Cultural Activities as Learning Arenas for Children to Negotiate and Make Sense Mathematical Meanings

Wen-Huan Tsai
National Hsinchu Teachers College, Taiwan

Abstract: *The main purpose of this study was to develop a model called the " Cultural Conceptual Learning Teaching Model" (CCLT) that addresses the ways in which children's real experiences and cultural practices can be connected to mathematical classroom lessons and to improve children's understanding of mathematics. Eight second-grade classes participated in this study in Hsin-Chu, Taiwan. The results showed that school mathematics for those who are involved in CCLT model based on cultural activities improved more than for those who were involved in the control group. Children learned more in the transfer of learning in the CCLT group than Children in the control group.*

Introduction

In recent years, many studies have focused on mathematical cognition related to individual competence in daily life context (Bishop & Abreu, 1991; Carraher, 1988; Lave, 1988; Saxe, 1991; Tsai & Post, 1999; Tsai, 2000). A review of children's out-of-school mathematics raises critical questions about how children come to understand mathematics and how they connect informal knowledge out of school with formal knowledge in school. (Hibert & Carpenter, 1992; Millory, 1994; Resnick, 1987). According to Resnick (1987), teachers should concerned about the role of cultural aspects, constructing meaningful ways for students to make sense of the abstract symbols of school mathematics. She emphasized that culture contributes to better understanding in students' learning and it therefore needs to be integrated into mathematics teaching. Central to this study is the view that an understanding of mathematical meaning is the ability to connect different learning environments or situations (Greeno, 1991). Brown, Collins, & Duguid (1987) also emphasized the importance of the relationship among activity, concept and culture and claim that learning must involve all of them. Hiebert & Carpenter (1992) further proposed that children's informal knowledge could serve as a basis for the development of understanding of mathematical symbols and procedures in school setting, regardless of the content domain.

Based on these points of view, this study develops a learning-teaching model called the Cultural Conceptual Learning-Teaching Model (CCLT) (Tsai, 1996) that attempts to combine individuals, activities, concepts, and culture together. The hypothesis of the study stated that establishing a link between children's cultural activities and school mathematics will improve children's learning of mathematics in school and their ability to solve daily mathematics problems out of school. There were three questions raised in this study: (1) Did children achieve differently in school mathematics when they participated in different programs? (2) How did children involve in the CCLT group perform in solving addition problems as compared to control group? (3) How different were children's strategies of solving the word problems between CCLT group and control group?

The Cultural Conceptual Learning Teaching Model (CCLT)

The CCLT (Figure 1) contains three learning environments: construction environment; connection environment; and practice environment; and six learning stages: Play Stage; Construction Stage; Connection Stage; Reapplication Stage; Practice Stage; and Reflection Stage.

Play Stage: Play Stage provides children with an activity of playing monopoly. In this stage, children share, negotiate, and construct their immediate experiences to achieve the emergent goals of arithmetic problems with peers and more advanced children (the expert children).

Construction Stage: In the Construction Stage, the teacher designs a worksheet that has structural objectives that need to be accomplished by students. For example, children need to count the total money they have at the end of game.

Connection Stage: In the Connection Stage, based on children's experiences or strategies, the teacher tries to help children construct a connection between their experiences and concrete materials like ten-based blocks or mathematical symbols and procedures.

