EXAMINING THE DEVELOPMENT OF MATHEMATICS EDUCATION RESEARCH IN CHINESE MAINLAND FROM THE 1990s TO THE 2010s: A FOCUSED SURVEY*

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Abstract

Over the last few decades mathematics education in China (refers to the Chinese mainland throughout this paper) has made important progress, along with its rapid economic and social development, and attracted increasing attention internationally. At the same time, mathematics education research in China has also experienced a noteworthy growth in a variety of aspects. To examine how mathematics education research in China has developed and hence explore what are possible and needed directions, we conducted a focused survey of research as mainly published since the early 1990s in the *Journal of Mathematics Education*, the sole national research journal and primary publication avenue in China particularly devoted to mathematics education research. With a focus on first research methods in terms of the general dichotomy of non-empirical methods and empirical methods and then research issues in terms of different areas in mathematics education, the results revealed that over the three decades, empirical studies have turned to be the mainstream of mathematics education research in China, while issues about mathematics teaching and learning have received the dominant attention. Issues about curriculum and textbooks have also attracted fast growing attention, particularly when the issues are related to curriculum reforms. Other topics that have received noticeable increasing attention include issues about mathematics teacher education and professional development, and issues concerning culture and history in mathematics education. Possible and needed directions of the development of mathematics education research in China are discussed at the end of this article.

Key words: International mathematics education, mathematics education research in China, trends in mathematics education, Chinese mathematics education

1. INTRODUCTION

Over the last three decades, Chinese mathematics education has received increasing international attention. This is clearly, though not entirely, related to the fact that Chinese students have been consistently

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among the best performers in the subject of mathematics in international comparisons, including both small-scale studies and large-scale international assessments such as the Trends in International Mathematics and Science Study (TIMSS) and The Program for International Student Assessment (PISA) (e.g., Fan & Zhu, 2004; Jiang & Eggleton, 1995). The world has seen Chinese students' "unique characteristics" and "solid basic knowledge and skills" in their mathematical performance, as well as Chinese teachers' involvement in "teaching-research activities" (somehow like Japanese "lesson study") through Chinese schools' unique "teaching research groups" and teachers' delivery of well-structured lessons (e.g., Cai et al., 2004).

When looking at the contemporary Chinese mathematics education, one should be aware not only of its long cultural tradition starting from its ancient time – of which the most influential is known as the Confucius heritage culture (Wong, 2004) – that has contributed to the formation of Chinese educational philosophy, teaching and learning methods, but also of the rapid economic and social development of the country since China (hereinafter refers to Chinese mainland) adopted the reform and opening up policy in 1978. Such a fast development raises new requirements for education, including mathematics education in China. As a result, there have been a series of educational reforms for the last few decades, which were a driving force not only for mathematics teachers to reform their classroom instruction and improve the quality of instruction, but also for mathematics education researchers to pay attention to new issues emerging in the reform and development. Meanwhile, the opening up policy has also brought growing opportunities for the Chinese mathematics educators to learn about the mathematics education reform and development in other countries, which is another factor that has shaped the research and development of mathematics education in China over the last few decades.

This article is intended to examine how mathematics education research in China has developed during the last 30 years through a focused survey of research as mainly published in the *Journal of Mathematics Education*, the sole research journal in China particularly devoted to mathematics education research. The focus of the survey is on the research methods, and research issues in mathematics education as reflected in the research published. By doing so, we also hope to document and hence identify the main trends of the development of mathematics education research in China over the last three decades and explore what are possible and needed directions for further development.

2. RELATED LITERATURE AND CONCEPTUAL FRAMEWORK

Traditionally, mathematics education researchers in China had dominantly used non-empirical methods including philosophical, theoretical, analytical and historical approaches in carrying out their research, broadly defined, and publications, which was particularly prevailing until the late 1980s. Since around 1990, this issue has aroused increasing attention of researchers in mathematics education, often from an international and comparative perspective (e.g., Zhang, Zeng & Dai, 1990; Fan, 1993; Gu & Yang, 2003), as Fan criticised:

> "For a long time, the carrying out of research work and the obtaining of research results in mathematics education in this country [China] was mainly based on the researchers' synthesis of experiences, analysis of theories and dialectal enquiries. Although this type of research methods can

> sometimes obtain insightful and informative results, and should not be totally abandoned and rejected, there is no need to deny that they have a common limitation, that is, a lack of rigorous scientific argumentation, compelling factual evidence and empirical-based analysis, and often resulting in a relatively large degree of subjectivity and arbitrariness. This has also to a greater extent affected and hindered the improvement of the level of mathematics education research in China." (Fan, 1993, p. 2)

Therefore, Fan called for more use of empirical and experimental methods in mathematics education research. In fact, the issue about the need for more use of empirical methods has also attracted increasing attention from general educational researchers (e.g., Peng & Zhang, 1990; Zheng & Cui, 2001; Yao & Wang, 2013).

