An Investigation into Myanmar Preschoolers' Number Sense and Problem Solving Ability

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Abstract

The primary purpose of this study was to examine the preschoolers' number sense and problem solving ability in terms of organization, gender, their teachers' teaching experience and age level. Then, whether or not schooling has an effect on preschoolers, number sense and problem solving ability was next of interest. Finally, to investigate whether there would be direct relation between number sense and problem solving ability. Both quantitative and qualitative approaches were used in this study. In the Phase I, 412 preschoolers from 11 preschools and their respective teachers participated in this study. In the Phase II, 142 preschoolers participated in this study. Among them, 27 were selected from Taikgyi Township (Yangon Region), 20 from North Dagon Township (Yangon Region), 20 from Theinzaik (Mon State), 50 from Yekyi Township (Ayeyarwaddy Region) and 25 preschoolers from Thanetpin Township (Bago Region).

Preschoolers' Number Sense Test (PNST) and Preschoolers' Problem Solving Test (PPST) were used as the research instruments. Preschoolers' Number Sense Test (PNST) consists of 41 items and eight sub-scales such as rote counting, counting backwards, number after, number before, number between, number identification, quantity discrimination and matching number/objects. The Preschoolers' Problem Solving Test (PPST) is composed of 20 items. It consists of four sub-scales such as addition, subtraction, commutativity, and associativity. Alpha reliability for PNST and PPST revealed at 0.856 and 0.876, respectively.

In this study, ANOVA results by department/organization indicated that significant differences were found to be on five sub-scales such as rote counting, counting backwards, number after, number identification and matching sub-scales of preschoolers' number sense test. Concerning preschool teachers' experience, the mean score of preschoolers whose teachers had less than 5 years teaching experience were found to be significantly lower than that of preschoolers whose teachers had 5 years and above teaching experience on the rote counting and counting backward sub-scales. However, there existed no gender related difference concerning all sub-scales of preschoolers' number sense test. Moreover, it was found that older preschoolers outperformed younger preschoolers on the entire number sense test.

Concerning problem solving ability of preschoolers, the mean score of preschoolers who attend the preschools under Ministry of Education (MOE) was higher than that of preschoolers who attend preschools under Department of Social Welfare (DSW) in the entire problem solving test. Gender related difference was not found to be significant different on preschoolers' problem solving ability. Concerning the age group, the mean score of older preschoolers was found to be higher than that of younger preschoolers. According to the multiple regression analysis, number identification was the strongest predictor for preschoolers' problem solving ability. On the other hand, rote counting, number after, counting backwards, number before, and number between were also the strong predictors for preschoolers' problem solving ability.

There was significant difference between preschoolers who attend preschool and who do not attend preschool in both sub-scales. The preschoolers who attend preschool can do better than those who do not attend preschool. This research revealed that schooling plays an important role on the development of preschoolers' number sense and problem solving ability.

Key words: number sense, problem solving ability and preschooler

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Introduction

Education of the children is the foundation of their life processes with which they can learn more advanced fields of studies and broaden their scope of knowledge in this rapidly changing world. Education for preschoolers becomes the important target for all parents around the world. During the early childhood, children learn much knowledge from their environment and apply their knowledge in many novel ways. Children show a natural interest in exploring everyday mathematical concepts. Children who can learn well mathematics in early childhood have the best chance of later mathematics achievement in formal schooling.

Significance of the Study

Gelman and Gallistel (1978) stated that the preschool years are the important period of learning and development in children's arithmetic. According to Gelman and Gallistel (1978), preschoolers are capable of appreciating various addition concepts. Levine, Jordan, and Huttenlocher (1992) stated that preschoolers are capable of solving simple addition problems. Early development of number concepts is critical in developing positive attitudes about mathematics at an early age. Therefore, educators need to investigate whether preschoolers actually develop early number sense concept and problem solving ability during early childhood.

Purpose of the Study

The major purposes of this study is to assess preschoolers' number sense concept and problem solving ability and, to study the effect of preschoolers' number sense concept on the development of their problem solving ability and then to explore the effect of preschool education on the development of their number sense concept and problem solving ability of children is of next interest.

