoral theses of these two themes is respectively over 40 and the proportion over 20% and together 59.5% of the all of the doctoral theses, which indicates, to some extent, that these two themes are emphasized in the field of research on mathematical education. It also shows the focus of the research on mathematics education in China on students' learning and classroom teaching.

The second category consists of theory and practice of mathematics curriculum, history of mathematics and mathematics education, assessment of mathematics education, and research on mathematics textbooks. The number of doctoral theses with these four themes is respectively over 10 and the proportion over 5%, and together 27.2% of all the doctoral theses.



**Table 2.** Distribution of research themes

Themes	Theses	%
Mathematics learning theory	71	36.4
Research on classroom teaching of mathematics	45	23.1
Mathematics teacher education	29	14.9
Theory and practice of mathematics curriculum	17	8.7
History of mathematics and mathematics education	13	6.7
Assessment of mathematics education	12	6.2
Research on mathematics textbooks	11	5.6
Philosophy of mathematics education	4	2.1
Research on teaching reform and experiment of mathematics	4	2.1
Mathematics education technology	4	2.1
Research on mathematics education of ethnic minorities	2	1.0
Others	2	1.0

The third category embraces philosophy of mathematics education, research on reform and experiment of mathematics teaching, mathematics education technology, and research on mathematics education of ethnic minorities and others. The number of theses with these themes is respectively less than 10. Although the studies of these themes are only a few, it is still reflected in them that the research system of mathematics education in China is developing and being improved continuously.

### 3.6. Statistics and analysis based on the research methods of the Ph. D. theses

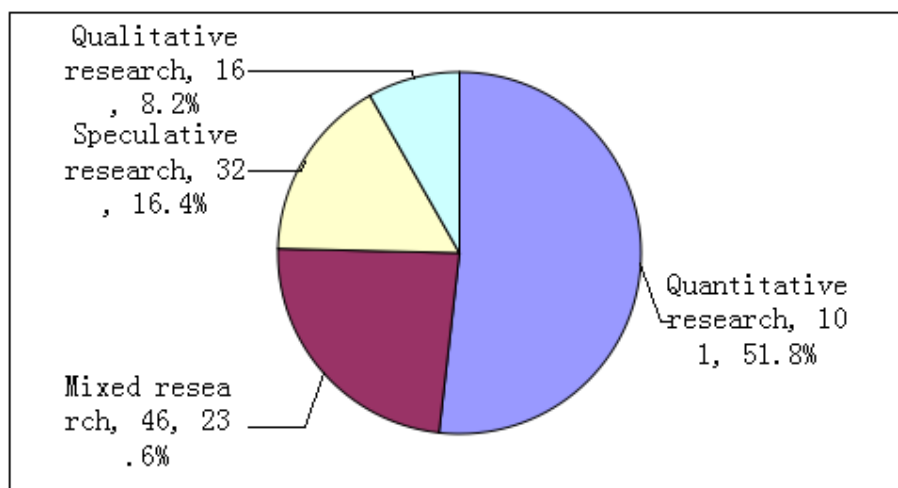


Figure 5. Research methods of the Ph. D. theses

In Figure 5, we may see that the major research method of the Ph. D. theses on mathematics

education is quantitative research. Next to it is mixed research and speculative research. Qualitative research is the least method employed in the theses. The main reason may be that most of the authors of the doctoral theses on mathematics education have a background of mathematics, which gives them a certain advantage of exercising quantitative research, and a certain number of the authors from the psychology majors are skilled in quantitative research.

In the quantitative research, experimental methods and questionnaires are mostly employed. In his *A Study on Influencing Factors and Strategy of Primary Mathematics Teachers' Interpretation of Textbooks*—focusing on the case of textbooks published by Southwest Normal University Press, Shen (2011) uses structural equation modeling as his method of analysis, which is very rare in the Ph. D. theses in China.

Yang (200) is a representative in the qualitative research. In her thesis “A Research into Mathematics Teacher's Instructional Decision-making—Based on a Case Study of an Upper Grades Mathematics Teacher in Primary School”, Yang reaches her conclusion of the characteristics of decision making strategies in mathematics teaching by analyzing oral reports, conducting interviews and examining written materials, a closing-up after experiencing the whole process of teaching planning and decision making.

#### 4. SUMMARY AND FUTURE DIRECTIONS

The achievement of doctoral theses on mathematics education in China kept growing in the last 20 years. In 1993, there was only one thesis, but now every year turns out more than ten. There was no doctoral training base of mathematics education before, then since 1999, a few universities such as East China Normal University set up their doctoral training bases, and now the doctoral programs in the direction of mathematics education have been offered in more than ten universities such as Beijing Normal University. Different academic disciplines are involved and diverse methods employed in research on mathematics education, which leads to the expansion of the research territory. But undoubtedly, there are still problems for us to solve, especially the problems in subject selection, research methodology and so on.

##### **4.1. To upgrade the discipline level of mathematics education**

In the analysis of the disciplinary origins of the 195 theses, it is shown that mathematics education is neither second to the first-level discipline of education nor to that of mathematics. It is only a direction under the second-level discipline of theory of curriculum and teaching. That has seriously hampered the growth of research on mathematics education. We propose to upgrade the discipline status of mathematics education to the second-level discipline.

#### **4.2. To buttress researches on Weak Subjects such as mathematics education of ethnic minorities**

In the analysis of the themes of the 195 doctoral theses, it is obvious that the themes are extensive. But it is statistically shown that the concerns on the themes are unbalanced, some of them over focused, such as learning theory, and others under-concerned, such as mathematics education of ethnic minorities. We suggest more efforts be made to research on the less-concerned themes like mathematics education of ethnic minorities.

#### **4.3. To emphasize the application of diversified research methods in research on mathematics education in China.**

In the analysis of the research methods of the 195 doctoral theses, most of them are quantitative research, some are speculative research and mixed research, and qualitative research is the least employed method. But in the educational domain, most objects of research are adaptive to qualitative research. Therefore, it is important for us to emphasize the application of diversified methods in research on mathematics education in China.

#### **4.4. To strength the standardization of research on mathematics education in China**

Chinese voice is rarely sounded in the international domain of research on mathematics education. Being less standardized may be the first reason. Some foreign colleagues usually remark:

“Mathematics education in China is unique while its research is unsatisfactory. In the theses, serious problems may be found, such as unclear delivery of what to be resolved and with what method, and conclusions reached without reliable evidence.” (Zhang, 2004)

In such cases, it is necessary to strength the standardization of research on mathematics education in China.

#### **4.5. To highlight mathematics in research on mathematic education in China**

In the analysis of the 195 doctoral theses, it is noticeable that some of the doctoral theses on mathematics education, especially those produced by students from the section of developmental and educational psychology, are astray from mathematics itself and get ever closer to general pedagogy and general psychology. Just as Zhang (2005) critically remarked,

“To keep off mathematics has become a trend in research on mathematics education.”

Therefore, the nature of mathematics should be highlighted and research on mathematics education must be distinguished from those of general pedagogy and psychology in future research.

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