In this study, we examine the development of research methods in mathematics education in China over the last thirty years by analysing the use of non-empirical methods and empirical methods in research so as to reveal how the field has changed in terms of research methods over the time. Conceptually, as researchers have argued, "empirical methods typically involve systematic collection and analysis of data (i.e., observation and evidence). They are used primarily in quantitative research involving original collection of data, but also in secondary analyses and increasingly in qualitative research"; in contrast, non-empirical methods typically involve reflection, personal observation, and authority/experience for knowledge acquisition or conclusion (Dan, 2017). Accordingly, following the general dichotomy, we use the term "empirical studies" to refer to those using empirical methods, while using "non-empirical studies" to refer to those using non-empirical methods.

Like in any educational research field, research issues also have fundamental importance in mathematics education research, as research issues reflect not only the interest of researchers, but more importantly, a recognition of what are important to be addressed in their research effort. In this regard, examining and hence identifying researchers' seeking of what constitutes significant issues to address in their research is essential to understand the development of mathematics education research in any particular period (also see Fan, 2013).

In the present study, we examine the research issues as reflected in mathematics education research published over the last thirty years in China by classifying them into different areas. For this purpose, three widely recognised areas in the field of mathematics education research were first identified in the study, which include (1) classroom teaching and learning, (2) mathematics curriculum and textbook research, and (3) teacher education and professional development. Those three broad areas basically correspond to the three constituents of the pedagogical triangle as conceptualized by educational researchers (Ailincai et al., 2015; Friesen & Osguthorpe, 2018), which are students, teachers, teaching and learning materials. In addition, we also looked into a fourth area, namely the issues about culture and history in mathematics education, chiefly due to the fact that the national mathematics curriculum in China has increasingly put more emphasis on culture nurturing in mathematics education (Ministry of Education of the People's Republic of China, 2003, 2018). Moreover, as researchers argued, culture and history are often intertwined (Nagel, 1994). A more detailed description of the framework is given below.

Mathematics teaching and learning. This research area covers issues about how mathematics teaching and learning take place mainly within but also outside mathematics classrooms. Examples in this category

include studies about teachers' different teaching approaches and practices, about students' learning behaviors and difficulties, and about technological and psychological aspects of teaching and learning. Moreover, issues about classroom-based measurement, assessment and evaluation in students' learning of mathematics are also included in this category.

Mathematics curriculum and textbook research. This research area concerns issues about both theoretical and practical aspects of mathematics curriculum reform and development, as well as the use, development and evaluation of mathematics textbooks and more broadly instructional materials.

Mathematics teacher education and professional development. Issues addressed in this area are about mathematics teachers, about their pre-service and in-service training programmes and activities, and about their growth in professional knowledge, skills, beliefs and other professional aspects.

Culture and history in mathematics education. Issues in this research area fall into three specific subareas: (1) culture in mathematics education, e.g., about the concept and value of mathematics culture and how it can be integrated into educational practice, (2) history in mathematics education in both China and other countries, which includes studies, e.g., on how to use knowledge from mathematics history to help mathematics education nowadays, and (3) mathematics education concerning minority students, including studies from an ethnomathematics perspective.

Table 1 presents a summary of the conceptual framework as described earlier. It should be noted that about research issues, given the complexity and breadth of issues in mathematics education and its research, a fifth category, namely "other issues in mathematics education", is added to include all the other studies that do not fall in the first four main areas.

Table 1 A conceptual framework of the survey

Focus	Category/Area
1. Research Methods	Empirical methods Non-empirical methods
2. Research Issues	Mathematics teaching and learning Mathematics curriculum and textbook research Mathematics teacher education and professional development Culture and history in mathematics education Other issues in mathematics education

3. METHODS

Before we conducted this study, we were already aware that there were numerous professional and research journals officially published in China in the field of mathematics education, including *Journal of Mathematics Education*, *Journal of Mathematics (China)*, *Shuxue Jiaoxue* (*Mathematics Teaching and Learning*), to name a few. However, only *Journal of Mathematics Education* (hereinafter referred to as *JME*) is particularly devoted to mathematics education research, while all the others are mainly for publishing discussion and experience-sharing articles about school mathematics and its teaching and learning at different school levels, though some of these journals occasionally also publish articles that might involve, to a greater or lesser

degree, research work. Because of the uniqueness of *JME* as a mathematics education research journal, it has been the primary and most important publication avenue for mathematics education research in China since the journal's founding. This is the main reason that we decided to choose *JME* and analyze the full text of all the articles published in it to achieve the research aims.

JME was launched in 1992 with its editorial board consisting of leading mathematics educators, most being university professors, from all over the country, which in many senses can be considered as a milestone in the development of contemporary mathematics education research in China. The inaugural issue of *JME* was published in 1992, and then the following issues were first published biannually (1993-1994) and later quarterly (1995-2007), and since 2008, bimonthly. As a result, the number of issues and hence articles published in *JME* varied from earlier years to recent years, though each issue usually contains about 20 to 30 articles. In most years, the editorial board also published a list of priority areas of mathematics education as calls for submissions of research articles for publication in the journal.