Scope and Procedure

This study was conducted by survey method. Preschoolers' Number Sense Test (PNST) and Preschoolers' Problem Solving Test (PPST) were used as the research instruments. Preschoolers' Number Sense Test (PNST) consists of 41 items and eight sub-scales such as rote counting, counting backwards, number after, number before, number between, number identification, quantity discrimination and matching number/objects. The Preschoolers' Problem Solving Test (PPST) is composed of 20 items. It consists of four sub-scales such as addition, subtraction, commutativity, and associativity.

Review of Related Literature

Number Sense

Number sense refers to a person's general understanding of number and operations along with the ability and inclination to use this understanding in flexible ways to make mathematical judgments and to develop useful strategies for handling numbers and operations. It reflects an inclination and an ability to use numbers and quantitative methods as a means of communicating, processing and interpreting information. It results in an expectation that numbers are useful and that mathematics has certain regularity. Number sense is widely used in current mathematics education reform documents as it typifies the theme of learning mathematics as a sense-making activity. Like common sense, number sense is an elusive term which has stimulated discussion among mathematics educators, including classroom teachers, curriculum writers and researchers (McIntosh, Reys, & Reys, 1992).

Components of number sense found in two or fewer studies are number writing, measurement concepts, understanding patterns, recitative counting, classification, ordinality, inversion principle, part-whole relationship, communicativity, moving between number representations, counting out objects to match spoken number, understanding symbols used to denote numbers (Politylo, White, & Marcotte, 2010).

Previous Research on Number Sense

Previous research showed that girls and boys possess identical primary numerical ability. Demie (2001), Gorard, Rees, and Salisbury (2001) analyzed the British National Curriculum Key Stage 1 measurements (children aged four to seven years) and reported that girls outperformed the boys in basic arithmetic. Carr and Jessup (1997) reported contradicting outcomes, as in their first school year, boys and girls may use different strategies for solving mathematical problems, but there is no difference in the level of performance (as cited in Aunio, 2006).

Problem Solving

According to Goldberg (2003), mathematical problem solving has been defined as the ability to read, process, and solve mathematical situations (as cited in Hines, 2008). Developmental and schooling-based improvements in basic arithmetical competencies are reflected in changes in the distribution of procedures, or strategies, used in problem solving and in advances in children's conceptual understanding of arithmetic and related domains, such as counting. Mathematical problem solving has been defined as the ability to read, process, and solve mathematical situations (Goldberg, 2003). Problem solving is an important component of mathematics education because it is the single vehicle which seems to be able to achieve at school level all three of the values of mathematics listed at the outset of this article: functional, logical and aesthetic (Taplin,2011). Cockcroft (1982) also advocated problem solving as a means of developing mathematical thinking as a tool for daily living, saying that problem-solving ability lies 'at the heart of mathematics' because it is the means by which mathematics can be applied to a variety of unfamiliar situations.

Methodology

Sample of the Study

Simple random sampling technique was used in this study. In phase I, participants of the study were preschool-age children selected from eleven preschools; 4 from Ministry of Education (MOE), 4 private schools, 1 from Myanmar Maternal and Child Welfare Association (MMCWA) and 2 from Department of Social Welfare (DSW). In Phase II, 142 preschoolers participated. Among them, 27 were selected from Taikgyi Township, Yangon Region, 20 from North Dagon Township, Yangon Region, 20 from Theizaik, Mon State, 50 from Yekyi Township, Ayeyarwaddy Region and 25 from Thanetpin Township, Bago Region. A total of 554 Myanmar preschoolers participated in this study.

Instrumentation of Preschoolers' Number Sense Test

The present study investigated preschoolers' number sense concept, their problem solving ability and the effect of number sense concept on the development of their problem solving ability. The instrument to measure preschoolers' number sense concept was developed by researcher. This process was undertaken by the guidance of existing standardized tests such as Test of Early Numeracy (TEN) by Clarke, B. and Shinn, M. R., (2002), and Sandwell Early Numeracy Test Revised (SENT-R) developed by C. Arnold, M. Talents and B. Walden (2008). In this study, researcher adapted from the number sense components of SENT-R and TEN. The Problem Solving Test was adapted from a judgment task designed by Canobi, Reeve, and Pattison (2002) and problem solving task adapted from a non-verbal calculation task designed by Levine, Jordan, and Huttenlocher (1992).

