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Mathematics learning for school readiness of kindergarteners in the western rural area of China – taking county S as an example*

Summary

Taking 167 kindergarteners just one year before elementary school from 7 different kindergartens in county as an example, this research examined kindergarteners' math development for school readiness in a rural area of western China. From the research carried out, it was concluded that development in different math abilities are not coordinated, that the children's performance in number and volume are much better than in geometry and relationship, and that there are significant differences between different kindergartens regarding location and funding – children from independent public kindergartens and private kindergartens, charging expensive tuition fees and located in county towns, are much better than others. Therefore, it is reasonable to assert that math education in rural kindergartens is in urgent need of improvement, with teachers needing to update their ideas and techniques in math education so as to enhance support and guidance in the areas of geometry and relationship. Also, government must make further effort to improve the condition of educational equity within country areas, which, at this stage, means reinforcing high quality resources such as good teachers in countryside kindergartens.

Keywords: rural area of western China, mathematics, school readiness, equity of education

1. Background

School readiness has become a hotspot for early childhood education research on the Chinese mainland in the last 10 years. This can partly be attributed to the positioning of early childhood education in mainland China, where it is stated that "early childhood education should lay a good quality foundation for young children in their recent and lifelong development" (the Ministry of Education 2001[1]). On the one hand, this positioning is related to an important principle, namely that "kindergartens and elementary schools should keep close contact and cooperate with each other, and pay attention to the connection

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[1] In 2001, the Ministry of Education published a legal document named The Guidelines for Preschool Education (trial) or in Chinese《幼儿园教育指导纲要（试行）》. It is the national curriculum guideline for preschool education and is still in effect.

between the two stages of education" (the Ministry of Education 1996[2]). On the other hand, it is also influenced by school readiness research in other countries, especially the United States. School readiness in the United States "is not only an issue in the field of early childhood education, but also a social and political issue related to educational equity and racial harmony" (LIU Yan 2006). This perspective has led research into school readiness to go further. Under the national policies named "promote equity and improve quality" as stated in the Outline of the National Medium-and Long-Term Program for Education Reform and Development (2010-2020), there are important obligations to narrow the gap between urban and rural areas, to improve the quality of early childhood education for each and every child. In addition to this, from the perspective of regional balance and educational equity, it is of obvious and significant value to research young children's school readiness in Chinese western rural areas.

"Mathematics is an important component of school readiness" (Xiao Shujuan et al. 2009), 5 to 6 year old children's mathematics learning is the most powerful predictor of later academic performance (Duncan et al. 2007). Liu Yan (2012), Feng Xiaoxia (2009), Gai Xiaosong (2008) and other researchers' studies have revealed that young children's mathematics development is obviously different between urban and rural areas and between families of different socio-economic status. Based on this information, some corresponding policy suggestions have been proposed. However, since educational equity is not something that exists just between urban and rural areas, but also inside the same rural area, as well as within the same county, issue of difference and equity are worthy of further exploration. At the same time, mathematics, as the weak field in current rural early childhood education, is also worth continuous attention. Therefore, this research intends to investigate kindergarteners' mathematics development for school readiness, exploring the possible paths for promoting the quality of kindergarten mathematics education and improving the balance and equity of early childhood education in western rural counties.

2. Methods

2.1. Sampling

Using a purposive sampling technique, county S was chosen as the sample area. Located in Chongqing and autonomously governed by the minority Tujia, county S is on the list of national counties of poverty. Within this county, using stratified random sampling, 7 kindergartens and 167 children were invited to become samples.

Information of samples

Locations	Public		Private
	Independent	Affiliated	
County town	1(38)		1(19)
Countryside		3(60)	2(50)

[2] In 1996, the Ministry of Education published a legal document named The Preschool Work Order or in Chinese 《幼儿园工作规程》. It served as the "law" for preschools. This document is also still in effect.

Note: numbers outside of the brackets are kindergartens, inside, children. In total there are 90 boys and 77 girls, 99 children are aged five, 67 are aged six, and 1 is aged seven. Although they are both established and funded by government, an independent public kindergarten is a legal entity while an affiliated public kindergarten is not. Usually, an affiliated public kindergarten is affiliated to an elementary school.

2.2. Tool

The research adopts **the Assessment of School Readiness: Mathematics** (Pan Yuejuan and Liu Yan 2010) as its basic tool. This assessment concerns 4 areas of math learning including: numeracy, quantity, geometry and space, and relationship. The 4 areas are further divided into 8 dimensions. These include 28 questions and a total score of 29 points (see table 1). The internal consistency reliability (Cronbach's alpha) is 0.763.

