A REVIEW OF THE HONG KONG EARLY CHILDHOOD CURRICULUM FROM THE PERSPECTIVE OF MATHEMATICS EDUCATION

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Abstract
In Hong Kong, a committee is recently set up in 2013 to explore provision of quality and free kindergarten education. In connection with the potential free provision of early childhood education to all children, this paper aims to examine the current curriculum from the perspective of mathematics education. Elements of early mathematics in the intended curriculum are analyzed. Recommendations to ensure mathematics developmentally appropriate early childhood curriculum are provided.

Key words: *early childhood curriculum, mathematics education, learning progression*

1. INTRODUCTION

9-year compulsory education (6-year primary and 3-year secondary) and 12-year free education (6-year primary and 6-year secondary) are currently provided to children in Hong Kong. There are voices from the society concerning the quality of early childhood education and requests for extending free education to pre-primary education. In response to the concerns from the society, the Chief Executive of Hong Kong Special Administrative Region addressed the issues related to kindergarten education in his 2013 Policy Address (Chief Executive, Hong Kong 2013). To explore the feasibility of implementing free kindergarten education then became one of the major education initiatives in Hong Kong. The Committee on Free Kindergarten Education was set up in April 2013 to explore provision of quality and free kindergarten education and to provide recommendations on the implementation of free kindergarten education in the context of 15-year free education to the Education Bureau of Hong Kong. Objectives of kindergarten education and issues related to kindergarten curriculum are under review by the Committee.

2. EARLY CHILDHOOD EDUCATION IN HONG KONG

At present, kindergartens, no matter they are non-profit-making kindergartens or private independent kindergartens, provide services for children from three to six years old. Most common operation mode is on a half-day basis while some are in whole-day basis. They offer upper kindergarten, lower kindergarten and nursery classes (Education Bureau, Hong Kong n.d.). A variety of teaching approaches was adopted by different pre-primary institutions in Hong Kong (Curriculum Development Institute, Hong Kong 2006).

The education reform in Hong Kong at the beginning of the 21st Century paid attention to several key aspects of early childhood education, including the competence of early childhood professional, establishment of a quality assurance system as well as the transition from early childhood education to primary education (Wong 2012, Education Commission 2010). The Guide to the Pre-primary Curriculum, endorsed by the Curriculum Development Council of Hong Kong, was first published in 1996 and revised in 2006. In-phase with the changes of the Hong Kong education system and curriculum reforms (Education Commission, Hong Kong 2000), the current Guide to Pre-primary Curriculum (2006) was developed under the premise that early childhood education is the foundation for life-long learning and whole person development. Child-centredness is the core value. Basic principles of children's development and children's learning, as well as consideration on children's interests, needs and abilities, are emphasized. In the curriculum framework, developmental objectives

in four domains, namely "Physical Development", "Cognitive and Language Development", "Affective and Social Development" and "Aesthetic Development", are supposed to be achieved through six learning areas, namely, "Physical Fitness and Health", "Language", "Early Mathematics", "Science and Technology", "Self and Society" and "Arts". "Knowledge", "Skills" and "Attitudes" are the three key elements emphasized in children's learning. It is remarked that "knowledge acquisition involves mainly the development of basic concepts, rather than the study of specific subjects" (Curriculum Development Institute 2006, p. 14). The curriculum goals of the early childhood stage are "to nurture children to attain all-round development in the domains of ethics, intellect, physique, social skills and aesthetics, and to develop good habits, so as to prepare them for life; and to stimulate children's interest in learning and cultivate in them positive learning attitudes, in order to lay the foundation for their future learning" (Curriculum Development Institute 2006, p. 16). Regarding to curriculum planning, an integrated curriculum across different learning areas is expected. In terms of learning and teaching approach, informal learning through play activities is encouraged. Mathematics is not supposed to be taught as a subject in Hong Kong.

