Mathematics Teaching in Hong Kong Pre-schools: Mirroring the Chinese Cultural Aspiration towards Learning?

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Abstract

Chinese pre-school children perform well in learning mathematics compared with English-speaking children. This study investigates the scenes behind Chinese pre-school children's mathematics performance using teacher questionnaires and interviews. Results indicated that the Chinese number system appeared to afford advantages to Chinese children in learning individual mathematics concepts but this was not enough to explain why children perform well in other areas. Frequent practice and exposure to mathematics in pre-schools, together with parental support at home might explain why children performed well in mathematics learning. Study results also revealed that although the underpinning philosophy of pre-school curriculum planning in Hong Kong might be similar to some pre-schools in other parts of the world, such as the adoption of integrated curriculum and unstructured play, contradictory practice might also be incorporated. Mathematics teaching in Hong Kong pre-schools mirrors the Chinese cultural aspiration towards learning, and both teachers and parents play an active role in pursuing academic success for each child.

Keywords: early childhood education; mathematics; culture.

1 Introduction - The influence of culture and the number system in early mathematics learning

Asian children perform better than their peers in other parts of the world in cross-national mathematics studies at the primary and secondary levels. Studies have found that Asian children’s learning is supported by their distinct number systems (Miller & Stigler, 1987; Miller & Zhu, 1991) and cultural contexts (Huntsinger et al., 1997;
Stevenson & Stigler, 1992; Saxton & Towse, 1998). In understanding the relationship between the Chinese cultural context and the learning of mathematics, Ng and Rao (2010) have reviewed studies on how the discrete Chinese number system supports Chinese children in learning mathematics concepts such as counting, numbers, operations, place value and ordinal numbers, while arguing that the Chinese cultural context may also be important in supporting children’s mathematics learning.

Based on Ng and Rao (2010), the author conducted a study (Ng, 2012) employing the Rasch model to analyse number and operations learning amongst Hong Kong Chinese pre-school children. Results showed that the developmental sequence of Hong Kong children was generally aligned with standards in English-speaking countries, but that they performed better in some areas such as counting, writing and using numerals, and learning ordinal numbers. The study concluded that although the Chinese number system might help us to understand why children excel in learning some mathematics concepts, it is not enough to establish the relationship between children’s performance and the Chinese number naming system. Classroom instruction and cultural beliefs in mathematics learning are also important in explaining children’s performance. In addition, although the results of the aforementioned study had high levels of item and person reliability, they did not help to elaborate on the reasons behind children’s performance. To communicate the essence of the empirical data in a meaningful way and to show that the measures employed were valid (Bond & Fox, 2007), the present follow-up study was conducted to investigate the scenes behind children's performance. Specifically, this study explores (i) the planning of mathematics teaching in Hong Kong pre-schools; and (ii) teachers’ views on mathematics teaching and children’s performance, and how they are related to the Chinese number system or the cultural context of learning.
2 Mathematics teaching in Chinese societies

Hong Kong primary and secondary school students perform well in comparison with their English-speaking counterparts in cross-national mathematics studies such as the TIMSS and the PISA mathematics literacy test (HKPISA Center, 2008; Leung, 2005; TIMSS, 2007). Smaller scale studies involving pre-school children have also highlighted that Hong Kong children outperform their English-speaking peers (Aunio, Ee, Lim, Hautamaki, & Luit, 2004; Aunio, Aubrey, Godfrey, Pan, & Liu, 2008; Aunio, Niemivirta, Hautamaki, Van Luit, Shi, & Zhang, 2006; Cheng & Chan, 2005). There is a dearth of empirical study informing us about the teaching of pre-school mathematics in Chinese societies. Therefore, mathematics teaching and learning in primary schools are examined to serve as a frame of reference for the present study.

Hong Kong is considered as a very Asian city, with over 95% of the population ethnic Chinese. This section provides a brief description on the ideas influencing Chinese culture. Confucianism is widely used by both Chinese and Western researchers in understanding Chinese perspectives on child development (Lau & Yeung, 1996), and has been acknowledged to exert a profound influence on Chinese culture (Ebrey, 1993; Higgins & Zheng, 2002). Confucian values, which place a high value on academic success and stress effort and external motivation (Leung, 2001; Li, 2000, 2002), influence Chinese people residing in societies such as mainland China and Hong Kong.

Studies of mathematics learning have revealed that Chinese primary school students receive more support from their families (Cai, Lin, & Fan, 2004; Rao, Chi, & Cheng, 2009; Zhang & Zhou, 2003) than do other students, in the form of a positive attitude towards education and academic achievement. Varying beliefs between Chinese and Western mathematics teachers also result in different time spent on academic activities (Stevenson et al., 1985) and the adoption of different teaching strategies (Cai,
Moreover, in comparison with their English-speaking peers, Chinese primary school children may benefit from more coherent lesson organisation (Leung & Park, 2002; Leung, 2005) and more well-designed textbooks (Fuson & Kwon, 1991; Leung & Park, 2006; Murata, 2008). Many of the above studies reveal how the Chinese cultural context supports the learning of mathematics focus in primary schools and they serve as basis for discussing mathematics teaching in pre-school years.

3 Pre-school mathematics teaching in Hong Kong

Official documents and empirical studies provide an understanding of pre-school mathematics teaching in Hong Kong schools.