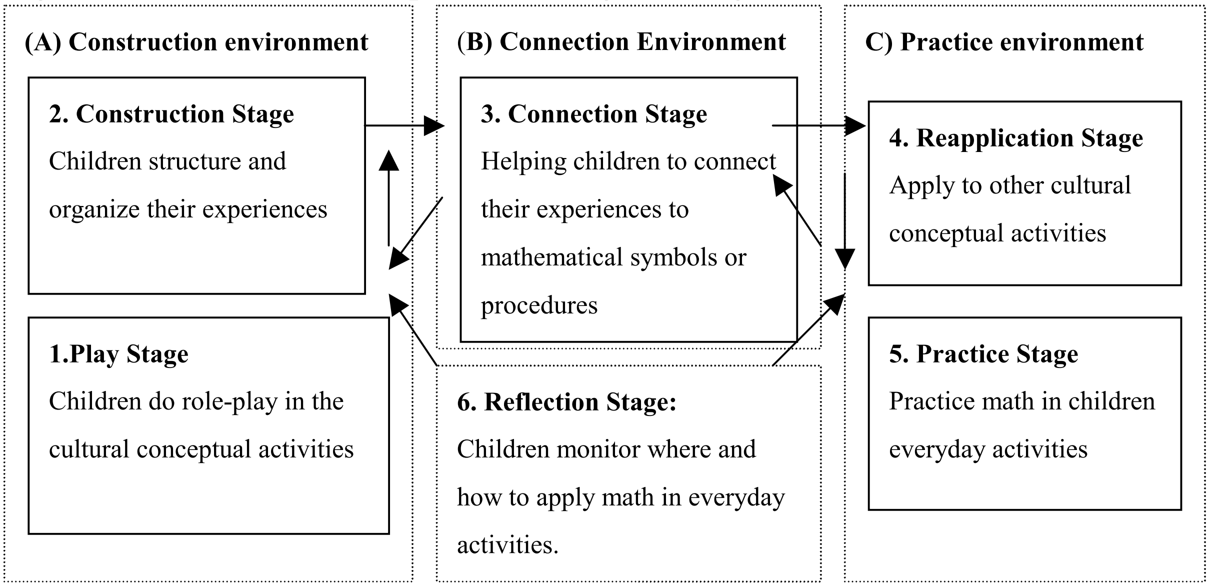
Reapplication Stage: In the Reapplication Stage, the teacher provides another similar or same cultural-conceptual activity for children to reapply to the learned mathematical concept.

Practice Stage: In the Practice Stage, children try to practice school mathematics in everyday situations by using opportunities provided for them.

Reflection Stage: In the Reflection Stage, children are trained to monitor their thinking and to be aware of where and how they can apply school mathematics in everyday activities.

In the CCLT, four kinds of cultural activities are integrated into classroom teaching, these activities include Pick-Ten-Point Game, Counting Lucky Money Activity, Shopping and Selling Toys Activity, and Monopoly Activity. This paper discusses only some findings from the Monopoly Game.

Figure 1: The Cultural Conceptual Learning Teaching Model



Methodology

Eight second-grade classes in a school located in the city of Hsin-Chu participated in this study. Four classes were randomly assigned to the CCLT group and the rest were assigned to the control group. Teachers from the control group classes met in a half-day workshop to discuss the arithmetic content of the textbook. On the other hand, teachers from the CCLT group classes met every Friday to design the cultural activities and sharing their experience of teaching.

Three tests, The Situation Test, The Standardized Test, and The Achievement Test, were conducted to examine the effects of teaching approaches and the children's ability to solve everyday task problems. The classroom instruction of each teacher was observed and videotaped. Students' worksheets and journals were also collected and analyzed.

Space allows us to present and discuss only the some findings of the Situation Test problems (some results will be presented in the meeting of PME25 conference).

The Situation Test problems contain two problems. The first problem was presented in a story form, such as "John plays the monopoly game with his friends. When the game is over, John sorts the bills he won and recorded all the bills. In all, there are fifteen ten-dollar bills; six fifty-dollar bills and three one-hundred-dollar bills totally. Could you help John count how much money he won?" The students were asked to count how much money John had and write down the process in which they calculate the amount. The second problem was also presented in the same form but asked them to calculate more and different values of bills as follows: seven ten-dollar bills; two fifty-dollar bills; eight one-hundred-dollar bills; four two-hundred-dollar bills; two five– hundred-dollar bills; three one-thousand-dollar bills; three two-thousand-dollar bills; two five-thousand-dollar bills. Children's strategies and processes of calculation were analyzed and recorded.

