The development of numerical thinking of early childhood in traditional games of minorities

การพัฒนาไปสู่การคิดเชิงคำนวณของเด็กปฐมวัยในเกมพื้นบ้านของชนกลุ่มน้อย

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Abstract

In some traditional games, the cognition and presentation of a number influence children understand what that number is all about. The development of number sense is a concrete representation of children’s numerical thinking, which can be a proper foundation for mathematic study. In China and Thailand, the majority of ethnic minorities live in remote border areas, where the development of basic education is unbalanced when compared to urban areas. Thus, children’s traditional games often play an important role in early childhood education. It is necessary for children to nurture and further develop their mathematical thinking skills in traditional games to reduce some related problems about early childhood mathematic development in minority area of China and Thailand.

Keywords: children’s mathematical education in early childhood, traditional games, numerical thinking, number sense

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บทคัดย่อ

ในเกมพื้นบ้านบางอย่าง ความรู้ความเข้าใจและการนำเสนอตัวเลข มีผลต่อการช่วยให้เด็กท้าความเข้าใจคือความรู้ในด้านต่างๆ ภาพการพัฒนาความรู้สึกเชิงจำนวนมีผลต่อการช่วยให้เด็กทำความเข้าใจต่อความรู้ในด้านดังกล่าว การพัฒนาความรู้สึกเชิงคำนวณเป็นตัวแทนที่เป็นรูปธรรมของการคิดเชิงคำนวณในเด็ก ซึ่งทำให้เกิดพื้นฐานที่เหมาะสมสำหรับการศึกษาคณิตศาสตร์ สำหรับในประเทศจีนและประเทศไทย ชนกลุ่มน้อยส่วนใหญ่อาศัยอยู่ในพื้นที่ชายแดนที่ห่างไกล ที่ซึ่งการศึกษาขั้นพื้นฐานขาดความสมดุล เกมพื้นบ้านจึงมักจะมีบทบาทสำคัญในการศึกษาสำหรับเด็กในชั้นปฐมวัย ดังนั้นจึงจำเป็นอย่างยิ่งสำหรับเด็กในการรักษาและพัฒนาความรู้สึกเชิงคิดเชิงคำนวณในเกมพื้นบ้าน อันจะเป็นการลดปัญหาบางอย่าง ที่เกี่ยวข้องกับการพัฒนาทางคณิตศาสตร์ของเด็กปฐมวัย ในพื้นที่ของชนกลุ่มน้อยในประเทศจีนและไทย

คำสำคัญ: การศึกษาคณิตศาสตร์ในเด็กปฐมวัย เกมพื้นบ้าน การคิดเชิงคำนวณ ความรู้สึกเชิงคำนวณ

Introduction

China is a multi-ethnic country. The majority of ethnic minorities live in remote border areas, especially the southwest and northwest. Due to some natural, historical, political and other reasons, economic development is lagging behind in these minority areas, the basic education is quite weak, educational investment and the number of teachers is even more inadequate, high-quality educational resources is seriously lacking, which lead to the decline of the quality of teaching. Compared to developed areas, the education gap is growing, which will impact on the development of entire ethnic areas. In fact, the educational environment of minority areas in Thailand is similar with china. Under the ethnic educational background, corresponding problems also exist in early mathematics education, so, the research emphasizes on representation, nurturing and outward development to numerical thinking of early childhood in traditional game1 of minorities which becomes an important part of early childhood education in minority areas.

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1 The meaning of traditional game in the research refers to original children playing. They do it for entertainment, sometime they play with rules or sometime they not. Traditional games have song or music to make it more fun and enjoyable. The elements of nature are what they use for there “raw material.” Sand castles, mud balls, rocks, stones, seeds, pods, grass and straw are, with their imagination, used in the making of these games.
The formation and development of numerical thinking is one of the goals of early mathematics education, the cultivation and development of numerical thinking, are not confined to classrooms, should be extended to daily life in current status of education, so the cultivation of numerical thinking in everyday life is complementary with classroom teaching, educational effects can be more effective, the traditional game is just an important part of the linkage process. From the perspective of folk mathematics to the research on traditional games, many of them directly or indirectly involve in number and graphic, these games would exert a subtle influence on the development of children’s number intuition, this kind of intuition is precisely seen as number sense\(^2\), while the construct of number sense is a direct reflection of the acquisition of numerical thinking aptitude, it is very important for the development of high-level numerical thinking, and directly impact on the numerical problem-solving ability.