The Guide to the Pre-school Curriculum in Hong Kong (Education Department, 2006) and the list of 'Dos and Don'ts' (Education Bureau (EDB), 2010) are official documents providing basic principles guiding the orientation of curriculum planning. It is suggested that the curriculum should match the experience, ability, interests, development and thinking ability of children (Education Department, 2006; EDB, 2010), and it is recommended that overloading or a difficult curriculum be avoided (EDB, 2010). Various activities based on children’s own and school-provided experiences should be organised to make learning more effective and meaningful (EDB, 2010). Teachers should make use of every opportunity to introduce and consolidate mathematics concepts through play and learning activities' (Education Department, 2006, p.31). In assessing children, dictation, tests or examinations are not recommended as assessment modes. Instead, it is suggested that continuous observation be employed to monitor children’s performance and progress in various respects (EDB, 2010). The Guide provides 'general directions for curriculum development', and states that' [p]re-primary institutes need to formulate their own curriculum based on this Curriculum
Guide and transform it into appropriate learning experiences for children’ (Education Department, 2006, p.10). In short, a play-based integrated approach of learning is proposed. However, these guides made no detailed recommendations on the mathematics concepts that have to be introduced in pre-school years.

In addition, there is a gap between the recommendations made in official documents and practices adopted in the classroom. First, there is the problem of the pre-primary to primary transition (Chan & Chan, 2002, 2003; Rao, 2002; Rao & Koong, 2000). There is 'downward pressure on kindergartens to adopt formal academic curriculum as well as test-oriented and teacher-centered approaches to prepare children to seek admission into certain primary schools favored by parents for their high academic-oriented and unduly difficult curriculum' (Chan & Chan, 2002, p.82). Wong (2003) found that there was top-down pressure on the pre-primary sector to adopt an academically focused curriculum to help children gain access to desirable primary schools and prepare them to adapt to the primary curriculum more easily. Li and Rao (2005) found that Hong Kong teachers used a drill-and-practice approach in teaching early literacy, although there was an attempt to follow the guidelines by using interactive teaching methods. Pearson and Rao (2006) also concluded that the main pedagogical objectives at the pre-primary level are to ensure children achieve formal literacy and numeracy skills through direct instruction. Intense competition amongst pre-schools as also resulted in the provision of a more academically focused curriculum parents expect (Rao & Li, 2009). Therefore, it is not clear whether the planning of mathematics teaching in pre-schools is influenced by Chinese cultural aspiration or the downward pressure from the primary schools in looking for good academic results. It is also unclear whether the principles advocated in official documents are observed in pre-school mathematics curriculum planning.
In curriculum planning, many principals and teachers adopted one of the learning packages provided by local publishers (Li, 2006). Based on their chosen package, principals or teachers designed classroom activities for their children, but admitted that they were not sufficiently qualified to develop their own school-based curriculum independently without expert guidance and other input. The findings echoed a previous study investigating pre-school teaching involving numbers and addition (Ng, 2005), which found that pre-school teachers had weak mathematics content knowledge and had little confidence in teaching mathematics. Against this background, it is necessary to examine how the pre-school mathematics curriculum is planned, how teachers view their mathematics teaching and children's performance, and how curriculum planning and teachers' views related to the Chinese number system or the cultural context of learning.

4 Teachers’ knowledge and children’s learning

In exploring whether children's mathematics learning is supported by the Chinese number system or the cultural context of learning, the present study obtained evidence from teachers. Both the planning of mathematics teaching and teachers' views on mathematics teaching and children's performance were investigated to see whether and how they are related to the Chinese number system or the cultural context of learning. Research has indicated that teachers’ decision-making process is greatly influenced by their knowledge, beliefs and attitudes (Fang, 1996; Pajares, 1992; Schoenfeld, 2001). The research literature on teachers’ mathematics content knowledge and pedagogical knowledge will be discussed in the next section.

Teachers’ knowledge influences their teaching. According to Reys (1980), knowledge of mathematics includes knowledge of 'its extent and depth; its structure and unifying concepts; knowledge of procedures and strategies; links with other subjects;
knowledge about mathematics as a whole and its history' (p.16). Teacher’s knowledge will 'underpin the teacher’s explanations, demonstrations, diagnosis of misconceptions, acceptance of children’s own methods, curriculum decision (such as emphasising central concepts), and so on' (p.16, 17). Teachers’ mathematics content knowledge impacts on the richness of mathematics available for children as well as the structure of the classroom (Fennema & Franke, 1992). When teachers’ knowledge of the topic is organized and explicit, they can represent the topic in varied ways, teach more dynamically and can respond to children’s questions more flexibly. Children’s responses can form the basis for extended discussion and further learning. The lesson is likely to be more child-centered. It is clear that instruction and subsequent learning is richer. On the other hand, when a teachers’ knowledge is limited, they tend to teach according to textbooks and the lesson becomes more teacher-directed with less teacher-student interaction (Fennema & Franke, 1992). Therefore, the need to study the planning of pre-school mathematics and the role of learning packages in the planning process are highlighted. More than that, it has been recommended that teachers understand the development of number from a mathematical point of view before they explain number concepts to young children. Although teachers are not going to introduce the concepts of natural numbers, integers, rational numbers and real numbers to children, they should get hold of what later ideas can be built on the foundations of number development concepts.

More than that, teachers should acquire pedagogical knowledge to transform and represent mathematics knowledge for teaching. Such pedagogical knowledge includes the knowledge of the different ways and approaches in presenting different mathematics topics (Ernest, 1989). Pedagogical content knowledge implies the ways of representing the subject knowledge that makes it understandable to learners. This includes the
knowledge of using illustrations, examples, explanations, demonstrations (Fennema & Franke, 1992), and 'a knowledge of typical student understandings and misunderstandings of particular topics, and how they might be anticipated or dealt with in instruction' (Schoenfeld, 2001, p.267).