3. EARLY CHILDHOOD MATHEMATICS EDUCATION IN HONG KONG

Whether mathematics should be an instructional subject in preschool and kindergarten level has long been a controversial issue (Geist, 2009, Ginsburg & Golbeck 2009). Hong Kong follows the "old regime". Though the objectives of children's development are classified in six learning areas, it "is not intended to promote teaching by subjects or to prepare for this practice which will be adopted in primary schools. …In terms of pre-primary curriculum planning, an integrated curriculum across different learning areas offers both education and care for young children" (Curriculum Development Council, Hong Kong 2006, p.21). On the other side of the world, paradigm shift is happening in the United States (Hachey 2013). The call for attention to early childhood mathematics education is increasing (Klein et al 2005). Hachey (2013) stated that early childhood education is "in the midst of a revolution" (p.419) as research found that children's early mathematics performance is a strong predictive factor of their future academic achievement (Duncan et al 2007). Children are born mathematicians (Geist 2009). They engage in mathematics learning in their interaction with the real world and build intuitive foundational knowledge and skills in mathematics in early years (Gelman 2006, Zur & Gelman 2004). Calls for provision of systematic and evidence-based early childhood curricula as well as the needs for rich mathematical instructional interactions "for pre-elementary children to build conceptual depth in a wide variety of mathematical areas" are identified (Hachey 2013, p.422). Facing the increasing recognition of the importance of early childhood mathematics education and the exposure of intentional mathematics instruction to young children, guidelines and standards of practices (National Governors Association Center for Best Practices 2010, NAEYC 2010, NCTM 2006), which are developed based on research-based and professional sources, play important roles in the "radical philosophical swing" in the United States (Hackey 2013, p. 422). Under the trend of increasing recognition and more understanding of children's wisdom in early mathematics, it is interesting to know whether Hong Kong pre-primary education is ready for the revolution in early childhood mathematics education.

In the Guide to the Pre-primary Curriculum (2006), the curriculum goals are generic in nature. Out of the seventeen development objectives in four domains, there are three objectives in the Cognitive and Language Development Domain. The only developmental objectives specific to mathematics learning is "to develop children's simple logical concepts in mathematical literacy, so as to help them in analysis, reasoning, judgment and problem-solving" (Curriculum Development Institute, 2006, p. 19). It is further elaborated in four learning objectives and five principles of teaching in the Early Mathematics Learning Area. In addition, developmental characteristics of children of 0-2 and 2-6 year-old are listed out, as appendices of the curriculum guide. to provide teachers an understanding of children's development and to act as teachers' reference. However, such developmental characteristics lists cannot be considered as official standards or statements of expectation on student performance. Teachers are expected to "make use of the information and draw relevant verification in light of their everyday observations, in order to provide appropriate and sufficient opportunities for children's

development" (Curriculum Development Institute, 2006, p. 11). In the lists, description of children's performance, for example, "begin to understand the meaning of number one and two", which are more specific to mathematics learning are mostly under the intellectual developmental characteristics category (Curriculum Development Institute, 2006, p. 86).

The Pre-primary Education Voucher Scheme (PEVS) was introduced in 2007. Under the scheme, parents' choice of school became important as it links with the resource available to the schools. Not only changed the mode of subsidy, it also bought issues and problems in various levels, in particular, impact on teachers, such as the increase in workload and changes in nature of work (Wong 2012, Tai, 2012). Teachers are one of the key decision-makers of curriculum (Marsh 2009), there are concerns on the teachers' professional capabilities needed for the implementation of new pre-primary curriculum (Ma 2010). Although new statutory requirements were imposed on teacher qualification with the implementation of PEVS, requirement specifically related to mathematics is still missing. For instance, the minimum academic entry qualification for kindergarten teachers was still five passes, including both Chinese and English, in the Hong Kong Certificate of Education Examination (HKCEE) or equivalent (Education Bureau Hong Kong n.d.). Content knowledge and pedagogical content knowledge are important parts of the teacher knowledge base (Shulman 1987). Facing the revolution, it is important to know to what extent the curriculum guide helps our frontline early childhood teachers, whose content knowledge and pedagogical content knowledge probably varies greatly, to prepare our children for the challenges in their study and future life.