1. The relationship between cultivation of numerical thinking skills and traditional games under the context of social culture

Early childhood mathematics education in minority areas is inseparable from the context of their own unique minority education. Their early mathematics education tends to focus on an organic combination with the experience of daily life and classroom education, and cognition to a number is more easily acquired and strengthened in the interactive process of traditional games in daily life. The former Soviet psychologist Vygotsky put forward to socio-cultural theory, which reasonably explained the dialectical relationship between traditional games and children’s mathematical cognition. Vygotsky continued to interest in mental development in the cognitive psychology since Piaget, but he thought that cognition could not be solely understood on the individual level, because the psychological function and cognitive

\(^2\)Since Dantzig formally proposed number Sense in 1954, the concept of number sense is becoming terminology widely used in the field of psychology and mathematics education. It is first mentioned in Compulsory Education Mathematics Curriculum Standards (Trial version) in 2001 in China ".
Construction started from social relations and interaction, gradually internalized by individuals; in other words, the development of mental capacity is the result of social interaction and social experience, it firstly appeared the level of social relations about human interaction, then entered the inner psychological level of children [1]. Emotional driving force about imaginary, illusion and achievement to non-realistic desire hidden in the game, is the one to promote children’s self-confidence, sense of control and social cognition and interaction.

Content, type, game play of traditional games are influenced by the national social history, geography, customs, culture, morality, possess the national social attributes, and thus form a certain cultural context. So, with the aid of the cultural tools of the game, cultivation of numerical thinking are closely linked with folklore. “The folklore mathematical thinking contained in the math curriculum will not only allow students to experience the process of mathematics development in different cultural contexts, but also to follow the process of individual mathematical cognitive development (from concrete to abstract), so that students may have the opportunity to feel the essential attributes of mathematics as human culture. As a result, folk mathematics should be used as a supplement or the cornerstone of academic mathematics in mathematics curriculum [2]”. This is an important prerequisite for the all-round development of children’s early mathematical thinking. When Bergeron and Herscovics talked about numerical thinking in the early mathematical research, as far as the cultivation of numerical thinking was concerned, they raised that the focus on what should be learnt in order to acquire numerical competence has moved further away from a view that emphasizes the mastery of particular concepts, procedures and their skilled application, towards a dispositional view of mathematical competence involving the integrated availability and flexible application of different components. This notion of disposition involves, besides availability of conceptual schemes and strategies, notions of inclination and sensitivity, as nicely reflected in the increasingly popular construct of “number sense” (or “numeracy”). [3]. It is thus clear that the development of numerical thinking was particularly evident in the establishment and expansion of the number sense.
Early childhood education concentrates on pre-school and lower grade. From the view of the relationship between playing traditional games and childhood education, their age is about from 4 to 8 years old. At this phase, the main aspects of counting and arithmetic cognition as early numerical thinking cultivation is attracted much attention, which has become a hot spot of psychology and mathematics education. These aspects are involved, such as to identify the unit in the counting, to form the concept of cardinal, and to gradually understand the structure of addition and multiplication, the initial fractions and some geometric figure. For example, Von Aster proposed the arithmetic cognitive development need to experience four phases of the physical representation, speech representation, symbolic representation of number and representation of the mental number line. Verschaffel pointed out that numerical thinking was mainly related to five fields about the number concept and number sense, arithmetic operation, to grasp the basic arithmetic facts, mental arithmetic and written calculation, application of arithmetic number knowledge and skills to solve the word problems. Therefore, number sense as a component of numerical idea is a broad concept based on understanding of the quantitative relationship and the number representation, implicit characterization capabilities for the number space (mental number line), a series of explicit development about the concept of numbers, facts, skills, and more capabilities which are used to solve related numerical issues, such as comparison to number size, development of estimate and mental arithmetic, judgment number’s reasonableness. So, number sense to build is a solid foundation for the formation and development of numerical thinking. Some games concerned with numbers are just kept in ethnic traditional games. According to children’s interest as starting point, these games are controlled by the children’s internal motivation. Children pay