After we selected *JME*, we applied the conceptual framework, as aforementioned, to code all the articles published in *JME* from its first issue in 1992 to the last issue in 2019, i.e., from Vol. 1, No. 1 to Vol. 28, No. 6. To ensure the reliability, the coding of the articles was done by two researchers of the team independently. A reliability test was then conducted to the two coders' work on a randomly selected 30 articles, and the result shows an overall 90% inter-rater consistency in the coding of research methods. For the coding of research issues, a third coder was invited when a disagreement between the first two coders on an article occurred. Eventually, all the coders agreed on the classification of the articles based on the conceptual framework. As a result, we believe that the data collected through coding are highly reliable.

Like in many other countries, some research journals in education and even in social sciences in China also occasionally publish research articles in mathematics education. Due to the scarcity of this type of articles and a great variety of these journals, they were not included in the coding, which is a limitation of the study, though we did include some research articles obtained from other journals when appropriate, especially when interpreting the results. Besides, it should be noted that some Chinese researchers have published their research about the mathematics education in China in international journals or research monographs. However, due to the scope of the study, we did not include these publications in our coding, though we did include some of these articles for interpreting the results. In addition, readers should be reminded that this study is essentially not intended to provide, nor should it be viewed as, an evaluation of the quality of Chinese mathematics education research over the last decades.

To conclude, we think, given the uniqueness and importance of *JME* as aforesaid, the results obtained from all the research articles published in *JME* can provide us with a relatively comprehensive and important picture of the development of mathematics education research in China over the last thirty years.

4. RESULTS AND DISCUSSION

Below we report the results of the study about the development of mathematics education research in China as published in the *JME* since its founding, first about research methods employed by mathematics educators in terms of non-empirical and empirical studies, and then research issues or interests addressed in terms of

different areas as described earlier.

4.1 Research methods: non-empirical vs empirical studies

In total, there were 3263 academic or research articles, again broadly defined, published in *JME* in its 28 volumes from 1992 to 2019. Figure 1 presents the percentage of empirical studies in all the research articles published in *JME* over the years.

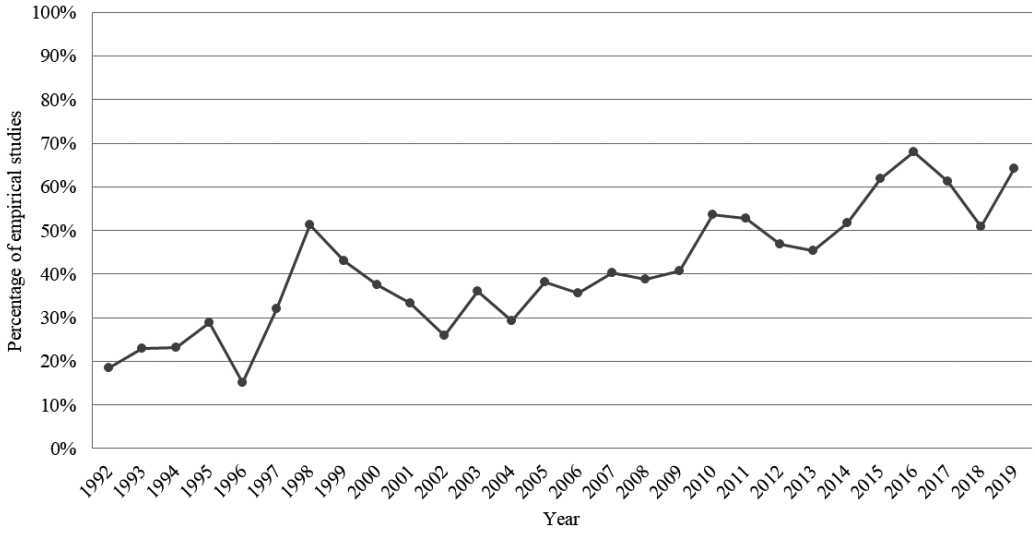

Figure 1 The percentage of empirical studies published in *JME* across years

From the figure, we can see that, though with some fluctuation, there is an overall upward trend in terms of the percentage of empirical studies published in the journal, from about 18% in 1992 to around 65% in 2019.

We further examined the data in the three different decades. The results show that, in the 1990s, about 32% of all the 658 articles published in *JME* were empirical studies, while the other 68% were non-empirical. Most of these non-empirical articles in these years were for discussion and experience-sharing purposes, presenting authors' reflection, insights and practices on various issues about mathematics teaching, learning and problem solving. Such a pattern remained unchanged until 1998, when many articles started to be based on studies using experimental or quasi-experimental methods on mathematics classroom teaching.

In the 2000s, the percentage of empirical studies published in *JME* increased to nearly 36%, out of all the 1221 articles, though still much less than the number of non-empirical studies published in the same period of time. The increasing trend was maintained into the 2010s, during which period the percentage of empirical studies published surpassed that of non-empirical studies, reaching slightly more than 55%, out of all the 1384 articles.

We can also see from Figure 1 that empirical studies have gradually become the mainstream in the 2010s, especially for the recent few years (also see Chen & Tian, 2011; Niu et al., 2016). Among those empirical studies, researchers usually used questionnaire surveys, interviews and achievement tests as their

main methods to collect data (Yu, 2015; Niu et al., 2016).

