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# A Comparative Study of Children's Abilities in Mathematics Problem-Solving in Pedagogy of Text And Non-Pedagogy of Text-Based Schools of Center for Mass Education in Sciences (CMES)

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*Centre for Mass Education in Sciences (CMES) started implementing Pedagogy of Text (PoT) in 70 schools in 2014. A baseline was developed in 2014. This study conducted in June 2015 examined, 17 months later, the adaptation and implementation of PoT in the area of (i) mathematical operation: addition-subtraction and (ii) word problem solving. The research question was: which differences can be observed in language and mathematics performances when teaching traditionally versus when teaching by Pedagogy of Text approach (PoT) after one year and half of teaching? The objective of the mathematics test was to assess the following elements: (i) mathematical operation for addition and subtraction with regrouping and regrouping with zero; (ii) word problem solving involving addition and subtraction. Overall, children from Schools following the Pedagogy of text approach (PoTSch) performed better than children from Schools following the traditional Bangladesh approach (NPoTSch). Large number of children from PoTSch was able to calculate column addition and subtraction, solved addition and subtraction equations and solved word problems compared to a few number of children from NPoTSch. Globally the results show that the type of teaching had influences on language and mathematics performances of children.*

***Keywords:***

## Introduction

In Bangladesh, the PoT approach is being implemented in the Centre for Mass Education in Science (CMES) since 2009 in 124 schools under its responsibility. In others schools, traditional ways of teaching exist.

Teaching mathematics in the primary schools of Bangladesh remains very much traditional. Immediately after entering the world of learning, children start to memorize how to pronounce the numbers. At the same time they start copying to learn how to write the numbers. These children are familiar with many objects and they can count the objects in many cases, but this prior knowledge base is not taken into consideration by teachers. The children do the same thing repeatedly without understanding. For example, the children of eight to nine years from working class families have the capacity to go to shop with a hundred taka note and to do shopping. They can easily buy four to five items with this amount and

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can compute the total process. When these same children are given an easier problem to solve, they fail to do so. Rote learning may account for this failure. Thus mathematics becomes a scary subject to the children. Many children know the four principles of arithmetic. But when a problem is given, they become nervous. Sometimes they depend on particular words in order to opt for the appropriate operation. In absence of this word they often fail to do it.

National Curriculum and Textbook Board (NCTB) publishes good textbook which need to be followed by the teachers appropriately. Unfortunately, teachers do not follow the methodologies required for teaching the particular theme of mathematics books. Teaching learning aids are not used in the process of teaching. Moreover, no activity based teaching learning takes place in the classroom. As a result, learning mathematics becomes a burdensome subject to many students.Teachers do not get opportunities of receiving adequate training on teaching mathematics with fun. This situation exists in most of the primary schools of Bangladesh.

## Teaching Approaches

### *Traditional Approach*

The majority of *mathematics* primary school's teaching is focused on explaining how to do calculations. The teaching-learning process is also based on children's repetition. Teachers show children operative techniques and give them similar tasks to perform from textbook exercises. Learning these techniques is therefore relatively mechanical. Teachers mostly tell the process of thinking while doing math's exercises or present the process to solve a word problem, explaining his/her way of doing. The children are not invited to create by them self a strategy for calculate or solve problems. Often, learners memorize the mathematical content without understanding them, and so forget them quickly.

Furthermore, conceptualization, which allows them to understand the concepts of the various calculations in their different forms and the links between adding, subtracting, multiplying and dividing are not addressed. For instance, addition and subtraction are taught separately, teachers tend to explain how decimal system works and, in some cases, some children are invited to explain, but the majority of the learners do not have the opportunity to link those abstracts explanations with the representation of the concepts by concrete objects, such us the abacus or by grouping the objects by ten.

## The Pedagogy of Text (PoT) Approach

In the PoT approach, pupils must invent their own computation techniques to solve problem situations. In doing so, they deepen their understanding of the importance of number positioning and establish solid foundations to develop flexible and effective calculation methods. Separating the acquisition of numeracy skills and the development of the concept of positioning values, as is done in traditional Bangladeshi schools, is no longer necessary.

## Purpose of the Study and Research Questions

To the extent that CMES wishes to measure the value added of the PoT approach, there arises the central question of precisely what results are produced by teaching based on PoT in terms of the development of mathematical abilities of learners.

The purpose of this study is to understand the outcomes of the implementation of a non-traditional approach to mathematics problem sovling on pupil's performance at the middle of the 2$^{nd}$ school year, compared with the performance of pupils exposed only to traditional teaching methods.