Table 1. The structure of ***the Assessment of School Readiness: Math***

Areas	Dimensions	Questions	Scores
Numeracy	Meaning and comparison	5	5
	Addition and subtraction	5	5
Quantity	Comparison	5	5
Geometry and space	Geometry	4	4
	Spatial orientation	2	2
Relationship	Classification	2	2
	Ordering	3	3
	Pattern recognition	2	3
Total		28	29

Data was managed and operated by SPSS 18.0.

2.3. Process

7 graduate students (2 PhD and 5 Masters) majoring in early childhood education were invited to perform the assessment. Training was provided in advance to help them understand the intention of the research, to familiarize them with the instructions and the way to score and record. The children were assessed one by one in an independent room arranged by the kindergarten. One teacher was always in the room as an assistant providing psychological support and a sense of security for the child. The process was approved by the internal research board of Southwest University and the local authority of county S.

3. Results

3.1. Children's overall situation for school readiness in mathematics

3.1.1. Mathematics test scores in general

The test scores for the whole sample of children are from the minimum 4 to the maximum 27. The average is 15.8 and standard deviation is 4.795. The frequency distribution of the different scores is as below.

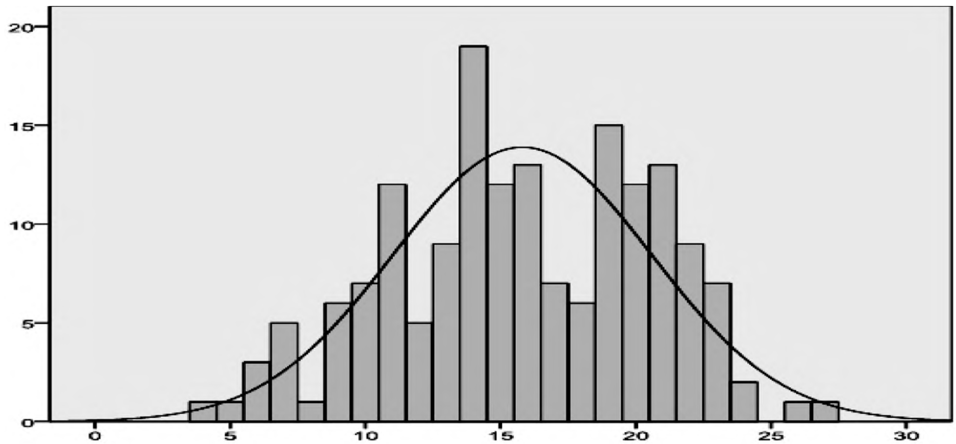

Figure 1. The frequency distribution of different scores

3.1.2. Condition of numeracy

The scores in numeracy are shown in table 2. The pass rate of each question is in table 3. Based on a T test, it can be seen that addition and subtraction is much better than meaning and comparison of numbers.

Table 2. Summary of conditions in numeracy

<table>
<tr><th></th><th>N</th><th>Minimum</th><th>Maximum</th><th>Mean</th><th>Standard deviation</th><th>t</th><th>P</th></tr>
<tr><td>Meaning and comparison of numbers</td><td>167</td><td>0</td><td>5</td><td>2.81</td><td>1.102</td><td rowspan="3">-3.459</td><td rowspan="3">.001</td></tr>
<tr><td>Addition and subtraction</td><td>167</td><td>0</td><td>5</td><td>3.18</td><td>1.462</td></tr>
<tr><td>Numeracy</td><td>167</td><td>0</td><td>10</td><td>5.99</td><td>2.200</td></tr>
</table>

Table 3. Pass rate of each question in numeracy

Question number	Test content	Pass rate %
1	Meaning and figure of numbers	91.6
2	Comparison of numbers (with pictures)	42.5
3	Comparison of numbers (with pictures)	77.8
4	Multiple comparison of numbers (with numbers)	25.2
5	Comparison of numbers (mental arithmetic)	44.9
6	Subtraction within 10 (with pictures)	81.4
7	Addition within 20 (with pictures)	63.5
8	Subtraction within 10 (with pictures)	77.2
9	Addition within 20 (mental arithmetic)	43.7
10	Addition within 20 (mental arithmetic)	52.1

3.1.3. Condition in quantity

The test scores are from the minimum 0 to the maximum 5, the average is 3.07, the standard deviation is 1.285. The pass rate of each question is as below.