Against the background of understanding whether children's mathematics learning is supported by the Chinese number system or the cultural context of learning, the aims of the present study are:

(1) To explore the planning of mathematics teaching in Hong Kong pre-schools; and
(2) To examine teachers’ views on mathematics teaching and children's performance, and how they are related to the Chinese number system and/or the cultural context of learning.

5 Research design and methodology

5.1 Participants

The present study was a follow-up study to a previous study by the author (Ng, 2012) investigating the performance of Hong Kong Chinese pre-school children based on Western studies involving English-speaking children, and examining the relationship between the Chinese number naming system and children’s performance in number and operation concepts. To communicate the essence of the empirical data in a meaningful way and to show that the measures employed were valid (Bond & Fox, 2007), the present follow-up study was conducted to investigate the scenes behind children's performance. As in Ng’s study, the present study was guided by the framework in discussing the influence of culture and number system in pre-school mathematics learning (Ng & Rao, 2010).

The children and teachers in Ng's (2012) study were sampled by systematic sampling comprising 299 children aged from 3 to 5 years and their teachers (30 teachers)
from 10 pre-schools located on Hong Kong Island (4 schools) and in Kowloon (3 schools) and the New Territories (3 schools). All teachers and children who participated in the study are ethnically Chinese. Teachers assessed children’s performance using a checklist (Ng, 2012) constructed on the basis of the investigation of Baroody (2004) and other empirical studies. All participating teachers were invited to join the present study, and seven out of the ten sample pre-schools agreed to join. The other three schools withdraw due to the departure of their school principals, teachers or both. As a result, 19 teachers (7 K1 teachers, 5 K2 teachers and 7 K3 teachers) participated in the present study. A questionnaire and semi-structured group interviews were used to collect data.

5.2 Questionnaire

The questionnaire (Appendix 1) was administered to teachers to examine the mathematics curriculum planning and teachers’ views on children’s mathematics performance. The questionnaire consisted of three parts. The first part addressed the first aim of the study on how the pre-school mathematics curriculum was planned, including content selection, teaching and learning strategies, and time scheduling. It was designed in accordance with literature showing that Asian students might benefit from their cultural context, including aspects such as well-designed textbooks (Fuson & Kwon, 1991; Leung & Park, 2006; Murata, 2008), more coherent lessons (Leung, 2005; Leung & Park, 2002) and more school time spent on mathematics activities (Stevenson et al., 1985). The second part addressed the second aim of the study on investigating teachers' views on mathematics teaching and children's performance, and how they are related to the Chinese number system or the cultural context of learning. Teachers had to elaborate on the reasons behind children’s mathematics performance from the previous study (Ng, 2012), which demonstrated that Hong Kong children performed well in general, and performed exceptionally well in areas such as writing numerals,
learning counting and learning ordinal numbers. However, children did not perform well in learning relational terms and estimation. The third part aimed to examine teachers’ knowledge of number and operational concepts. Practically, the second and third parts merged to form a table for teachers’ easy reference. Quantitative data was calculated, and answers to open-ended questions were coded as qualitative data using codes for interview data. The development of codes for group interview data is displayed in the following section.

5.3 Group interviews

After responding to the questionnaire, the participating teachers (n=19) were invited to attend semi-structured focus group interviews to elicit additional information on their views on curriculum planning, mathematics teaching, and children’s performance. To ensure consistency between interviews, the interview protocol (Appendix 2) was constructed and focus questions were prepared which matched the three foci of the questionnaire. The interviews were audiotaped for follow-up analysis with the teachers’ consent. A preliminary analysis of interview data following the steps of data reduction, data display, and conclusion drawing were done. Qualitative data was coded according to the focus of the study and after re-reading of data. As a result, keywords such as curriculum content, time, learning activities, and teachers’ mathematics content knowledge emerged and developed into codes for coding the data. The codes were also used to link the open-ended data collected by teachers' questionnaire. Therefore, the qualitative data collected in the interviews was used to perform data-type triangulation to validate the responses collected by the questionnaire.

6 Results and discussion

The data collected by the questionnaire and the interviews are reported together to address data triangulation. The following sections are organised according to the
research aims in understanding (i) the planning of mathematics teaching in Hong Kong pre-schools; and (ii) teachers’ views on mathematics teaching and children’s performance, and how they are related to the Chinese number system or the cultural context of learning.

6.1 **The planning of mathematics teaching**

In investigating the planning of mathematics teaching, curriculum content selection, teaching and learning strategies, and time scheduling were taken into consideration.

6.1.1 **Curriculum content selection** The questionnaire asked teachers to tick and list all the reference materials they adopted in selecting curriculum content (Table 1). Among the 19 teachers, all of them use commercially published materials as their references. Teachers at all levels teaching at one school also made reference to the official curriculum guide (Education Department, 2006), and one teacher from another school chose content according to her past experience and children’s performance.

| Table 1 Reference materials teachers adopted in selecting curriculum content |
|------------------|---|---|---|---|
|                  | K1 (n=7) | K2 (n=5) | K3 (n=7) | Total (n=19) |
| Commercially published materials | 7 | 5 | 7 | 19 |
| Teacher’s past experience | 1 | 0 | 0 | 1 |
| Children’s performance | 1 | 0 | 0 | 1 |
| Official curriculum guide | 1 | 1 | 1 | 3 |

In the interviews, two teachers from different pre-schools claimed that commercial learning packages were useful in helping them to plan their mathematics teaching. As Teacher A said,

The learning packages provide suggested mathematics concepts, activities and relevant worksheets. We usually plan [the curriculum] according to these references… It is OK…

(K1 Teacher A)

Teachers all noted that they had confidence in their curriculum planning and one teacher noted that the planning process was a group task involving the principal and the...
teachers concerned. One teacher further elaborated that the learning packages provided adequate information and support for them, including lists of mathematics concepts and activities design. These findings echo that of Li (2006), who found that commercial learning packages were commonly adopted by teachers as curriculum resources. Teachers also believed that children from different pre-schools were learning similar mathematics concepts if commercial learning packages were used in planning. The following interview excerpt represents the views of the teachers.