Results

The teaching effects. Each part of the results was described in accordance with each research questions. The first part documented the effects of the CCLT teaching model on children's ability to solve the two problems described previously when compared to a regular teaching program.

Table1: Summarization of frequency, or percentage, and test results between the CCLT group the control group of the correct answers to the situational problems

	Treatment		Test	P
	CCLT	Control		
1. Totaling NT$ 750	60.3% (76)	23.1% (30)	χ^2 (1, N = 256) = 36.57	P*** < .001
2. Totaling NT$ 21770	16.7% (21)	2.3% (3)	χ^2 (1, N = 256) = 15.53	P*** < .001

Though by the end of the year second graders are expected to learn to add 2-digit numbers with a sum of no more than 100 and to learn numbers up to 1,000 by counting, the result of table 1 show that children who learn addition through the CCLT model gained more transfer learning than the national standard goal for the elementary school curriculum when compared with the control group. For the first problem, 60.3% of CCLT group children were able to solve the addition problems involving 3-digit numbers. On the contrary, only 23.1% of children in the control group were able to solve them. The difference between these two groups was tested significantly.

For the second problem, 16.7% of CCLT group children were able to solve the addition problems involving 4-digit and 5-digit numbers, while only 2.3% of control group children were able to add the same 4-digit and 5-digit numbers. This difference was also tested significantly.

Achievements in different levels of addition. Some children couldn't express the processes of the problems s correctly, but they do some parts of the solutions. This part describes the different levels of addition between the children involved in the CCLT group and those involved in the control group when they calculate two problems.

Table2: Summarization of frequency, percentage, and test results between the CCLT group and the control group of the achievement level for addition in the situational problems

	Treatment		Test	P
	CCLT	Control	χ^2 (1, N = 256)	
Totaling NT$ 750				
O	7.1% (9)	25.4% (33)	15.525	P***<.001
2D	92.1% (117)	74.6% (97)	13.938	P***<.001
3D	86.5% (109)	61.5% (80)	20.646	P***<.001
Totaling NT$ 21770				
O	10.3% (13)	30.0% (39)	15.314	P***<.001
2D	88.9% (113)	69.8% (91)	14.155	P***<.001
3D	86.5% (110)	63.8% (83)	17.525	P***<.001
3DTH	77.0% (98)	43.8% (57)	29.135	P***<.001
4D	73.8% (93)	33.8% (44)	41.078	P***<.001
4DTH	46.8% (59)	13.8% (18)	33.090	P***<.001
5D	35.7% (45)	10.0% (13)	24.144	P***<.001

When we analyzed students' calculating procedures, seven levels of addition were identified. Level 0 coded as the symbol (O) is characterized as students who were incapable of solving the given problem. Level 1 is characterized as students who were able to add the 2-digit numbers (2D). Level 2 is characterized as students who were able to add the 3-digit number, but the sum is less than 100 (3D). Level 3 is characterized as students who were able to add the 3-digit numbers with the sum up to several thousand (3DTH). Level 4 is characterized as students who were able to add the 4-digit numbers with the sum of less ten thousand (4D). Level 5 is characterized as students who were able to add the 4-digit numbers, with the sum of more than ten thousands (4DTH). Level 6 represents that students who were able to add the 5-digit numbers, but with a sum of less than several ten thousands (5D).

The data sketched in table 2 show that CCLT group had higher percentages at each level to the control group. In the first problem, the CCLT group standing at the highest level (3D) had significantly higher percentage (86.5%) than the control group (61.5%). In the second problem, the CCLT group at each level possessed a higher percentage than the control group. This difference was tested significantly. Therefore, children learning of addition using the CCLT model based on cultural activities achieved a higher level than the control group based on the textbook.

Strategies used. This part described the comparison of strategies used to solve the situational problems between CCLT group and control group. According to children's solutions, six children's strategies for solving the two given problems were identified.