There are at least three important reasons to explain the gradual but steady shift in mathematics education research from non-empirical methods to empirical methods in terms of research methodology. Those reasons are related to the social, educational and economic development of China, including the national "reform and opening up" policy, as mentioned earlier.

First, Chinese mathematics education researchers have increasingly been aware of the importance of empirical research. In fact, this trend about the awareness has continued to gain growing momentum for the last few years not only in mathematics education, but also in general education. For example, an annual academic event (conference) devoted specifically to empirical research in education, "National Forum on Empirical Education Research", has been held every year since 2015, which attracted a large number of education researchers, including mathematics education researchers (Wang & Gu, 2015; also see http://feer.ecnu.edu.cn/main.htm).

Second, with the fast growth of Chinese economy, there has been a steady increase of the research funds from different sources at both national and local/university levels available for researchers in the field of education as well as mathematics education, which made it increasingly more feasible financially and logistically for researchers to employ empirical methods to undertake educational studies concerning mathematics teaching and learning.

Third, Chinese researchers of newer generations in mathematics education, as in many other areas of education, have received better training on research methods compared with the past. This is particularly the case since an increasing number of universities in the country have set up research degree programmes at master and doctoral levels in mathematics education; as a result, an increasing number of master and doctoral theses were published over the years, which, to a great extent, employed empirical methods as part of their training in the doctoral programmes (Li et al., 2019).

4.2 Research issues: the change of research interests

Below we first present an overall picture of the mathematics education research in China concerning research issues and then take a more in-depth look at the specific issues in each of the four main areas, as discussed in the conceptual framework.

4.2.1 An overall picture

The results of the study show that overall, during the three decades, the largest focused area of mathematics education research in China as published in the *JME* has been "mathematics teaching and learning", with about 41% (or 1333) of all the 3263 published articles addressing issues in this area. Meanwhile, nearly 15% (or 485) of the articles were about "mathematics curriculum and textbook research", and 15% (or 487) were about "mathematics teacher education and professional development". In contrast, the proportion of the articles about "culture and history in mathematics education" was much smaller (8% or 257).

In addition to the four main research areas, the remaining 701 articles, about 21%, fell in the "others" category, i.e., addressing other issues in mathematics education. Among these 701 articles, about 62% (or 432) were on issues, methods and philosophy in mathematics education, and in particular, there were 24% (or 166) meta-studies focusing on various aspects of mathematics education in China or in the world, being

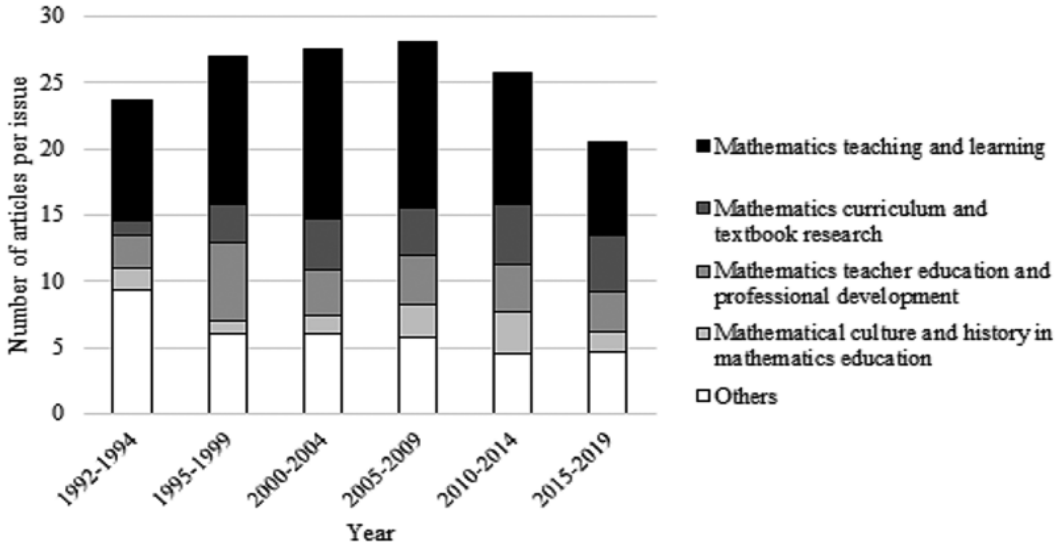

Figure 2 Distribution of articles in *JME* in different research areas from the 1990s to the 2010s

the mostly discussed topic besides the four main areas.

We further examined the distribution of the studies published in terms of the different research areas across different periods to see if there has been a change over time. The results, as depicted in Figure 2, show that the area of "mathematics classroom teaching and learning" has always taken up the largest portion in each time period. Nevertheless, the distribution of the articles on different areas has become more balanced, which appears particularly evident in the last decade.