To tie in the policy intention and expectation on early childhood education, the quality assurance system plays a part. All kindergartens under PEVS are subject to quality review by the Education Bureau. When the review teams assess the quality and standard of kindergartens, they refer to a set of performance indicators (Education and Manpower Bureau & Social Welfare Department 2003). In the framework of performance indicators, there are four major domains, namely, Management and Organization, Learning and Teaching, Support to Children and School Culture, and Children's Development. In the Children's Development Domain, performance indicators are classified into four areas, they are Cognitive Development, Physical Development, Affective and Social Development, and Aesthetic and Culture Development. The other domains and areas are relatively generic while prescribed standards which are relatively more specific to mathematics are mainly found in the Logical Thinking Aspect in the Cognitive Development Area of Children's Development Domain. To support teachers to have a better understanding of the performance indicators, the Bureau prepared an assessment tool entitled Children's Developmental Milestones, in which 10 developmental characteristics of children aged 2 to 6 are listed hierarchically for each aspect of performance indicators. Similar to the development characteristics in the Pre-primary Guide, the Milestones is a "Recommended Version" (Education and Manpower Bureau & Social Welfare Department 2003, p.7) which supposed to serve as reference materials for practitioners.

Official statements and guidelines show the policy and curricular intention. Though intentional content and expectation are usually selected and stated explicitly, the nature, extent and specificity of curricular guidance, even in primary education, can vary greatly among countries or even within country (Ruddock and Sainsbury 2008). In the context that our Hong Kong frontline early childhood teachers are with a diverse range of mathematics knowledge background, it is necessary to examine whether the official statements and guidelines, including the Guide to the Pre-primary Curriculum (2006) and the Performance Indicators (Pre-primary Institutions) (2003), are informative, clear and coherent enough for teachers to comprehend the curricular intention and expectation on children's mathematics capability, foundation knowledge and skills in mathematics in pre-primary education before we can further investigate whether our teachers are prepared for changes.

While the conceptions of curriculum gradually change, statement of standards gradually took up the form of objectives and outcomes in expressing the expected students' achievement (Marsh 2009). Content and performance standards are both useful to address the expectation at a general level as well as at developmental level (Marzano & Kendall 1996). Expectation on students' performance should be clear, specific and coherent but not overly prescriptive. Regarding to coherence, "the standards should convey a unified vision of the big ideas and supporting concepts within a discipline and reflect a

progression of learning that is meaningful and appropriate (National Governors Association Center for Best Practices n.d.).

4. RESEARCH OBJECTIVE AND METHOD

In this paper, the main objective is to answer the question:

"How do the pre-primary education official documents in Hong Kong prepare the teachers to facilitate children's mathematics learning?"

The question is further divided into three secondary questions:

Q1. To what extent do the content of the official documents be specific in mathematics?

Q2. To what extent do the content of the official documents be specific in the students' mathematics learning process?

Q3. To what extent do the content of the official documents be coherent in the expectation on children's mathematics performance in pre-primary education?

To capture the curricular intentions, data to be analyzed are from the following sources:

Source 1 (So1): the description of 2-6 years old children's performance under the intellectual developmental characteristics category in the Guide to the Pre-primary Curriculum (2006)

Source 2 (So2): the Children's Developmental Milestones in the Logical Thinking Aspect in the Cognitive Development Area in the Performance Indicators (Pre-primary Institutions) – Domain on Children's Development for Quality Assurance Framework (2003)

Children's performance cannot be discretely separated and classified. It is possible that statements in other developmental characteristics categories or aspects and areas of development milestone are related to students' mathematics capability. For instance, the statement "able to draw a cross and inclined line by imitation" (Curriculum Development Council, Hong Kong 2006, p.87) in the Physical Development Characteristics Category relates to children's ability in drawing shapes. However, the curriculum intention of this statement is more on the physical development of children instead of cognitive development in mathematics. Hence, as this study is on curricular intention from mathematics perspective, only statements from the two above-mentioned sources are selected for analysis.

With reference to the framework of some cross-national comparison of mathematics curriculum (Ruddock, G and Sainsbury 2008, UNESCO Institute for Statistics 2012), the primary mathematics curriculum of Hong Kong (Curriculum Development Institute 2000), the curriculum documents and standards of other countries(National Council of Teachers of Mathematics 2006, National Governors Association Center for Best Practices 2010, Ministry of Education, Taiwan 2012, Ministry of Education, People's Republic of China 2012) and research related to mathematics developmental progression and learning trajectories (Sarama & Clements 2009, National Research Council 2009), a list of content categories and sub-categories is generated (see Appendix I). In the list, mathematics content are divided into four domains (Numbers, Shape and Space, Measures and Data, Others) and mathematics topics under each domain are further divided into several sub-categories. A total of 18 sub-categories are created. The two Hong Kong curriculum documents are then analyzed according to the categories to examine the specificity, coverage, levels of progression and coherence of curriculum intention in mathematics education.