The instruments used in this study were adapted to Myanmar version to be suitable for Myanmar preschool children. Next, revisions in item length, and the wording of items were made during preliminary administrations of these two forms and pilot study was done with a sample of 15 preschool children from a private school to test whether the

wording of items, statements and instructions had their clarity in Myanmar version. After preparing the measuring scale, expert review was conducted for face validity and content validity by 13 experts who have sound knowledge and closed relationship with this study area.

Data Analysis and Results

After developing the required instrument, number sense and problem solving ability of preschool children were investigated.

Result of Phase I

Number Sense of Preschoolers

The standard z-scores for Preschoolers' Number Sense Test are shown in Figure 1. Number sense test includes eight sub-scales such as Rote Counting (RC), Counting Backwards (CB), Number After (NA), Number Before (NB), Number Between (NBwn), Number Identification (NI), Quantity Discrimination (QD) and Matching number/objects (Mat). According to Figure 1, the standard score of rote counting of the preschoolers was the highest among the eight sub-scales. The matching sub-scale was the second highest. Therefore, it can be said that preschool children can perform rote counting sub-scale better than other sub-scales of number sense. The standard score of quantity discrimination of the preschoolers was found to be the lowest on the entire number sense test.

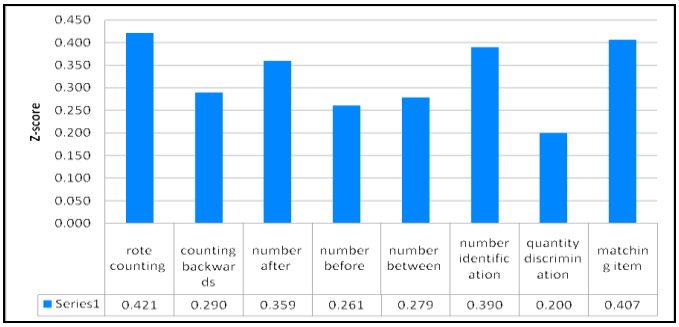

Figure 1 Sub-scales of Preschoolers' Number Sense by Standard Z-Score

To explore whether or not there was significant difference among the number sense sub-scales by department/organization, further data analyses were conducted. Concerning the number sense, Table 1 shows the mean comparisons of eight sub-scales as well as total scale scores by department/organization. Based on the ANOVA results, significant differences were found among rote counting, counting backwards, number after, number identification and matching sub-scales of preschoolers' number sense test (See Table 1).

Concerning rote counting, there was significant difference between the mean score of preschoolers from preschools under MOE and that of preschoolers who attend preschools under MMCWA. Regarding number after sub-scale, there was also significant difference between the mean score of preschoolers who attend preschools under MOE and that of preschoolers who attend preschools under MMCWA.

In relation to rote counting, counting backwards, number after, number identification and matching sub-scales, the significant mean differences were found between the mean score of preschoolers who attend preschools under MOE and that of preschoolers who attend preschools under DSW. Concerning number identification, there was significant difference between the mean score of preschoolers who attend preschools under MOE and that of preschoolers who attend preschools from private school. It can reasonable be said that preschools under MOE geared more on the development of preschoolers' number sense than that of other organization.

Table 1 Preschoolers' Number Sense Sub-scales by Department/ Organization

Sub-scales	MOE	Private	MMCWA	DSW	*F*	*p*
Rote Counting	2.36 (.70)	2.31 (.76)	1.83 (.82)	1.75 (.87)	16.29**	0.000
Counting Backwards	.47 (.50)	.37 (.48)	.28 (.45)	.12 (.32)	11.46**	0.000
Number After	4.39 (2.23)	4.30 (2.2)	3.48 (2.28)	3.35 (2.5)	5.39*	0.001
Number Before	1.42 (1.98)	1.55 (2.24)	1.40 (2.37)	1.04 (1.92)	1.20	0.306
Number Between	1.87 (2.35)	1.54 (2.23)	1.67 (2.40)	1.37 (2.09)	1.00	0.393
Number Identification	4.11 (1.74)	3.50 (2.08)	3.35 (2.14)	2.97 (2.14)	6.16**	0.000
Quantity Discrimination	5.79 (.74)	5.77 (.72)	5.61 (1.09)	5.69 (.82)	0.74	0.523
Matching	3.84 (1.88)	3.43 (2.1)	3.28 (2.24)	2.77 (2.29)	4.83*	0.003

MOE= Ministry of Education, MMCWA= Myanmar Maternal and Child Welfare Association, DSW= Department of Social Welfare

Note. Numbers in parentheses are standard deviations.