## Research Questions

Research questions were as follows:

- Are the pupils in 2nd grade mastering the mathematical operation for addition and subtraction of integers and with restraints?
- Are they able to solve problems involving addition and subtraction?

## Methodology

### *Sample*

This study examinedthe adaptation and implementation of PoT during 17 monthsin the area of:

(i) Mathematical operation: addition-subtraction ; and
(ii) Problem solving.

This case-control study included 100 pupils of grade II randomly selected in CMES schools. 50 of them are studying in 70 PoT based schools (PoTSch) and the other 50 in 40 non PoT-based schools (NPoTSch).

Average class size in both categories is almost the same. All schools are located in rural areas with a similar socio-economic level. Teachers of both categories have similar educational background.
Stratified Random Sampling was used to ensure representative sampling from six intervention units of CMES units: Suruj, Ranirbandar, Damcura, Vatpara, Gobratali and Deuty. Each of the six CMES units was considered a stratum. The number of sampled pupils included in each stratum (unit) was proportional to the size of the stratum. At the second stage, within each stratum, a proportionate stratified random sample was taken using pupil's gender (for more details see table in p. 9).

### *Data Collection*

All pupils in PoT or non-PoT based schools undertook a mathematics test at the beginning of school year (grade I) in February 2014. The results of the test were used in this study as a baseline to ascertain the participants' mathematics abilities. At that moment, the results were homogeneous for both groups. (cf. table in appendix).

This current study conducted from 15th to 18th June of 2015 aimed at measuring changes in learning outcomes for some of pupils who were at that moment in the middle of grade II.

### *The Test*

On the basis of review of didactic materials and discussion with CMES trainer's team, data collection tools were drafted by the researcher team and EdM Geneva. For mathematics, the test consisted of addition, subtraction and multiplication problems with carrying and without carrying and of three word problem solving involving addition and subtraction.
The data collection tools were pre-tested in two schools supported byAparejeyo Bangladesh with 38 pupils in Dhaka City. Based on the feedback of field test, the tools were revised and finalized by the research team.

### *The Data Collection Team*

The data collection team was composed of a principal investigator and five CMES education team members, all from the core education team and PoT team, having master degrees either in education or

social sciences. In each unit, a team of two data collectors was engaged. The members of data collection team were oriented to the process of data collection by the principal investigator.
Prior to starting the test, the data collectors made efforts to create a friendly environment. They then distributed the questionnaires to the participants and collected them when the time accorded had lapsed. They did not discuss anything with the participants about the questions and answers. The participants were informed that the test would not create any influence on their terminal assessment.

*Data Analysis*

The aim of the data analysis was to determine whether the scores on the assessment tests (i.e. Mathematics) differed significantly between PoT and non-PoT pupils through comparative analysis and test.

## Results in Mathematics

The mathematics test was in Bangla and composed by seven tasks involving adding and subtracting numbers. Tasks demands concerned (cf. Figure 1):

1. To add or subtract two numbers by column using grouping technic (items 3.1 and 3.2);
2. To fulfil the blank of an equation (items 3.3 and 3.4) and
3. To solve three word problems involving additions or subtraction (items 3.5; 3.6 and 3.7).

*Figure-1*

Mathematics Test's items: Children performances in addition-subtraction

| Column additions and subtractions | Fulfilling the blank addition and subtraction equation | Addition and subtraction Word problems |
|---|---|---|
| 3. Find the solutions:<br>3.1) 35<br>+ 49<br>_____<br>3.2) 70<br>- 49<br>_____ | 3.3)<br>65 - … = 33<br><br>3.4)<br>33 + …= 78 | 3.5) There are 16 boys and 17 girls in Bikash grade (class 2). How many boys and girls are there in that class?<br><br>3.6) Moyna had 47 taka. She gave 19 taka to her sister. How much money Moyna has now?<br><br>3.7) There are 32 students in Angkur grade (class 1) has 32 students. A 40-seated bus has been rented for picnic. Will everyone be able to seat in the bus? If yes, how many seats will remain empty? |