5. DATA ANALYSIS AND FINDINGS

5.1. MATHEMATICS SPECIFIC

Firstly, statements of development characteristics or milestones from the two source documents are examined and classified as mathematics-specific or non-mathematics specific. For example, "able to

identify daily necessities by their senses" is classified as non-mathematics specific item. For statements like "able to distinguish between two objects by their sizes, length, texture, hardness" (Curriculum Development Council, Hong Kong 2006, p.87), it is classified as mathematics-specific as it relates to sizes and length although texture and hardness do not relate to mathematics concepts. In order not to miss out all possible underlied curriculum intention, statements like "able to point out a different type of object", though vaguely stated, it is still coded as mathematics-specific.

Amongst the statements related to children's cognitive and intellectual development, over 60% of the statements explicitly link with some kind of mathematics topics (See Table 1).

Source	Total no of statements	No of Mathematics-specific Statement	Mathematics Specific (%)
So1	53	35	66.04%
So2	18	11	61.11%

Table 1: Proportion of mathematics-specific statements

5.2. COVERAGE

Mathematics-specific statements are further classified to domains and their sub-categories. For example, for statement "able to recite from one to twenty, count from one to ten or follow instructions to show one to five things" (Curriculum Development Council, Hong Kong 2006, p.90), it is coded under both the sub-category "Recognition of whole numbers and subitizing" and "Concept of correspondence and counting" of Number Domain.

Most of the statements fall into one sub-category only. Number Domain and Shape and Space Domain carry similar weighting in the Pre-primary Curriculum and take up 70% of the counts while about half of the counts of the milestones come from the Measurement and Data Domain (See Table 2).

Source	Number	Shape and space	Measurement and Data	Others	Total no of counts
So1	15 (34.9%)	17 (39.5%)	8 (18.6%)	3 (7.0%)	43
So2	7 (36.8%)	2 (10.5%)	9 (47.4%)	1 (5.3%)	19

Table 2: Coverage of mathematics topics

Domain & Sub-category	Number		Shape and space		Measurement and Data		Others	
	So1	So2	So1	So2	So1	So2	So1	So2
1	6	3	4	1	2	2	1	1
2	5	2	**4**[#4]	**0**	4	2	**2**[#3]	**0**
3	2	1	6	1	**0**[#5]	**1**		
4	1	1	**0**[#1]	**0**	2	4		
5	**1**[#2]	**0**	3	0	0	0		
6			0	0				
Total	15	7	17	2	8	9	3	0

Table 3: Distribution of mathematics topics

The pre-set categories with clearly stated topics cover most of the statements. However, no statement from the two sources covers the topic 3-D shapes (See Table 3, #1).

5.3. COHERENCE

Only three statements falls in the "Others" domain or "Others" sub-category (See Table 3, #2 and #3). The three statements involve concept of non-integer, time, and speed respectively. They are:

- Understand the difference between "half of a piece" and "one full piece".
- Begin to understand the concept of time, able to tell what they usually do in the morning, afternoon and evening.
- Begin to understand … speed, e.g. … fast and slow… etc.

However, there are two sub-categories which are covered by either one of documents only (See Table 3, #4 and #5). Spatial visualization and imagery of the Shape and Space Domain is only covered by the Pre-Primary Curriculum while the concept of volume in the Measurement and Data domain is only covered by the Milestones of Performance Indicators for Quality Assurance Framework. Strictly speaking, the statement involves the concept of capacity instead of volume. Children are expected to be able to "differentiate the concepts of 'full' and 'empty' through manipulating containers in water play" (Education and Manpower Bureau & Social Welfare Department 2003, p.16). Except that statement, no statement from the two documents mentions any measurement of 3-D objects.