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3 Generally speaking, early childhood education is a branch of educational theory which relates to the teaching of young children up until the age of about eight, with a particular focus on education, notable in the period before the start of compulsory education. But in China, many young children begin to accept the compulsory education when they are 6 years old. In addition, young children only play games by themselves when they are 3-4 years old. Because the research emphasizes on traditional games, early childhood education concentrates on 4 to 8 years old.
attention to the recognition of the numbers, counting and operational capacity through playing games, stress on acquiring the pleasure in the process of playing. Game plays change the abstract to the concrete which are more easily understood, and it is particularly important for the establishment of early number sense. That is to say, traditional games provide a natural and relaxed platform for cultivation and development of numerical thinking.

2. The representation of numerical thinking in ethnic traditional games

In ethnic traditional games, the cultivation of numerical thinking is different from formal schooling that school-age children receive; after all, the main purpose of game is not to let the children grasp the specific significance of a number, the size of numbers, and the rules of operation from the perspective of numerical thinking. But, in the process of psychological development of individuals and numerical thinking at the earlier age, experiences and common senses also play irreplaceable roles in some games compared with school education. Representation of numerical thinking is mainly reflected in the number cognition and expressions, as well as the reification of number sense in the popular game. From the angle of ethnic enlighten education, children grasp and understand the numbers according to the representation, and gradually build an early numerical thinking.

Manchu play “Gachuha⁴”, Mongolia seize “Shah”. Oroqen grasp “small stones”, are somewhat similar which are the representative traditional games related to numerical thinking. Gachuha as a case study plays as follows:

(1) Several Gachuha are scattered (usually 4-8 in pieces).

(2) Player picks a small sandbag and throws it into the air, and then pull all of Gachuha the same sides quickly according to the four sides of “zhenr, beir, lunr, kengr”, before sandbag fall down and player catches it.

⁴Gachuha is a bone joint the shank and shin bone of sheep, pig, Mongolian gazelle, cattle and other animals, which is to be scraped the meat and fat through being boiled and cooked. Mongolian calls it as “Shah”or “Shiah”. Gachuha is surrounded by different sides called “zhenr, beir lunr”, and kengr in Pinyin of Chinese. The game play of “Gachuha” is the traditional entertainment of Mongolian, Manchu, Daur, still popular in some areas of northern China.
(3) Player pulls one piece once a time, or pulls 2-4 pieces once a time. All Gachuha are pulled proper sides each round.

(4) Player throws the sandbag to the air, and then immediately grasps several Gachuha according to gamers’ agreement by the same hand (usually one-four pieces of the same side). At the same time, player catches the sandbag before it falls down the ground.

(5) If player can seize pieces of Gachuha on the ground and catch the bag in the air, she may continue to play the game, until she fails.

(6) At the end, if player put the Gachuha proper side quickly and grasp all of Gachuha, she will win.

The step (1), (4) and (6) strengthen the recognition and representation of a number in the game, reinforce the changes of number in children’s logical thinking, and children can also simply grasp computing method of division. Similarly, Manchu “hopscotch”5, cultivates children’s intuition about the sequence of number, improves their sensitivity of the applications to number. In Thailand, game play of Mark Keb (Jack Stones) and other traditional game are similar with Gachuha.