Overall, from the results, we think that, first, Chinese mathematics educators have paid most attention to the issues concerning mathematics teaching and learning over the last thirty years, which is quite understandable as, after all, the ultimate goal of research in mathematics education is to improve the quality of mathematics teaching and learning and addressing issues in this area has central importance for researchers, and second, the researchers have expanded the scope of research effort and gradually paid more attention to other related areas in mathematics education, which is also a noteworthy indicator, concerning the breadth of research, for us to understand the development of mathematics education research in China.

In addition, we also looked into the stages of education addressed in the articles since *JME* covers all educational levels from kindergarten to university. The results show that about 44% of the studies published were not specifically focused on one certain stage. For those studies which specified the stages of education, most of them addressed issues concerning secondary education, with 12% of all the studies concerning junior high schools (Grades 6-9), 13% senior high schools (Grades 10-12), and 12% secondary education in general. On the other hand, research about primary mathematics education has become more popular in recent years. In comparison, there were few articles focusing on mathematics education at pre-school and vocational high school levels.

4.2.2 Mathematics classroom teaching and learning

There were 1333 articles or 41%, the largest percentage as aforesaid, of all the *JME* articles over the last

three decades devoted to various issues in the area of mathematics teaching and learning.

Looking further into the concrete topics addressed in these articles, we can see that the researchers (authors) conducted a considerable number of studies concerning the innovation or reform of teaching methods in China, such as "teaching with variation" (Gu et al., 2004), "mathematical methodology (MM) teaching experiment" (Xu et al., 1998) and "reducing burden and improving quality (GX) project" (Chen et al., 1994), "situated mathematics problem teaching" (Lü & Wang, 2001), among others.

While "teaching with variation", a term first used by Gu (1981), has become one of the most internationally well-known Chinese teaching methods, the "MM teaching experiment" and the "GX project" had also received much attention from researchers in Chinese mathematics education in the 1990s, as reflected in the *JME* articles. For example, the article of Xu et al. (1998) presented a comprehensive review about the MM teaching experiment, which was largely based on Polya's ideas about problem solving, as well as mathematics teaching and learning, conducted in Wuxi city since 1989, and the article of Chen et al. (1994) reported the GX project, which was aimed to reduce the burden of teachers and students and improve the quality of teaching and learning and started in Chongqing city from 1992. There were also a number of *JME* articles published in other years, most noticeably in 1998, reporting the related results from the two projects. In the 2000s, Lü and Wang (2001, 2006) published a series of articles presenting their research work, which were conducted in both primary and secondary schools in the southwest of China on how to teach mathematics using situational problem and problem posing, an approach apparently influenced by the situated learning theory (Clancey, 1995). In the 2010s, studies published in *JME* put more focus on the teaching and learning of specific core contents (e.g., Wu et al., 2017) and classroom activities (Ye et al., 2010) rather than teaching strategies, though in the last few years, "deep learning" as an instructional approach, instead as a concept in machine learning, had become a hot topic in mathematics education research as published in the *JME* (e.g., Zhu, 2019).

Along with other teaching methods, how to teach different topics in mathematics has always been one of the most discussed issues in China. Among them, open-ended questions, a concept from Japanese mathematics education, have received much attention from mathematics education researchers in China since the 1990s (e.g., Dai, 1993; Chen, 1997; Hu, 1998; Wang, 1999; Qian, 1999). Another highly noticeable theme, mathematics modelling, has also received increasing attention especially since the early 2000s (e.g., Feng & Zhang, 2000; Wang et al., 2005).

In contrast, the number of articles on the learning of mathematics is overall fewer than that on teaching. Nevertheless, the last two decades have seen an increasing number of studies focusing on the issues of learning mathematics. This trend seems related to the shift in the Chinese mathematics classroom instruction being from more "teacher-centred" to more "student-centred", as advocated in the national mathematics curriculum reform.

Along with the economic development, the technological advancement in China was also reflected in mathematics education research. In the 1990s, there were only a small number of the *JME* articles devoted to the issues related to Information and Communication Technology (ICT) and mathematics education. After 2000, with the ICT being increasingly available to teachers and students, and the integration of information technology in mathematics instruction being highly advocated in the curriculum reforms (Ministry of Education of the People's Republic of China, 2001a, 2010), this topic had received considerably

more attention from researchers, as revealed in the articles published in *JME*.

During the past three decades, many researchers have also paid attention to issues on different aspects related to the psychology of mathematics teaching and, particularly, learning, such as ability development (Ning, 2003), learning transfer (Tu, 2006; Ning & Yu, 2010; Zhang, 2001), and cognition on problem solving (Xiao, 1994; Xing et al., 2014).

Finally, let us look at the topic of measurement, assessment and evaluation. In the early 1990s, studies in this aspect of mathematics education were mostly on issues about the ways of examination and evaluation on students' learning abilities, attitudes and outcomes. From the late 1990s to the 2000s, there were increasingly more studies published with focus on new methods of assessment, including formative assessment and summative assessment (e.g., Li, 1996; Yang, 1999; Fan, 2006; Shi & Zheng, 2008). Since 2010, following the new ideas of mathematics literacy raised by the new curriculum, researchers started to pay more attention to the evaluation and measurement of mathematics literacy (e.g., Yu, 2017).