Table 4. Pass rate of each question in quantity

Question number	Test content	Pass rate %
11	Comparison of size and arrangement (with pictures)	55.7
12	Comparison of length and arrangement (with pictures)	80.2
13	Comparison of thickness (with pictures)	68.3
14	Multi-weight comparison (with Pictures)	47.3
15	Multiple length comparison (with Pictures)	55.1

3.1.4. Condition in geometry and space

This area consists of 2 secondary dimensions. Test scores are given in table 5. The pass rate for each question is in the following table 6.

Table 5. Summary of condition of geometry and space

	N	Minimum	Maximum	Mean	Standard deviation
Geometry	167	0	4	1.42	1.016
Spatial orientation	167	0	2	1.12	.638
Geometry and space	167	0	6	2.54	1.308

Table 6. Pass rate for each question in geometry and space

Question number	Test content	Pass rate %
16	Graphical differences (with pictures)	52.1
17	Triangle cognitive (with Pictures)	48.5
18	Graphic combination (with Pictures)	22.8
19	Graphic combination (with Pictures)	20.4
20	Right-left direction (with Pictures)	73.7
21	Multiple upper and lower direction (with Pictures)	38.3

3.1.5. Condition in relation

This area contains 3 secondary dimensions. Test scores are in table 7. The pass rate of each question is in the following table 8.

Table 7. Summary of condition of relation

	N	Minimum	Maximum	Mean	Standard deviation
Classification	167	0	2	1.01	.665
Ordering	167	0	3	2.13	.952
Pattern recognition	167	0	3	1.06	.897
Relation	167	0	8	4.20	1.817

Table 8. Pass rate of each question concerning relation

Question number	Test content	Pass rate %
22	Physical classification (with pictures)	32.9
23	Pattern - size - shape classification (with pictures)	68.9
24	The ordering of numbers (with pictures)	71.9
25	The ordering of height (with pictures)	73.7
26	The ordering of size (with pictures)	67.1
27	Simple pattern recognition (with pictures)	49.1
28(1)	Complex pattern recognition (with pictures)	45.5
28(2)	Complex patterns of cognitive expansion (with pictures)	12.0

3.2. Differences among children

3.2.1. Gender differences

The T test shows that there is no significant difference between boys and girls in both the total score (see the table below) and the sub-areas.

Table 9. Gender differences in test scores

Gender	N	Mean	Standard deviation	t	P
Male	90	16.02	4.769	Male	90
Female	77	15.55	4.844		

3.2.2. Differences between locations

The T test shows that there is significant difference between children from kindergartens located in different places. In each area and the total score (see the table below), children from kindergartens located in county towns score much higher than children from countryside kindergartens.

Table 10. Differences between locations (total scores)

Locations	N	Mean	Standard deviation	t	P
County town	57	18.96	4.248	6.931	.000
Countryside	110	14.17	4.225		

3.2.3. Difference between kindergartens

ANOVA analysis shows that children in independent public kindergartens perform much better than others, in total score (see the table below), and each area ($P<0.001$). Affiliated kindergartens trail behind in almost every area.

Table 11. Nursery – nature of differences in test scores

	N	Mean	Standard deviation	D		P
Private	69	15.26	4.598	Public affiliated-private	-.928	.240
Public affiliated	60	14.33	4.610	Public independent-affiliated	4.772	.000
Public independent	38	19.11	3.894	Public independent-private	3.844	.000
Total	167	15.80	4.795			
between groups F=14.225 , P<0.001						

ANOVA analysis and further multiple comparisons also show that among the 7 kindergartens, the independent public kindergarten and WX private kindergarten located in a county town are much better than the others (P<0.001).

4. Discussion

4.1. The differences among different learning areas in mathematics

Firstly, the average pass rate of the 4 areas from high to low are: quantity (61.32%), numeracy (59.99%), relationship (52.64%), geometry and space (42.63%). And the average pass rate of the 8 secondary dimensions from high to low are: ordering (70.9%), addition and subtraction (63.58%), comparisons of quantity(61.32%), the meaning of number and comparison (56.4%), spatial orientation (56%), classification (50.9%), geometry (35.95%) and pattern recognition (35.53%). Secondly, analysis of the pass rates one by one shows that the questions with the highest pass rate are the ones for number and comparison (question No.1, 91.6%), addition and subtraction (question No.6, 81.4%), the comparison of quantity (question No.12, 80.2%), while the questions with the lowest pass rate are the ones for number and comparison (question No.4,25.2%), geometry (question No.18, 22.8%), geometry (question No.19, 20.4%), orientation (question No.21, 38.3%), classification (question No.22, 32.9%), and the second question for pattern recognition (question No.28-2,12%).