5.4. CLARITY AND PROGRESSION

Statements from Source 1 are divided into 4 age-levels (2-3 years, 3-4 years, 4-5 years and 5-6 years) while the milestones from Source 2 are divided into 10 hierarchical stages. Out of the 18 sub-categories, only 8 sub-categories have counts coming from more than or equal to 3 age-levels or hierarchical stages (See Table 4, *). For the rest of sub-categories, there is very limited degree of differentiation on the learning progression. For instance, for the topic "addition and subtraction", the only statement from Source 1 is "able to do simple mathematical addition and subtraction" at the age of 5-6 year-old. From the perspective of clarity of the expectation, the level of difficulties of the sums or semantic structure of problem types (Sarama & Clements 2009) are not specified. The range of addends is not stated. From the perspective of progression, children's development from nonverbal addition and subtraction to understanding on part-whole relationship among three quantities of the sums (Sarama & Clements 2009) is not differentiated into development at different age-levels. From Source 2, for the same topic "addition and subtraction", the statement "children can grasp the concept of addition and subtraction within 10 and apply in games and their daily life" (Education and Manpower Bureau & Social Welfare Department 2003, p.16) explicitly sets the level of difficulty (within 10) and states the expectation (apply in games and their daily life). From the perspective of coherence, application of addition and subtraction in games and in daily life, which is at a high level of Bloom Taxonomy, is a set milestone of children development from Source 2. On the other side, the statement from Source 1 does not mention children's developmental characteristics at that level yet.

Domain & Sub-category	Number		Shape and space		Measurement and Data		Others	
	So1	So2	So1	So2	So1	So2	So1	So2
1	4*	3*	3*	1	2	2	1	1
2	3	2	4*	0	3*	2	1	0
3	1	1	4*	1	0	1		
4	1	1	0	0	2	4*		
5	1	0	0	1	0	0		
6			0	0				

Table 4: Number of age-levels involved

Mathematics topics having counts coming from different age-levels do not necessarily imply that the concepts related to the mathematics topic are mathematically differentiated and the expectation is progressively illustrated. Taking the following developmental characteristics from Source 1 as examples,

- Age 2-3: "able to assemble puzzles of three to five pieces"
- Age 3-4: "able to assemble puzzles of six pieces"
- Age 4-5: "able to assemble puzzles of eight pieces"

(Curriculum Development Council 2006, p. 86-90)

Levels of difficulty are expressed in terms of number of pieces of the puzzle instead of the shapes to be recognized and matched or attributes to be compared (Sarama & Clements 2009).

6. DISCUSSION AND CONCLUSION

Though expectation on children's cognitive development in mathematics learning is notably stated in official documents, the coverage of mathematics knowledge and skills is not sufficient for teachers to develop appropriate learning experience to children. Important topic, such as three dimensional shapes, is omitted. The lists are rather condensed. Characteristics are usually in single tier or of very limited degree of differentiation in terms of children's age. In the official documents, it was already stated that the lists of developmental characteristics and milestones are for teachers' reference only. Curriculum developers with different conceptions of curriculum generate curricula in different nature, forms and specificity (Marsh 2009). It may be not the curriculum developers' intention to develop a comprehensive and progressive map of children's cognitive development in mathematics learning. However, the children's developmental characteristics and milestones sometimes are vaguely stated and the expectation is ambiguous. The demand on teachers' professional knowledge in mathematics is high for the teachers to master the curricular intention and expectation on children's mathematics learning from a few of exemplary developmental characteristics and milestones. The inconsistency of the curriculum intention conveyed in the two official documents is notable. Discrepancies were found in various aspects, including different emphasis on domains, coverage of topics and levels of cognitive demands.

If free education is going to be extended to kindergarten, a clear and consistent view on mathematics education conveyed in curriculum document(s) coherently at the pre-primary levels is necessary. To ensure early childhood frontline teachers could possibly develop mathematically appropriate learning experience for children, exemplary statements of students' mathematics performance at granular level are not enough. It is suggested that a comprehensive and research-based learning progression of early mathematics, supplemented with exemplary instructional activities, should be prepared.

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Appendix I

Content categories (Domain) and sub-categories (Topic) for coding

1	Number Domain (N)
1.1	Recognition of whole numbers and subitizing
1.2	Concept of correspondence and counting
1.3	Comparing, ordering and estimating numbers
1.4	Addition and subtraction
1.5	Others
2	Shape and Space Domain (S)
2.1	Spatial orientation
2.2	Spatial visualization and imagery
2.3	2-D shapes
2.4	3-D shapes
2.5	Embedded geometry
2.6	Others
3	Measurement and Data Domain (MD)
3.1	Length Measurement
3.2	Area Measurement
3.3	Volume Measurement
3.4	Classifying and sorting objects
3.5	Others
4	Others Domain (O)
4.1	Patterns and structure
4.2	Others