*. The mean difference is significant at the 0.05 level.

**. The mean difference is significant at the 0.001 level.

The results of independent sample t-test revealed that there were significant differences between the mean score of preschoolers whose teachers had 5 years and above teaching experience and that of preschoolers whose teachers had less than 5 years teaching experience. So, the more the teachers have teaching experiences, the greater their teaching effectiveness. Whether there was gender difference, or not, in the performance of preschoolers' number sense was worthwhile to explore. Therefore, to investigate whether number sense of preschoolers varies with regard to gender, analyses were conducted again. The results of t-test on the sub-scales of preschoolers' number sense by gender revealed that there was no gender difference for the whole number sense test. This finding is consistent with previous number sense research conducted by Howell and Kemp (2009). Howell and Kemp (2009) found that there was no difference between the boys and girls on most of the components of number sense.

In addition, preschoolers were categorized into two groups; younger preschoolers (under 4 years old) and older preschoolers (above 4 years old). And then, the mean comparisons of preschoolers' number sense sub-scales by age group were explored. The means and standard deviations for preschoolers in both age groups (younger and older) were shown in Table 2. To investigate the mean differences of number sense of preschoolers by age group, independent sample t-test was conducted and it became apparent that there were significant mean differences on eight sub-scales as well as overall number sense test. The results of t-test confirmed that older preschoolers outperformed younger preschoolers in the entire number sense test. This finding is consistent with previous research conducted by Jordan, Kaplan, Olah, and Locuniak (2006). Jordan, Kaplan, Olah, and Locuniak, (2006) found that there was a positive and statistically significant association between the age of entry into kindergarten and exit number sense score across the three classes of total number sense, meaning that children who are older when they enter kindergarten demonstrate significantly better exit number sense scores than their younger counterparts.

Table 2 Preschoolers' Number Sense Eight Sub-scales by Age Group

Number Sense	Age	Mean	SD	*t*	*p*
Rote Counting	younger	1.43	0.69	-15.21**	0.000
	older	2.49	0.64		
Counting Backwards	younger	0.05	0.22	-9.18**	0.000
	older	0.46	0.50		
Number After	younger	2.31	2.22	-12.06**	0.000
	older	4.85	1.89		
Number Before	younger	0.25	0.91	-8.11**	0.000
	older	1.92	2.30		
Number Between	younger	.33	1.06	-8.77**	0.000
	older	2.24	2.42		
Number Identification	younger	1.92	2.17	-13.54**	0.000
	older	4.34	1.42		
Quantity Discrimination	younger	5.41	1.13	-6.033**	0.000
	older	5.90	.49		
Matching	younger	1.62	2.13	-14.42**	0.000
	older	4.25	1.51		

**. The mean difference is significant at the 0.001 level.

Problem Solving Ability of Preschoolers

Looking across department/organization, Table 3 shows the mean comparisons across four sub-scales of problem solving as well as total scale scores and standard deviations. According to Table 3, the overall mean score of preschoolers who attend the preschools under Ministry of Education (MOE) was the highest in the four clusters of school. The mean score of preschoolers who attend private preschool was found to be the second highest in the four clusters of preschool.

Table 3 Mean Comparisons of Preschoolers' Problem Solving Sub-scales by Department/Organization

Sub-scales	MOE	Private	MMCWA	DSW	*F*	*p*
Addition	5.82 (2.34)	5.31 (2.59)	4.74 (2.53)	3.70 (2.81)	13.64**	0.000
Subtraction	3.73 (1.52)	3.28 (1.57)	3.17 (1.84)	2.73 (1.88)	6.64**	0.000
Commutativity	3.47 (1.56)	3.26 (1.52)	2.77 (1.57)	2.20 (1.63)	14.14**	0.000
Associativity	2.53 (1.54)	2.14 (1.74)	1.55 (1.62)	0.90 (1.39)	21.32**	0.000

MOE= Ministry of Education, MMCWA= Myanmar Maternal and Child Welfare Association, DSW= Department of Social Welfare

Note. Numbers in parentheses are standard deviations.