We are all taking reference from commercially published learning packages. The difference may be the sequence in learning these concepts only. (K2 Teacher I)

As another teacher pointed out, the exception was curricula for privately run pre-schools. As K3 Teacher R said,

We believe that the selection and sequencing of mathematics concepts are similar for most of the schools. Exceptions may be found among the privately run pre-schools [and the curricula of these pre-schools] may be comparatively difficult in order to attract parents.

In line with previous findings (Rao & Li, 2009), this quotation showed teachers have the perception that some parents prefer a more difficult curriculum for their children although the exact impact on teachers' curriculum planning was unknown.

6.1.2 Teaching and learning strategies

The questionnaire asked teachers to tick or state the activities and strategies they used for mathematics teaching. The results show that various activities were adopted (Table 2).

Table 2 Mathematics teaching activities reported by teachers in Hong Kong pre-schools

<table>
<thead>
<tr>
<th>Activity</th>
<th>K1 (n=7)</th>
<th>K2 (n=5)</th>
<th>K3 (n=7)</th>
<th>Total (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching themes</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Group work</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Daily routines</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Naturalistic classroom settings</td>
<td>7</td>
<td>5</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Worksheets</td>
<td>7</td>
<td>5</td>
<td>5</td>
<td>17</td>
</tr>
</tbody>
</table>
Physical activities*  1 2 2 5  
Musical activities*  1 2 2 5  
Arts activities*  0 0 1 1  
English activities*  0 0 1 1  

Note. Items asterisked in the table were added by teachers

During the interviews, teachers of all schools admitted that their mathematics lessons were structured and integrated with the curriculum as a whole. However, children also learned through naturalistic classroom settings, such as by queuing up or going to washrooms. These results are aligned with the recommendation in the official curriculum guide (Education Department, 2006), which stated that 'teachers should make use of every opportunity to introduce and consolidate mathematical concepts through play and learning activities' (p.31).

According to the questionnaire, all teachers used both observation and worksheets to assess children’s learning (Table 3). A variety of assessment activities was observed, and both formative and summative assessment methods were adopted to track the learning and development of children. However, pencil and paper tests were used by three pre-schools in assessing children, which is not in line with Education Bureau recommendations (EDB, 2010).

Table 3 Methods used to assess children’s learning

<table>
<thead>
<tr>
<th></th>
<th>K1 (n=7)</th>
<th>K2 (n=5)</th>
<th>K3 (n=7)</th>
<th>Total (n=19)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher’s observation</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Worksheets</td>
<td>7</td>
<td>5</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>Pencil and paper test</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>Others (teaching aids)</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>4</td>
</tr>
</tbody>
</table>

While teachers pointed out in their interviews that the teaching and assessment strategies advocated in the official guide had been adopted, they also remarked that it was necessary to use pencil and paper tests to assess children, especially in mathematics learning. For example, one teacher remarked that pencil and paper tests were 'reliable'.
and teachers in other schools also have similar comments. The following excerpt helps to explain the reasons.

It is easy to assess children’s performance using pencil and paper tests because the answers were apparent. Of course, we are doing it in a casual way. (K3 Teacher S)

These results indicate that not all the principles of teaching and learning suggested in official documents were being implemented.

6.1.3 Time scheduling

Past studies have reported that more time is spent teaching mathematics in Asian schools than in schools in the West, which is considered one of the factors contributing to the better performance of Asian children (Stevenson et al., 1985). We commenced our analysis of this issue by considering the amount of structured time devoted to mathematics teaching at different age levels.

![Figure 1 Time allocated for mathematics teaching at different age levels](image)

A wide range of time spans ranging from 20 to 315 minutes per week were reported by teachers in the questionnaire amongst the seven pre-schools (Figure 1). There was no relationship between time allocated to mathematics teaching and age level. The details of the number of sessions per week and the duration of mathematics activities for individual schools are reported in Table 4. The number of sessions scheduled for
mathematics teaching ranged from two to five per week. The amount of structured time allocated to mathematics learning ranged from 10 to 90 minutes per day. The wide range of reported time, ranged from 20 to 315 minutes per week, reflected the flexibility the pre-schools enjoyed in scheduling time for children’s mathematics learning. The site specific nature of time spent on different pre-schools also revealed that there was apparently no rule for teachers to set the minimum time needed for mathematics learning. However, the interviews showed that the number of time slots reported referred to structured learning integrated with the whole curriculum, and did not include unscheduled time when children were learning in naturalistic classroom settings. The exact time devoted to unstructured mathematics learning was thus difficult to count. It depended on the nature of the mathematics concepts and the overall scheduling of the schools. Some mathematics concepts, such as counting, was easy to be integrated with daily routines, and time spent on it would be difficult to measure. However, some other mathematics concepts, such as the teaching of relational terms, should normally be scheduled on planned time slots. Therefore, formally scheduled mathematics time as planned by teachers was used to illustrate pre-school mathematics learning in Hong Kong (Table 4).