Nancy C. Jordan summarized the main component of number sense, which included the five aspects of counting, number knowledge, number transformation, estimation, number patterns [5], most of which can be a specific interpretation related to traditional games. For example, for the number conversion, children mainly change the number of objects by plus and minus, operate mental arithmetic of plus and minus with the help of the physical operations. Some ethic traditional games just concretize the number sense component. As far as “quantity estimate” is concerned, children can learn to roughly estimate the sizes of the quantity of objects, using the reference point to estimate number through playing the game of “Grasp small stone”, “Catch the enemy” and the game of chicken in China. “One

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5Playing Manchu “hopscotch”, (Pinyin of Chinese is Tiao nian or Tiao fangzi) are as follows: Firstly, children draw six lattices on the ground, about 2 feet of each lattice, each lattice represents one year (or one room). Children jump into the lattice with single leg, then kick the tile to next lattice. If he hop all six lattices, win the game. Children kick the tile out of the lattice, or over the line, they become losers and stop jumping. Winner of the game may beat the loser’s palm.
Gradai Kha Dee-o” (Legged rabbit), “E-Gar Fuk Khai” (Crow sits on eggs), “Ngoo Kin Harng” (Tail eating snake) in Thailand.

In short, the number information and number computing contain in the ethnic traditional games. The expression, as well as operation of these numbers plays a fundamental role in traditional games when ethnic children cultivate early number sense and numerical thinking.

3. Further development of children numerical thinking in traditional games

Regardless of natural conditions, social systems, economic production, children always make use of time and materials, create and play their own games. When intellectual development is to adapt for nature, children can participate in games by themselves, grasp the relationship between number and counting, and improve the ability of numerical computing, inititatively accept and think about mathematical problems in life. In this process, the establishment and development of number sense is a specific and effective strategy for cultivation of numerical thinking in traditional games.

At present, Compulsory Education Mathematics Curriculum Standards in China describes that “the contents of number sense contain how to understand the significance of numbers; to use a variety of methods to represent numbers; to grasp the relative size of numbers in a concreted context; to use numbers to express and exchange information; to select the appropriate algorithm to solve the problem; to estimate the result of operation, and make a reasonable explanation for the results.”[6] The presentation of number sense in the mathematics curriculum in China mainly refers to general understanding to number and operation. Of course, it is the requirement for students who study in school. For pre-school and school-age children, their number sense is deepened and expanded, thus numerical thinking is cultivated for children further in traditional games in minority areas. Especially in the areas which the education is not developed and dropout rate is high, traditional games may promote children learning the math curriculum and get twice the result with half the effort.

“Number Sense” mainly plays a key role in three areas, namely number concepts, operations with number, and
applications of number and operation. The proposed framework is an attempt to identify key components and to organize these key components according to common themes. Framework for considering number sense is composed of three parts: 1) Knowledge of and facility with NUMBERS, 2) Knowledge of facility with OPERATIONS. 3) Applying knowledge of and facility with numbers and operations to COMPUTATIONAL SETTINGS. [7] In the course of cultivation of children’s early number sense, the forward two are easy to reinforce and develop when children play the traditional games related with number. This is an initial attempt for children to solve mathematical problems. Their ability to grow can be seen as part of children’s cognitive development, which enables them to understand and solve more complex mathematical situations. Then, how we reinforce the number sense in minority areas through traditional games, and then cultivate numerical thinking? In fact, we can find an entertaining way to reconstruct and expand traditional games through appropriate academic guidance so that they will be more effective.

In fact, the process of imagine in playing games is the one that those languages and actions, or substitutes deliver the information to activate the representation and diagram in children’s long memory and to restructure them. However, the game is seen as an effect combined information processing with control processes. When children play traditional games, their perception, and memory and so on, play an essential role. Riddle is an indispensable game during the growth of children in minority areas; some numbers in the riddles is helpful for children to master digital knowledge. For example, the riddle of an elephant is well known, as follows, “The face of long hook, head hanging fan, four thick pillars, and one little pigtail”. In the process of guess, children’s imagination, perception and memory capacity are mobilized, and numbers in the riddle is strengthened in their brain when they understand some information in the riddle. Children guess the specific things related to the numbers in terms of their experiences. The above-mentioned riddle is to highlight the cognition of concept of numbers 1, 2 and 4. When children guess the answer of the riddle, teachers, parents or elder children may further expand the game, and ask young children how many pillars two elephants have? How many pigtails? Through the expansion of the riddle and language symbols, children learn
operations of plus or furthermore learn more about the multiples with interest.