**. The mean difference is significant at the 0.001 level.

Concerning preschool teachers' experience, the mean scores of preschoolers whose teachers had 5 years and above teaching experience was found to be slightly higher than those of preschoolers whose teachers had less than 5 years teaching experience. It can reasonably be said that the more the teachers have teaching experiences, the greater their teaching effectiveness. Looking across the overall scale and four sub-scales, gender related difference was not found to be on preschoolers' problem solving ability. Moreover, the results of independent sample t-test revealed that there were significant age-related differences on the preschoolers' problem solving four sub-scales. Concerning the age group, the mean score of older preschoolers was found to be higher than that of younger preschoolers. Therefore, it can be said that preschoolers' problem solving ability is related with their age. This finding is consistent with previous problem solving research

conducted by Patel and Canobi (2009). Patel and Canobi (2009) found that older children group solved more problems correctly than the younger group.

The Relationship between Preschoolers' Number Sense and Problem Solving Ability

Concerning the relationships between eight sub-scales of number sense, the overall number sense and problem solving, Table 4 shows that the significant correlation among variables. Correlation between number sense and problem solving was significant, r=0.88**. Inter-correlation among eight sub-scales of Number Sense Test such as rote counting, counting backwards, number after, number before, number between, number identification, quantity discrimination, and matching number/objects were ranging from 0.15 to 0.86, and correlation were significant at 0.01 level (See Table 4).

Table 4 Relationships among Number Sense Eight Sub-scales, Overall Scale of Number Sense Test and Problem Solving

Sub-Scales	2	3	4	5	6	7	8	9	10	11	12	13	14
1.Rote counting	.52**	.66**	.47**	.46**	.62**	.42**	.64**	.75**	.69**	.62**	.66**	.62**	.72**
2.Counting backwards	1	.45**	.58**	.54**	.41**	.17**	.44**	.63**	.56**	.48**	.46**	.61**	.58**
3.Number after		1	.47**	.48**	.71**	.39**	.70**	.83**	.69**	.65**	.71**	.61**	.73**
4.Number before			1	.68**	.44**	.15**	.46**	.74**	.56**	.51**	.47**	.66**	.60**
5.Number between				1	.42**	.18**	.46**	.74**	.55**	.49**	.49**	.65**	.60**
6.Number identification					1	.35**	.92**	.84**	.73**	.69**	.71**	.61**	.76**
7.Quantity discrimination						1	.37**	.44**	.39**	.42**	.41**	.31**	.42**
8.Matching							1	.86**	.75**	.72**	.73**	.65**	.78**
9.Number sense								1	.84**	.77**	.78**	.79**	.88**
10.Addition									1	.86**	.77**	.73**	.94**
11.Subtraction										1	.77**	.67**	.91**
12.Commutati-vity											1	.73**	.88**
13.Associativit-y												1	.85**
14.Problem solving													1

**. Correlation is significant at the 0.01 level (2-tailed).

Results of Phase II

Comparison of Preschoolers' Number Sense between Preschoolers who Attend Preschool and did not Attend Preschool

According to table 5, preschoolers who attend the preschool possess significantly the better ability than preschoolers who do not attend the preschool in all of the eight sub-scales of number sense test. The result of t-test showed that there was significant difference between the preschoolers who do not attend preschool and the preschoolers who attend preschool. It can reasonably be said that attending preschool and having the exporesure in preschool may enhance preschoolers' number sense.