Table 4 Amount of time allocated to mathematics teaching

<table>
<thead>
<tr>
<th>School</th>
<th>Sessions per week</th>
<th>Duration (minutes per session)</th>
<th>Total (minutes per week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>3</td>
<td>60-90</td>
<td>180-315</td>
</tr>
<tr>
<td>A</td>
<td>5</td>
<td>30-40</td>
<td>150-200</td>
</tr>
<tr>
<td>J</td>
<td>2</td>
<td>20-30</td>
<td>40-60</td>
</tr>
<tr>
<td>D</td>
<td>2-3</td>
<td>20-30</td>
<td>40-90</td>
</tr>
<tr>
<td>C</td>
<td>4-5</td>
<td>10-15</td>
<td>40-75</td>
</tr>
<tr>
<td>F</td>
<td>4-5</td>
<td>10</td>
<td>40-50</td>
</tr>
</tbody>
</table>
The result of this site specific nature of time on planned mathematics learning is striking. The question is whether the time spent in planned mathematics learning related to children’s performance. Table 5 shows the relationship between time spent on mathematics teaching and children’s scores in the seven pre-schools, based on the previous study (Ng, 2012). The scores were generated by Rasch model. Rasch analysis software programs perform a logarithmic transformation of item and person probability data to convert the ordinal data from tests to interval data for measurement. The quantitative data were analysed using the Rasch model for dichotomous data, both to establish the sequence in which children learn number and operation concepts and to provide summaries of their performance.

Table 5 Time allocated for mathematics teaching and children’s scores

<table>
<thead>
<tr>
<th>School</th>
<th>Mean children’s score</th>
<th>Structured time allocated to mathematics teaching (minutes per week)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E</td>
<td>4.04</td>
<td>180-315</td>
</tr>
<tr>
<td>C</td>
<td>2.83</td>
<td>40-75</td>
</tr>
<tr>
<td>G</td>
<td>2.72</td>
<td>20-30</td>
</tr>
<tr>
<td>D</td>
<td>2.66</td>
<td>40-90</td>
</tr>
<tr>
<td>F</td>
<td>2.58</td>
<td>40-50</td>
</tr>
<tr>
<td>J</td>
<td>1.98</td>
<td>40-60</td>
</tr>
<tr>
<td>A</td>
<td>1.20</td>
<td>150-200</td>
</tr>
</tbody>
</table>

The Rasch model analysis generated in the previous study (Ng, 2012) shows there was no relationship between time spent on mathematics instruction and the performance of these pre-school children. Apparently, the results do not support the proposition that more structured time spent on mathematics instruction contributes to better performance.
in mathematics learning for children aged from 3 to 6. Nevertheless, the presence of uncountable time for unstructured mathematics learning in naturalistic classroom settings might help to explain why structured time spent in learning mathematics is not an apparent factor account for the better performance of children. What teachers choose to do with the time in structured sessions might also have impact on children's learning.

6.2  Teachers’ views on mathematics teaching and children’s performance

The questionnaire asked teachers to indicate and elaborate on their views of the findings about the performance of their pre-school children in the previous study (Ng, 2012). It aimed to understand teachers’ views on mathematics teaching and children's performance, and how they are related to the Chinese number system or the cultural context of learning. Results indicated that the majority of teachers ($n = 18$) found that children performed as expected, other than in learning ordinal numbers and estimation (Table 6).

Table 6 Teachers’ views on children’s performance (questionnaire)

<table>
<thead>
<tr>
<th>View</th>
<th>Unexpected ($n=19$)</th>
<th>Expected ($n=19$)</th>
<th>No comment ($n=19$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Older children perform better than younger ones</td>
<td>1</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Early mastery of counting concepts</td>
<td>1</td>
<td>18</td>
<td>0</td>
</tr>
<tr>
<td>Children recognise, write and apply numerals at an early age</td>
<td>0</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>Children perform better than their English-speaking peers in learning ordinal numbers</td>
<td>8</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>The relational terms ($&lt;$, $&gt;$, $=$, $\neq$) are difficult</td>
<td>0</td>
<td>18</td>
<td>1</td>
</tr>
<tr>
<td>The teaching of 'estimation' is difficult</td>
<td>3</td>
<td>13</td>
<td>3</td>
</tr>
</tbody>
</table>

6.2.1  Older children perform better than younger ones

Teachers said during interviews that it was normal for older children to perform better than younger ones. Teachers admitted that the existing reference materials served them
well in sequencing the mathematics concepts for children in different age groups. One teacher made the following comment to show their confidence in the curriculum.

Yes, we plan according to the commercial learning packages. There is enough information and we adopt the sequencing of mathematics concepts too. (K3 Teacher Y)

While being interviewed, no teacher had the idea on whether children’s performance and their developmental sequence were aligned with those of their English-speaking peers. However, this was not a concern because teachers agreed that the commercial learning packages gave them enough information.