The identification of a single number is the primary form of accumulating the number knowledge. When children begin to recognize number, they can not correctly understand the number word sequence. During cultivation of numerical thinking, the sense of number sequence is particularly important, such as number sequence of 10-0, or vice versa. The "count" not only refers to children’s earliest experience to unidirectional count, but practice through any appropriate way: they may make interval count through the arrangement of even number of 2, 4, 6, 8, or count forward or backward from the beginning of any a number, which can expand in the game of “hopscotch” of Manchu, Xibo minority and “hopscotch” in Thailand. Children hop the lattice according to the sequence of “natural number” or “even number”, realize a variety of numerical presentation, then their sense of number sequence is nurtured.

If children have good numerical thinking, they may have flexible computing ability with number and algorithms. As far as computing knowledge and computational simplicity are concerned, that is the core to understand the calculation result and basically grasp the rules of operation. In terms of early childhood education, the ability may form and develop through playing games. For example, the game of “hopscotch” can be appropriately extended; the number on the lattice can be converted into the game’s scores. After Several rounds of the game (the game may be played several rounds), children may calculate the scores they get, child who get top score will win. Sudokus (three squares high by three squares wide) is drawn on the ground. According to the sequence 4-9-2, 3-5-7, 8-1-6, natural number 1-9 will be filled into the sudokus, sum of three numbers in horizontal and vertical row equals to 15 in anyway, children hop on the lattice, so that they master the different digital computing methods which can get the same results. So, the extension of traditional games reinforces the ability that children make use of numbers and algorithms to do the flexible computing. Children’s mental arithmetic ability is trained enough; they grasp the addition operation between the 1-10 numbers, which fully presents the prominent link between the numbers and calculation in the game.

Other ethnic traditional games, such as Mongolian “Xitari” (a Mongolian chess), Tibetan chess, etc., have the same
function as above-mentioned games. Children may well understand the concept of number, meaning, and the number sequence, to cognize the relative size of the number and their mutual relations when they play the game. They are easier to build number sense, to master the abstract features of numerical thinking.

**Conclusion**

Currently, the imbalance of early childhood education is not solved overnight in the minority areas, which requires the macro-control on the national policy, and local government preferential policies on educational investment. The intervention of these external powers indeed solves any problems of minority education, but, as far as mathematics education is concerned, because it starts from daily life, so we actively stimulate the initiative of traditional games, build children’s number sense through the game, and then expand the cultivated way of numerical thinking, as an effective complement means to classroom education. In fact, some problems, such as early childhood mathematics education lagged behind, may be solved through playing games.

Additionally, either in contemporary China or Thailand, we also find that modern technology, especially high development of information technology, has affected children’s playing space deeply, so children have been reluctant to play traditional games with their partners. However more of them are willing to play video games with fascination by iPad or Tablet and so on, their games space are limited to the square inch of electronic products increasingly, and traditional games in outdoor are gradually being neglected or even forgotten.

However ethnic traditional games have more educational value contrast to modern games, not only act as an important role in the education of children numerical thinking, but also let children to master many local ethnic traditional knowledge, train children’s habit to focus on their own concern to the society, cultivate children’s thinking and problem-solving skills. Furthermore, under the premise of contemporary heritage and protection of intangible cultural heritage, traditional games in minority areas are slowly declined in China and Thailand. So, except for class teaching in the modern education system, we can take the form of the second class, serve the national intangible culture as a comple-
ment of modern knowledge, and apply traditional numerical games into the early mathematics education. The traditional games not only let children acquire the mathematical knowledge, but also sow seeds of traditional game in the children hearts, which would let the excellent national traditional games inherit well and carry forward generation by generation in the daily living space.

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Reference