Table3: Summarization of frequency, or percentage, and test results for group differences of strategies used in solving two problems

	Treatment		Test	P
	CCLT	Control	χ^2 (1, N = 256)	
Totaling NT$ 750:				
O	7.1% (9)	17.7% (23)	6.511	P*<.05
AI	27% (34)	40.8% (53)	5.420	P*<.05
GAI	15.9% (20)	4.6% (6)	8.887	P**<.01
GVAI	20.6% (26)	13.1% (17)	2.651	P> .05
MIGAI	11.1% (14)	9.2% (12)	.248	P> .05
MVGAI	18.3% (23)	14.6% (19)	.618	P> .05
Totaling NT$ 21770:				
O	7.9% (10)	15.4% (20)	3.431	P> .05
AI	16.7% (21)	33.8% (44)	9.968	P**<.01
GAI	16.7% (22)	3.1% (4)	13.410	P***<.001
GVAI	25.4% (32)	22.5% (29)	.336	P> .05
MIAI	9.5% (12)	3.8% (5)	3.327	P> .05
MVAI	23.0% (29)	22.3% (29)	.018	P> .05

O indicates that children were unable to solve the given problem or the strategies can't be identified. AI indicates that children calculated the addition problems with iterating method (one by one). For example, children solved the first problem as 10+10=20, 20+10=30, 30+10=40…140+10=150, 150+50=200…650+100=750. GAI indicates that children calculated the subtotals within each group using iterating method then calculate the subtotals to get the total. For example, 10+10=20…140+10=150; 50+50=100…250+50=300; 100+100=200, 200+100=300; 150+300=450, 450+300=750. GVA indicates that children calculated the subtotals with visualization and then calculated the subtotal. For example, children wrote 150+300=450, 450+300=750. Children understand that fifteen ten-dollar bills equivalent to $ 150, six fifty-dollar are $ 300, and then add up the total. During the Monopoly game, most children made use of the visualization method to count the total automatically. There was no time for children to calculate the answer slowly. MIGAI indicates that children used the multiplication method to calculate the subtotals one by one within each group, and then add up the subtotal. For example, children wrote 10×1=10,

$10\times2=20\ldots10\times15=150$; $50\times1=50\ldots50\times6=300$; $100\times1=100\ldots100\times3=300$; $150+300=450$, $450+300=750$. MVGA indicates that children used the "within each group with visualization method" and then added up the subtotals. For example, children wrote $10\times15=150$, $50\times6=300$, $100\times3=300$, then $150+300=450$, $450+300=750$.

From table 3, the data show that the CCLT group more frequently utilized the GAI strategy than the control group, while control group used the AI strategy significantly more often than CCLT group. The CCLT group using other strategies had higher percentage than the control group, but there were no significant differences. However, since the Monopoly game was arranged in the last month of the school year; it needed to taker more time for children to complete the Connection Stage and the Practice Stage.

Conclusions

A previous study (Lin & Tsai, 1999) found that children had a rich store of cultural experiences in daily life that can be applied in the classroom. From the results of this study, learning arithmetic through children's cultural activities not only affects children learning of school mathematics but also improve their ability to solve task problems. This evidence is consistent with the effect of the CCLT teaching model in pervious studies (Tsai & Post, 1999; Tsai, 2000). One of possible reason is that this study chose popular cultural activities for classroom teaching; therefore, children brought rich experiences to take and share. Another possibility is that the CCLT model provides a learning environment for children to connect their everyday experiences to school mathematics and to practice the learned mathematics in everyday activities again.

As the Taiwanese national curriculum standards described, second graders are merely expected to be able to solve two-digit additive problems and the place value of the number less than 1,000 at the end of the school year. According to the findings of this study, children learned more in the transfer of learning in the CCLT group than children in the control group. In the CCLT, children not only need to know the mathematics concepts but also need to know how to apply them in the cultural activities. Children make sense the mathematical meanings gradually when they connect their everyday experiences with school mathematics then reapply them in the cultural activities again. However, we need more time to validate this model.

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