6.2.2 Early mastery of counting concepts

The results of the earlier study (Ng, 2012) showed that Hong Kong pre-school children master verbal counting up to 100 at an earlier age (around 3) than their English-speaking counterparts and learn skip counting at around 5, whereas American and Australian children usually master these concepts at the age of six or above (Fuson, 1992; Wright, 1994). Teachers (n = 18) were not at all surprised by children’s performance (Table 6), but had no idea how their English-speaking peers performed in comparison. As K2 Teacher K said:

It is normal for children to master concept of counting up to 100 at the age of around four to five according to my experience… We practice verbal counting with children frequently, usually during daily routines, such as queuing up, clearing time, or going to washrooms. However, I did not know that English-speaking children have to take longer time to do that; why? (K2 Teacher K)

This excerpt reflects the lack of problems teachers experienced in teaching verbal counting, and the fact that children’s performance was no accident according to teachers’ experience. Hong Kong children frequently practice counting, as it is integrated with daily routines or activities. This provides further evidence that the Chinese cultural context, in which hard work and frequent practice are stressed, may
serve to support children in mastering verbal counting skills apart from the simple, straight forward number naming system at an early age (Ng & Rao, 2010). This excerpt also shows that teachers did not know that the consistent rule for generating numbers in the Chinese number system might help children to generate numbers above 10 more easily than English speaking children (Ng & Rao, 2010).

6.2.3 Recognition, writing and application of numerals at an earlier age

Children succeeded in reading and writing numerals at around three years old, approximately one year ahead of US (Baroody, 2004) and Australian (Wright, 1994) children (Ng, 2012). Once again, majority of the teachers found the results met their expectations (Table 6). One of the teachers wrote on the questionnaire that parents teach children numerals at home, a comment echoed by teachers of all schools during their interviews. The following quotation represents the beliefs of teachers.

It is a common practice for children to learn to recognise and then write the numerals [at school]. Some children have already learnt it at home. We do not have a problem with these normally. (K2 Teacher B)

This quotation shows that it is common practice to teach children how to recognise and write numerals, which is supported by parents teaching at home. These results are in line with past studies suggesting that Chinese parents are more likely to give more formal mathematics instruction and to teach mathematics to their children at home in advance (Huntsinger, Jose, Liaw, & Ching, 1997).

6.2.4 Learning of ordinal numbers

It is believed that Chinese children learn ordinal number more easily than English-speaking children because the names of Chinese ordinal numbers are simply formed by adding an ordinal prefix (第; di) to the cardinal number name. In the English number system, new words have to be learned for ordinals, making it possible for English-
speaking primary school children made mistakes by inventing ordinal number names such as "twoth" or "tooth" (Miller et al., 2000). In the Hong Kong study (Ng, 2012), children learned ordinal number concepts at a younger age of around four to five, approximately two years ahead of English-speaking children (Baroody, 2004). The questionnaire results demonstrated that teachers were less consistent in their views on children’s ordinal number performance (Table 6). In elaborating on the reasons for their diverse views about the expected learning outcomes, teachers just admitted that they were not aware that the way in which Chinese ordinal numbers are formed might afford children learning advantages (Ng & Rao, 2010). However, teachers all agreed that it was not difficult to teach and learn ordinal numbers, as illustrated by comments made by Teacher J.

There is no difficulty in teaching ordinal numbers. It is just adding the prefix ‘di’ to the number words! (K2 Teacher J)

The foregoing observation provides more evidence that the simple rule governing the formation of ordinal numbers in Chinese make teaching and learning straight forward at the classroom level. The findings provided evidence that children using the Chinese number system need to exert less effort in learning ordinal numbers than do children using English number system.

6.2.5 Learning of relational terms

The learning of relational terms (≤, ≥, =, ≠) was found to be difficult for children in comparison with all other items on the checklist. Most teachers (n = 18) were not surprised with the findings (Table 6), and admitted that children had very limited opportunities to grasp all these relational symbols, especially 'greater than' (>) and 'less than' (<). One of the teachers admitted that they taught the symbol ‘=’ only. The teaching of relational terms is not included in the official guide (Education Department, 2006) in
Hong Kong, and a brief examination of the commercially published materials revealed that the introduction of these relational symbols was not included in all packages.

6.2.6 The teaching of 'estimation'

Cai (2004) found that elementary Chinese teachers gave lower scores for responses involving estimation than did American teachers. Chinese teachers are more concerned with providing an accurate answer, and estimating the answer is not regarded as desirable. Similar views were identified amongst the pre-school teachers participating in this study. One teacher wrote in the questionnaire that she did not understand 'estimation' well, and three teachers admitted that it was not included in their school curriculum. During the interviews, one teacher pointed out that she would sometime skip the teaching of 'estimation'. Other teachers had reservations about teaching 'estimation' because they believed that it was the teaching of guessing and did not help children obtain the correct answer. One teacher went further by claiming that it would be better to teach estimation in primary school when the sums involved usually exceed 10, and when children are able to differentiate between 'estimation' and 'calculation of the correct answer'. One teacher was worried that parents might doubt her teaching ability because children were not being asked to identify the correct answer. The following comment from Teacher M illustrates teachers’ views.

I do not know why we have to teach estimation. Asking children to guess will not help them to get the correct answer. Then, they will not calculate seriously. I am also afraid that parents will query my teaching too. (K3 Teacher M)

One of the teachers wrote on the questionnaire that parents simply did not accept the teaching of estimation. Teachers from different schools reiterated during their interviews that helping children to calculate correctly was an appropriate way to prepare children to secure a place in a preferred primary school. Moreover, in order to better
prepare children for their primary studies, teachers had to spend time teaching the 'homework formats' required in primary schools. As teacher P wrote on the questionnaire,"[we have] to align with primary schools’ mathematics homework formats."

Three teachers who shared similar views believed that it was important to help children to write operational formats and calculate the correct answer, and that the teaching of estimation would not help. Teachers claimed that they had to teach K3 children standard procedures, and had to write vertical and horizontal operational formats in children’s exercise books. This would inevitably involve direct instruction and frequent practice. The following excerpt illustrates the concerns of teachers.