This situation shows that the level of learning and development for children's mathematics in different areas is unbalanced and not coordinated. This is consistent with a number of previous research conclusions (PAN Yue-juan, QIU Zhi-hui , LIU Yan, ZHOU Xue 2012). The better areas are numeracy and quantity, while the poor areas are especially geometry, pattern recognition, and so on. It is relatively consistent with ordinary parents and teachers' general understanding of mathematics in rural areas, namely mathematics is often approximately equal to arithmetic, and, therefore, the other learning areas, to a certain degree, are neglected. At the same time, it is also affected by the level of children's cognitive development. Five-six year old children in kindergarten stay at the preoperational thinking level, so that with the help of a physical operation or representation, they can solve simple and intuitive mathematical problems, but if the problem requires a continuous and complex representation operation and lacks the support of objects (such as multiple comparison of numbers, object rotation by representation in the mind, etc.), or the problem involves the general view and abstraction of phenomenon (e.g., object classification and pattern recognition), their performance is poor.

Children's performance in mathematics on the one hand, is a direct reflection of the quality of education they have received previously. Therefore, it is necessary for kindergartens in rural areas to improve and enhance the quality of mathematical education, especially to strengthen guidance given in mathematical areas such as geometry and relationships. It is also necessary to attach importance to cultivating children's abilities at representation, as well as to make abstractions and summaries through hands-on activities, and then the achievement of a balance of development in all areas of mathematics.

4.2. The differences among different children

Apart from gender, there are significant differences in school readiness for children's mathematics between kindergartens in county towns and the countryside, as well as among kindergartens with different funding. Firstly, in terms of the total score and all the areas and dimensions, children from kindergartens located in town areas score significantly higher than those from kindergartens in the countryside; secondly, in terms of the total score and all the areas and dimensions, children from independent public kindergartens score significantly higher than those from private and public affiliated kindergartens; thirdly, in terms of the differences between different kindergartens, children from the public independent kindergartens and the private kindergarten named WX located in town areas, score significantly higher than other ones. But there is no significant difference existing between them, as well as several other kindergartens.

This case shows that there are still significant differences and an imbalance between different pre-school institutions and children from town areas and countryside areas within the same county. This difference can be explained from several perspectives:

- The first is that the differences are affected by the socio-economic position of the family. With kindergartens located in county towns, whether the kindergarten is independent public, or private with higher fees, the families' positions are obviously higher than families located in the countryside.
- The second factor is the different qualities of kindergartens and teachers. The independent public kindergartens and private (cozy) ones have better mathematical school readiness and a better status with more professional teachers. In addition to this, public affiliated kindergartens on the one hand have weaker teachers (there are more teachers without certification, temporary teachers, and former primary teachers), on the other hand, there is more time spent on meaningless waiting, and a tendency towards inappropriate primary teaching activities.

The conclusion is that even though enrollment is no longer a major concern, the issue of equity in early childhood education is still a long way from being resolved. Even within the same county, due to problems related to the allocation of resources and other issues, there are still significant differences in the quality of early childhood education in different institutions; the weak area being the countryside. Therefore, further measures should be taken to optimize the structure for kindergarten teachers and to enhance the quality of kindergartens.

5. Conclusions and suggestions

At present, the development of early childhood education in China is focused on the countryside of western China. Even within the same county, according to the test results in children's mathematics, there are significant differences between children from different backgrounds, regions, and preschool institutions. These differences have revealed that the allocation of early childhood educational resources are not equal and that better quality resources are mainly concentrated in the town areas of the county. Meanwhile, children's performances in different areas of mathematics show that the development is obviously uneven and without coordination, something which is revealed in the deviation in mathematics education in the countryside areas of the county.

In order to raise the overall level of school readiness for children's mathematics, we need to change the educators' educational concepts of mathematics, to enhance the support and guidance of children's mathematical ability with regard to space, relationship and so on. In order to further improve educational equity in the countryside of the county, from the long-term strategic perspective, we need to solve the problems of equal allocation of quality resources (especially teacher resources) and to strengthen the allocation of quality resources in the kindergartens of countryside areas. From a short term strategic perspective, we can consider taking some measures to provide special support for kindergartens in countryside areas, such as various compensatory educational programs.

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