Table 5 Comparison of Preschoolers' Number Sense between Preschoolers who Attend Preschool and did not Attend Preschool

		N	Mean	SD	*t*	*df*	*p*
RC	Not attend preschool Attend preschool	25 117	1.72 4.68	2.33 1.94	-6.65	140	.000
Counting Back Ward	Not attend preschool Attend preschool	25 117	0.2 0.58	0.41 0.49	-3.59	140	.000
Number After	Not attend preschool Attend preschool	25 117	1.4 4.54	2.45 2.47	-5.78	140	.000

Number Before	Not attend preschool Attend preschool	25 117	1.04 3.86	2.09 2.66	-4.98	140	.000
Number Between	Not attend preschool Attend preschool	25 117	1.08 3.74	2.24 2.61	-4.73	140	.000
Number Identification	Not attend preschool Attend preschool	25 117	1 4.35	2.04 1.59	-9.08	140	.000
Quantity Discrimination	Not attend preschool Attend preschool	25 117	5.76 4.69	0.52 2.28	2.32	140	.021
Matching	Not attend preschool Attend preschool	25 117	0.24 0.67	0.44 0.47	-4.14	140	.000
NS Total	Not attend preschool Attend preschool	25 117	12.44 27.1	11.36 12.66	-5.34	140	.000

Comparison of Preschoolers' Problem Solving between Preschoolers' who Attend Preschool and do not Attend Preschool

Studying preschoolers' problem solving skill between preschoolers who attend preschool and who do not attend preschool is precious. A total of 142 participant preschoolers were selected to investigate whether or not preschoolers' problem solving skill was related to attending preschool and not attending preschool. Among these participants, 117 preschoolers attend preschool and 25 do not attend. In relation to addition, the mean score of preschoolers who attend preschool is higher than that of preschoolers who do not attend. Results revealed that there was significant difference between the preschoolers who attend preschool and who do not attend preschool on all problem solving sub-scales. It can reasonably be concluded that attending preschool made significant improvement in problem solving ability of preschool age children.

Table 6 Comparison of Preschoolers' Problem Solving between Preschoolers who Attend Preschool and did not Attend Preschool

		N	Mean	SD	*t*	*df*	*p*
Addition	do not attend preschool attend preschool	25 117	2.24 5.70	3.443 3.470	-4.53	140	.000
Subtraction	do not attend preschool attend preschool	25 117	1.64 4.28	2.691 2.645	-4.52	140	.000
Commutative	do not attend preschool attend preschool	25 117	.76 2.11	1.268 1.325	-4.66	140	.000
Associative	do not attend preschool attend preschool	25 117	.76 2.02	1.300 1.345	-4.26	140	.000
PS Total	do not attend preschool attend preschool	25 117	5.40 14.11	8.636 8.530	-4.62	140	.000

Conclusion

Findings from this study significantly extend the knowledge of preschoolers' number sense and problem solving ability. The results reported above were largely descriptive and provided the first evidence that the majority of preschoolers showed good performance in number sense. Another important component is that of the teachable moment: recognizing and capitalizing on children’s spontaneous math-related discoveries by asking questions that require children to reflect and respond, by providing vocabulary and representational support, and by demonstrating extension activities that elaborate on and further support mathematical ideas. Actually, play is the most popular component for early childhood education. It is also needed to use effective strategies and materials in different learning environments for the development of preschoolers' number sense and problem solving ability. Therefore, teachers need to apply suitable teaching strategies so that individual preschoolers may be familiar with number sense and problem solving ability.

Discussion and Recommendation

The majority of Myanmar parents have expressed concern that their children are not able to learn cognitive skills such as mathematical skill, social skill and language skill. In fact, early childhood mathematics education (ECME) has been around in various forms for hundreds of years. Educators, administrators, policy makers, and families must work cooperatively to enhance awareness of the importance of mathematics in early education. Staff-development programs and up-graded training courses should be frequently conducted to inform preschool teachers and caregivers with developmentally appropriate teaching methods and simultaneously provide them with essential resources of high-quality, equitable mathematical teaching practices. Again, Mathematics educators should be aware that children need to be immersed throughout the day in a variety of numeracy activities that enable them to be as fluent with numbers as they are with letters, sounds and words, and eventually can solve mathematical problems using their number sense.

Suggestion for Future Research

A study of longitudinal design is necessary to clarify the age appropriate differences in preschoolers' number sense and problem solving ability. Parents should consider the fact that their children's number sense concept and problem ability should be supported by day by day experiences at home. Parents should spend more time with their children on number sense related activities. Preschool teachers should arouse children's interest in number sense problem solving ability. Most important of all, for preschool teachers and all the personnel in the field of early childhood education, more attention should be given to implement teaching learning activities that are carefully planned to achieve learning objectives of developing children's number sense and problem solving ability.

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