It is necessary to teach them to write the procedures and formats accurately because they need to write them during their primary school studies… Double digit addition is included in our curriculum too… We have to prepare them well… A lot of practice is needed. (K3 Teacher Z)

This quotation demonstrates that teachers believed teaching children advanced concepts, standard procedures and correct formats were means of ensuring a smooth pre-primary to primary transition, and that it was necessary to perform drills. These results indicate that Hong Kong teachers continue to prepare children in advance to allow them to adapt more readily to the primary curriculum (Wong, 2003). In line with a past study involving elementary teachers (Cai, 2004), Chinese pre-school teachers were also concerned with providing the correct answer, and regarded estimated answers as undesirable.

7 Limitations of the study and suggestions for further research

This study is subject to several limitations. First, not all of the teachers who took part in the original study participated in the present follow-up study, and the small sample size makes it difficult to generalise the findings. Second, examination of the planning of
mathematics curriculum was limited to teachers’ self-reports. There was no examination of school-based curriculum content, and no direct classroom observation to reveal the implementation of the planned curriculum. Moreover, parents were not given an opportunity to voice their thoughts in this study. Nevertheless, despite these limitations, this study yields important findings that will serve as a reference for further research.

The present study provided empirical evidences informing us the scenes behind children’s better performance in mathematics learning. In line with the findings of a previous study (Li, 2006), teachers planned their mathematics teaching mainly on the basis of commercial learning packages. In contrast to the findings of Li (2006) and Ng (2005), mathematics teachers felt confident in their curriculum planning, and believed that they were planning according to children’s abilities. It is thus argued that such reference materials might provide substantial help to teachers and boost their confidence. However, despite their adoption of learning packages, teachers had limited mathematics content knowledge and a narrow understanding of mathematics teaching. Teachers had few ideas on the developmental sequences of numbers and operations, and were not aware of the factors influencing the acquisition of these concepts. It is likely that teachers found back up and support from these learning packages but whether it is enough for them to stay confident when they encountered different expectations from parents is another issue of concern. Teachers’ choice of mathematics concepts might depend very much on the perceived expectation from parents. Although teachers claimed that they were teaching according to the abilities of the children, they were at the same time preparing children in advance to allow them to adapt more readily to the primary curriculum. This is similar to the findings of a previous study by Wong (2003).

On the pedagogical side, although a range of activities are used for mathematics instruction and assessment, not all of the principles suggested by official documents are
found in the data. For example, direct instruction, the traditional drill-and-practice approach, and pencil and paper tests are sometimes adopted. These observations echo those of previous studies revealing that although teachers seek to follow guidelines by using interactive teaching methods, their strategies still include the drill-and-practice approach (Li & Rao, 2005), and that the primary pedagogical objective at the pre-primary level is to ensure children achieve numeracy skills through direct instruction (Rao & Li, 2009). While it appears that the teachers had pedagogical knowledge to transform and represent mathematics knowledge for teaching, the teachers in this study also reported that pursuing academic success was what they and children's parents aimed for. While a previous study (Ng, 2012) showed that the development sequences of mathematics concepts were observed among both Chinese speaking and English speaking children, Chinese teachers were eager to teach children mathematics concepts in advance for better preparing them for entering primary schools. The top-down pressure for pre-schools to adopt an academically focused curriculum and to prepare children in advance again raised the issue of providing appropriate learning for children in their early years. The study also revealed that although the underpinning philosophy of pre-school curriculum planning in Hong Kong might be similar to some pre-schools in other parts of the world, such as the adoption of an integrated curriculum and unstructured play, contradictory practices might also be incorporated dependent on the cultural context. In Hong Kong, for example, the Chinese cultural aspiration for academic success may influence the adoption of explicit teaching and pencil and paper assessment.

Nevertheless, it is acknowledged that quality education is contextually defined (Rao, 2010) and that a culturally relevant framework is to be used to assess quality (Woodhead, 1999). In an Asian city such as Hong Kong, where parents have high
expectations for children’s academic results and consider that pre-primary education
serves as preparation for primary schooling (Rao, 2010), it is arguable that the adoption
of mixed strategies comprising traditional and contemporary approaches complement
each other in supporting children learning mathematics. Past studies involving
secondary school mathematics teaching have shown cultural differences in lesson
organisation that may afford Asian children advantages in learning mathematics (Leung
& Park, 2002; Leung, 2005). Further studies involving direct classroom observation
may help to develop a culturally defined pedagogy.

It appears that the commercially designed learning packages support teachers in
selecting curriculum content and activities, but not in enhancing their content
knowledge or their understanding of the focus of mathematics teaching. This study has
implications for the design of teacher-training programmes. Moreover, it is unclear
whether learning packages benefit pre-school children in mathematics learning as they
do in primary and secondary schools (Fuson & Kwon, 1991; Park & Leung, 2006;
Murata, 2008). Further examination of such learning packages may help to reveal
whether Chinese pre-school children benefit more from their learning materials in
comparison with their English-speaking peers.