Overall, from the articles published in *JME*, we can see that, since the early 1990s, research in the area of mathematics teaching and learning has become more varied in terms of the issues addressed, and there has been a shift from a major focus on classroom teaching to a more even distribution of articles on different aspects of mathematics teaching and learning.

4.2.3 Mathematics curriculum and textbook research

As can be seen in Section 2, according to the conceptualization of this study, "curriculum (studies)" refers to studies on issues about both theoretical and practical aspects of mathematics curriculum reform and development, while "textbook research" refers to studies on issues about the use, development and evaluation of mathematics textbooks and more broadly instructional materials.

Figure 3 shows the number of the *JME* articles examined in this area. It can be seen that there was a growth of the number of articles overall in this area published in *JME* from the 1990s to the 2000s, which was the peak period, and then a slight decline in the 2010s. In addition, the number of articles published on curriculum studies was consistently more than that on textbook research for a long time in the first two decades, during which both subareas have received an overall increase, but the pattern was changed and

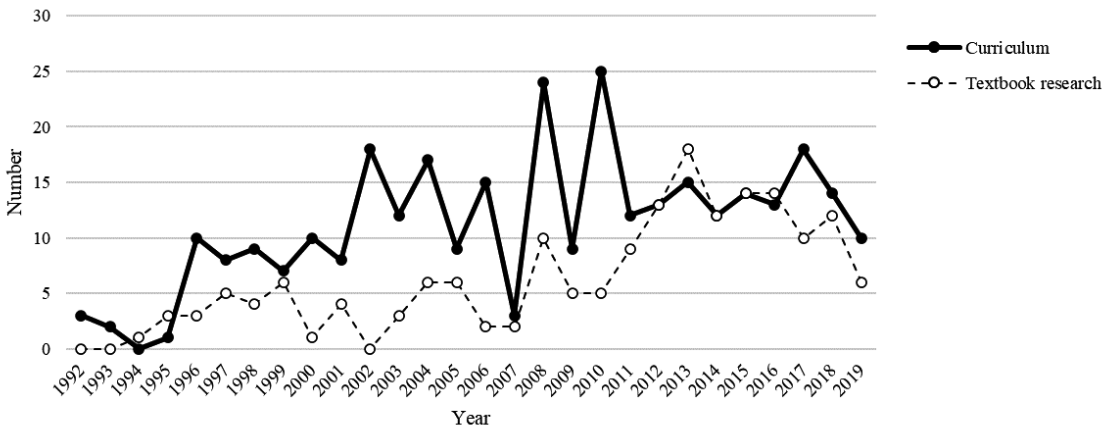

Figure 3 The number of the *JME* articles on curriculum and textbook research across years

largely no longer true in the 2010s.

Like in many other countries and regions, China adopts a highly centralized education system. There are national curriculum standards for virtually all school subjects including mathematics. All the textbooks, although being more decentralized in the 2000s and published by different publishing houses, must follow the curriculum standards. With this general context, it must be noted that there was a major curriculum reform taking place around the turn of the new century, culminating with the Ministry of Education's issuing new national reform-based mathematics curriculum standards (called "syllabus" before) in 2001 for compulsory education (Grades 1 to 9) and in 2003 for senior high schools (Grades 10 to 12) (Ministry of Education of the People's Republic of China, 2001b, 2003).

Following the new curriculum and the implementation of "one curriculum, multiple textbooks" policy, many different series of mathematics textbooks were approved for publication and use in schools. The new curriculum and new textbooks, which follow the curriculum, raised both theoretical and practical issues for researchers to address before, during and after the reform. Therefore, it is not surprising to see the overall change of the number of the *JME* articles in the area of curriculum and textbook research, which reached peak in the 2000s, as shown in Figure 3 (also see Xu, 2013).

Another reason that we think should be taken into account to explain the increase of the number of studies in textbook research in the 2010s is related to the international trend in textbook research (e.g., Fan, et al., 2013; Schubring & Fan, 2018). In other words, it is also a reflection of the international influence on Chinese mathematics education under the background of China's opening up to the outside world.

A further examination of the articles published in this area reveals that issues about the most commonly accepted concepts about mathematics curriculum in China, such as "two basics", "four basics" and "core literacy", were well studied in different periods (e.g., Zhang & Zheng, 2011; Zhu et al., 2018). More recently, issues about the development of students' "core literacy", which consists of six aspects: mathematical abstraction, logical reasoning, mathematical modelling, mathematical operation, intuitive imagination, and data analysis, have become very popular topics for researchers, in relation to the release of the latest curriculum standards (Ministry of Education of the People's Republic of China, 2018).

In the field of textbook research, the first article appeared in *JME* in 1994 (Yu, 1994), and in the 1990s, most studies focused on the evaluation of the structure and connectivity of knowledge in the existing textbooks, such as the structure of secondary trigonometry textbook (Zuo, 1996) and geometry textbook (Song, 1997). In the 2000s, researchers started to investigate the use of these new textbooks focusing on specific contents and modules (e.g., Liu, 2004; Yang, 2004) and teachers' perceptions about the new versions of textbooks (Peng, 2005), and in the 2010s, researchers paid increasing attention to textbook comparisons (e.g., Wu, 2016), and moreover, textbook development (e.g., Fan & Wu, 2015), which we think has highly practical significance worth further research.