The findings of this study also revealed that structured time spent in pre-school is
unlikely to be related to children’s academic performance. Nevertheless, children
experience frequent practice and exposure to mathematics during their daily routines,
which may provide additional support to children in mastering some concepts such as
verbal counting. Further studies may focus on whether the use of unstructured time in
practising or in repeat drilling of certain concepts might account for the reasons why
Chinese children excel in their performance.
Does the Chinese number system benefit children learning mathematics in the early years? The findings of this study based on teacher feedback support the proposition that the simple rules governing the formation of ordinal numbers in the Chinese number system apparently helped children to master the concept easily. However, it is less clear whether the Chinese number system itself helps children perform better in learning other mathematics concepts such as counting, writing and applying numerals. Instead, the teachers stated that children frequently practiced verbal counting during their daily routines. The active role of parents in children’s learning was reflected in teachers’ reports on how parents taught their children how to write numerals at home and their concern to find the correct answer in mathematics learning. It may also help to explain why structured time spent in learning mathematics is not an apparent factor in accounting for the better performance of pre-school children. As found in a previous study (Pearson & Rao, 2006), teachers in this study were also serious in helping children to master basic numeric skills by finding the correct answer. The results of this study are aligned with previous findings revealing that Chinese parents hold high expectations of academic achievement and tend to play an active role in helping children to learn mathematics (Cai, Lin, & Fan, 2004; Rao, Chi, & Cheng, 2009; Zhang & Zhou, 2003), and that Chinese children receive both family and school support in learning mathematics at the primary level (Cai, Lin, & Fan, 2004). Further studies may shed light on the roles played by teachers and parents in helping children to master individual concepts such as counting, writing and applying numerals.

8 Conclusion

This study investigated the scenes behind children's mathematics performance. The planning of mathematics teaching in Hong Kong pre-schools and teachers’ views on mathematics teaching and children’s performance, and how they are related to the
Chinese number system or the cultural context of learning were examined. Results indicated that the Chinese number system appeared to afford advantages to children in learning individual mathematics concept but was not enough to explain why children perform well in other areas. Frequent practice and exposure to mathematics in naturalistic classroom settings might explain why children's performance was not related to the structured time spent in learning mathematics at pre-schools. More unstructured time spent in mathematics learning might imply children's interests in learning mathematics or teachers' preference in teaching mathematics concepts to children. Parental expectations and support at home helped to tell how the Chinese cultural aspiration towards learning influenced teachers' curriculum planning and children's learning. Mathematics teaching in Hong Kong pre-schools mirrors the Chinese cultural aspiration towards learning, whereby both teachers and parents play an active role in pursuing academic success. It appears that children's mathematics learning in pre-school years is more likely influenced by their cultural context compared with the Chinese number system. However, the top-down pressure for pre-schools to adopt an academically focused curriculum and to prepare children in advance again raise the issue of providing appropriate learning for children in their early years. Further studies are needed to develop a culturally defined pedagogy that includes both schools and parents.

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References


developments in early childhood services (pp. 81-95). New York: Peter Lang Publishing, Inc.


Thank you for participating in the present study. This questionnaire aims to explore the planning of mathematics teaching and your views on mathematics teaching and children's performance. All information related to you will remain confidential, and will be identifiable by codes only known to the researcher.

Name of pre-school: ________________________________
I am the teacher of K1 / K2 / K3 class

1. I have ____ timeslot(s) of scheduled mathematics teaching a week, have ___ hours ____ minutes per timeslot.

2. I believed the scheduled time for mathematics teaching in adequate / not adequate because ____________________________

3. List the activities used for mathematics teaching and learning.
   Sequence the frequency in adopting these activities using 1 to 6 (1 indicate least frequent and 6 indicate most frequent)
   ○ Teaching themes
   ○ Group work
   ○ Daily routines
   ○ Naturalistic classroom settings
   ○ Worksheets
   ○ Others (Please specify: ________________________________)

4. List the assessment methods adopted.
   Sequence the frequency in using these methods using 1 to 6 (1 indicate least frequent and 6 indicate most frequent)
   ○ Observation
   ○ Worksheets
   ○ Pencil and paper test
   ○ Others (Please specify: ________________________________)

5. List the materials adopted for mathematics curriculum planning.
   Sequence the frequency in using these activities using 1 to 6 (1 indicate least frequent and 6 indicate most frequent)
   ○ Commercially publish learning materials / learning kits
   ○ Official curriculum guide
   ○ Tailor made according to the teaching themes
   ○ No reference
   ○ Others (Please specify: ________________________________)

6. What is the significance of this research for you? (May  ví more than one)
   ○ Help me to know the abilities of our children
   ○ Help me to know the abilities of other children
   ○ Help me to know the similarities and differences between the performance of
English-speaking children and our children
○ Help me in designing mathematics curriculum
○ No help
○ Others (Please specify: ____________________________)

7. Please indicate your views on the findings

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Interview protocol (Semi-structured interview)

Greetings

Thank you for participating in the present study. This interview aims to explore the planning of mathematics teaching and your views on mathematics teaching and children's performance. All information related to you will remain confidential, and will be identifiable by codes only known to the researcher.

Interview questions

In-depth discussion on teachers' views on the planning of mathematic teaching

- How you plan your mathematics curriculum content?
- What teaching and learning activities are adopted? Why?
- Is there any reference material you adopted in planning mathematics curriculum for the children? If yes, how useful are they?
- What kind of assessment activities were adopted? Why?

In-depth discussion on teachers' views on children's performance

- Please elaborate your views on children's performance one by one.
  - older children perform better than younger ones
  - early mastery of counting concepts
  - children recognise, write and apply numerals at an early age
  - children perform better than their English-speaking peers in learning ordinal numbers
  - The relational terms are difficult
  - The teaching of 'estimation' is difficult.

Teachers' knowledge of number and operational concepts.

- Please talk about what you know about the following:
  - development of number and operational concepts
  - the teaching of "estimation"
  - the relational terms
  - the similarities and differences in the learning number and operational concepts between Chinese speaking and English speaking children

Ending remarks

Thank you for your time and effort.