4.2.4 Mathematics teacher education and professional development

In order to examine the studies on issues about mathematics teacher education and professional development, we further classified this broad area into three subareas, pre-service teacher education, in-service teacher education and professional development, and knowledge of mathematics teachers.

Figure 4 presents the results about the number of studies published in *JME* in the three subareas in the

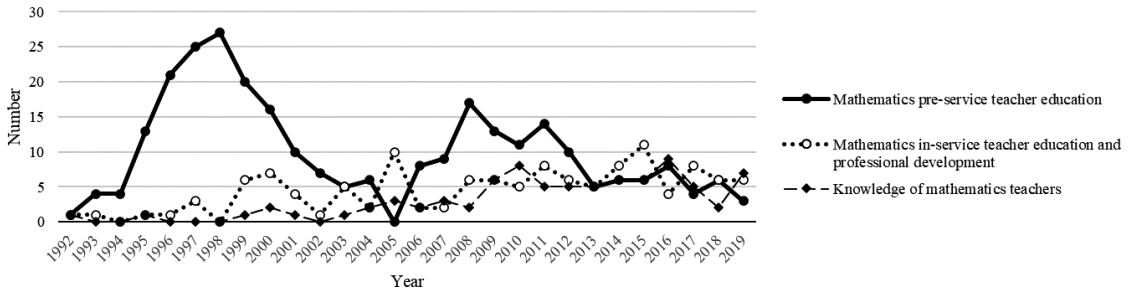

Figure 4 Trends of the *JME* papers on mathematics teacher education and development

three decades. From the results, it can be seen that, overall, the number of studies on pre-service education declined considerably from the 1990s to the 2010s, while the number of the studies on in-service teachers education and professional development had to some extent increased. These changes indicate that mathematics education researchers in China have paid growing attention to issues about in-service teacher rather than pre-service teachers since the 1990s. In addition, a particular domain about teachers, i.e., knowledge of teachers, also has received increasing attention for the last three decades.

A more specific look at the data reveals that, during the 1990s, most of the articles (or 88%) in this area were about issues on pre-service mathematics teacher education including, for example, how to set up pre-service teacher education programmes in normal universities, how to improve pre-service education quality, how to teach specific pre-service training courses using innovative teaching methods (e.g., microteaching), and how to better offer practicum and internship experiences in their pre-service training (Jin, 1997; Li et al., 1997; Zhang, 1999).

In the 2000s and 2010s, in-service mathematics teacher education and professional development received more attention in research, which appears related to a broad social background that the importance of in-service training and professional development was more widely recognized in the whole society including policy makers. It is particularly noteworthy that a nationwide large-scale in-service teacher professional development project, the *National Training Project for Primary and Secondary School Teachers,* was launched by the central government in 2010. As many normal universities were tasked to provide in-service training under the large project, researchers from those universities published numerous studies addressing related issues about, for example, in-service teachers' need for professional development and their professional knowledge, based on their participation in the project (e.g., Cheng et al., 2015; Yang et al., 2015).

Finally, regarding mathematics teachers' professional knowledge, over the last three decades and especially in the last fifteen or so years researchers have looked into a variety of issues from different perspectives, such as Pedagogical Content Knowledge (PCK), Mathematics Knowledge for Teaching (MKT), Mathematics Pedagogical Content Knowledge (MPCK), Technological Pedagogical Content Knowledge (TPACK), and in particular, how teachers developed their professional knowledge (e.g., Wang & Liu, 2008; Tong, 2010; Li et al., 2011; Yuan, 2012; Pang, 2018; also see Zhao & Fan, 2020). Overall, there has been a clear growth in the number of the *JME* articles focusing on the issues about teachers' knowledge.

4.2.5 Mathematical culture and history in mathematics education

When we examined the *JME* articles, a fourth area of research interests, that is, issues about culture and history concerning mathematics education, stood out clearly in addition to the three major areas, as discussed earlier. The results revealed that overall the number of the *JME* articles in this area reached pinnacles in the early 2010s but decreased in recent years (also see Figure 2).

Looking further at the three specific subareas: (1) culture in mathematics education, (2) history in mathematics education and (3) mathematics education concerning minority students, in particular from an ethnomathematics perspective, as mentioned in the conceptual framework, we found that articles on history and mathematics education took up one third of the work, while articles on minority students and ethnomathematics took up the least portion in this area.

Regarding issues concerning culture and mathematics education, a small number of articles published in *JME* in the 1990s focused on mainly practical issues, for example, how to integrate mathematical culture into mathematics education (e.g., Li, 1992; He, 1994; Huang, 1996). In the early 2000s, the demand of integrating mathematical culture into primary and secondary education had increased and hence attracted increasing attention from researchers to a wider range of issues, for example, Fu and Zhang (2005) and Zhang and Zhang (2009) examined the cultural factors of mathematics curriculum and senior high school mathematics textbooks, revealing that the mathematical culture represented was mainly from the west, while Zhou and Miao (2009) studied how to set up mathematical culture courses in universities to satisfy different needs of students in different specialisations. It is also worth noting that in the early 2010s, *JME* reserved a special column for articles on the construction of mathematical cultural courses, as a result of a national project on this aspect (e.g., Zhou, 2011; Cai, 2011; Zhu & Huang, 2012; Guo, 2012; Yang, 2014; Gu, 2014), and during this period, this subarea of research received the most attention.

It should be also noted that, the majority of the articles published in this subarea were non-empirical or general discussion papers, and moreover, articles specifically focusing on primary or secondary education were rare, which we think is an indicator of the complexity of issues about "culture" and the challenge in conducting research in this subarea (Fan et al., 2018). Clearly, further research effort is highly needed in this direction.

As China has a long history in mathematics and mathematics education, it is not surprising that Chinese mathematics education researchers have paid attention to related issues for a long time. The last three decades have saw a considerable growth in this direction, and especially, the History and Pedagogy in Mathematics (HPM) has become a highly dominant theme (e.g., Wang & Ou, 2003), while the First National History of Mathematics and Mathematics Education Symposium, held in 2005, has become a milestone event in the development of research in this subarea (Wang, 2017; Shen et al., 2017).

Regarding mathematics education for minority students, there has been a clear growth in research in this subarea since year 2001 (Zhang et al., 2015), though a closely related concept of "ethnomathematics" has received attention in China much earlier after the term was coined by D'Ambrosio (1999) in the 1970s. A sharp increment in the number of the *JME* articles appeared in year 2010, which was likely related to the issuance of an important government policy about improving education quality in ethnic minority regions (Ministry of Education of the People's Republic of China, 2010). Among the most frequently discussed topics in this field were issues concerning the gap between mathematics education of ethnic minorities and

the Han, about the effect of bilingual teaching – where "bilingual" means Mandarin and their ethnic languages – on mathematics education, and about integration of ethnic culture into mathematics education (Hu & Zhou, 2018). Overall, it seems clear to us that this subarea is still at an initial stage of development in terms of both breadth and depth of the research.

5. SUMMARY AND CONCLUSIONS

This study aimed to examine the development of mathematics education research in China by a relatively comprehensive survey of all the 3263 articles published in China's sole national research journal and primary publication avenue, *Journal of Mathematics Education*, over the last three decades since its inaugural issue in the early 1990s. The focus of survey was on the research methods in terms of the general dichotomy of non-empirical methods versus empirical methods, and on the research issues in terms of different areas in mathematics education. As a result, we think several conclusions can be summarized from the overall picture of the development of Chinese mathematics education research, which has been shaped by different factors, as discussed above.

Firstly, over the last three decades, empirical studies have gradually become the mainstream of mathematics education research in China, which is particularly the case in the last 10 years. Given the increasing awareness of the importance of empirical research in generating new knowledge in education and mathematics education, the wider availability of research funding and the better training of researchers of newer generations, it appears this trend will continue as a much needed direction, though non-empirical studies should not be totally abandoned or rejected.

Secondly, in terms of research areas, teaching and learning of mathematics have consistently received most attention from Chinese researchers, with 41% of the *JME* articles examined addressing issues in this area, in the three decades. Under this general pattern, a shift from a major focus on classroom teaching to a more even distribution on different aspects of mathematics teaching and learning can be observed, and in particular, the last decade has seen an increasing number of studies focusing on the issues of learning mathematics. We think this trend is clearly related to the fact that "student-centred" approaches have been strongly advocated in the national mathematics curriculum reform.

Thirdly, issues concerning mathematics curriculum and textbook research have attracted the second largest attention from researchers, with slightly more than 15% of the *JME* articles examined addressing issues in this area. This is not only related to the national curriculum reforms taking places during this period, but also related to the international development in this area, which is particularly the case when we observe the fast development of textbook research in the last two decades, a direction worth further research.

Fourthly, issues about mathematics teacher education and professional development also attracted considerable interest, with nearly 15% of the articles falling in this area. Moreover, pre-service teacher education received most attention in the 1990s, while in the 2000s and 2010s, in-service mathematics teacher education and professional development received increasingly more attention, and in particular, there was a fast growth in research on teacher knowledge and knowledge development for the last fifteen or so years. Given the importance of in-service teacher education and professional development, we think it is another

direction that merits further attention.

Finally, researchers have also paid considerable attention to issues concerning culture and history in mathematics education and some other topics such as issues, methods and philosophy in mathematics education research. Overall, the distribution of research interest on different topics or areas in Chinese mathematics education has become increasingly more balanced, particularly in the last decade. With the emergence of new research areas, issues and demands in mathematics education, such as the use of AI in mathematics classroom, e-textbooks, developing students' creative thinking, we think this trend, i.e., the expansion of research interest in mathematics education to a wider range of issues concerning mathematics teaching and learning is still at an early stage, and it should and will likely continue for the next decades to come.

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