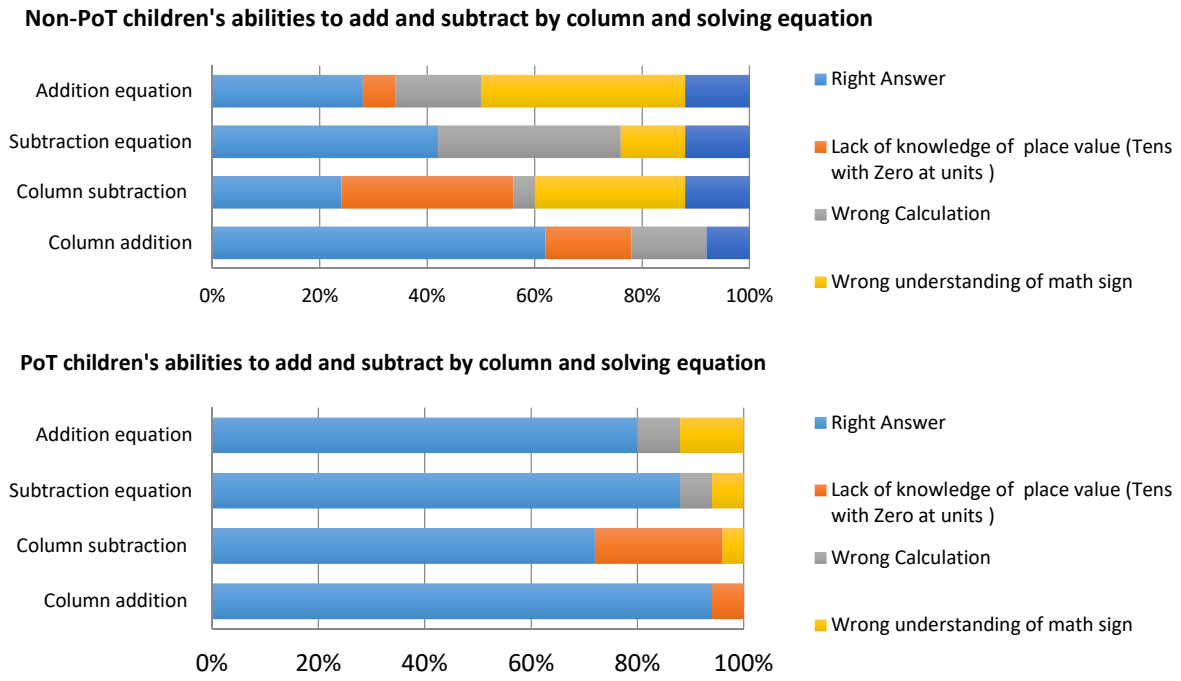
The Figure 2 represents the PoTSch children performances when adding-subtracting by column and solving addition-subtraction equations. In general, PoTSch children performed best than the NPoTSch children.

- The PoTSch group of children performed consistently well compared to the NPoTSch children. The majority of PoTSch children gave the right answer compared to the NPoTSch children. An elevated average (41/50) of PoTSch children added and subtracted satisfactory in the fourth items compared to the average (19/50) of NPoT children.
- In the group of NPoTSch children, systematically more than the half of the group had difficulties to perform as expected.

- Few number of PoTSch children had difficulties to answer correctly compared to the NPoTSch children: In both cases children did wrong calculations, did not used correctly the place value and showed a wrong understood of the math sign.
- All PoT children answered the forth items compared to the non-response to each item of some NPoT children (4 did not answer to the addition by column item, 6 to the subtraction by column, 6 to the subtraction equation and 6 to the addition equation).

*Figure-2*

**Pot and Non PoT children's abilities to add and subtract by column and by solving equations**




**Children's Performances in Solving Word Problems:**

Each problem implies a different mathematical thinking:

1. *Part-Part whole.* Problem 3.5) task implies to be able to add two parts (number of boys and number of girls) to find a whole (total number of boys and girls) by adding two parts.

2. *Separation*. Problem 3.6) task implies to be able to separate from the total (47 Mona's taka) a part (giving 19 taka to the sister) and find the other part.

3. *Separation two questions*. Problem 3.7) task implies to be able to answer two questions, if all 32 students will have their place in a bus of 40 seated and to find the number of empty places by founding the difference between number of students to be seated in the bus and the number of bus seats.

Figure 3 illustrates children's performances to solve addition and subtraction word problems.

- A significant number of PoTSch children were able to solve the problems compared to the NPoTSch children. 46 PoTSch children found correctly the total number of boys and girls, only 20

NPoTSch children did. 42 PoTSch children found the amount of taka left to Moyna, only 18 Non PoTSch found it. 35 PoTSch children found the number of empty bus seats, only 12 of NPoTSch did.

- More of 70 % of PoTSch children were able to find the right operation, calculated as expected, gave the correct numerical answer and wrote an explanation compared to less than 15% of the NPoTSch.

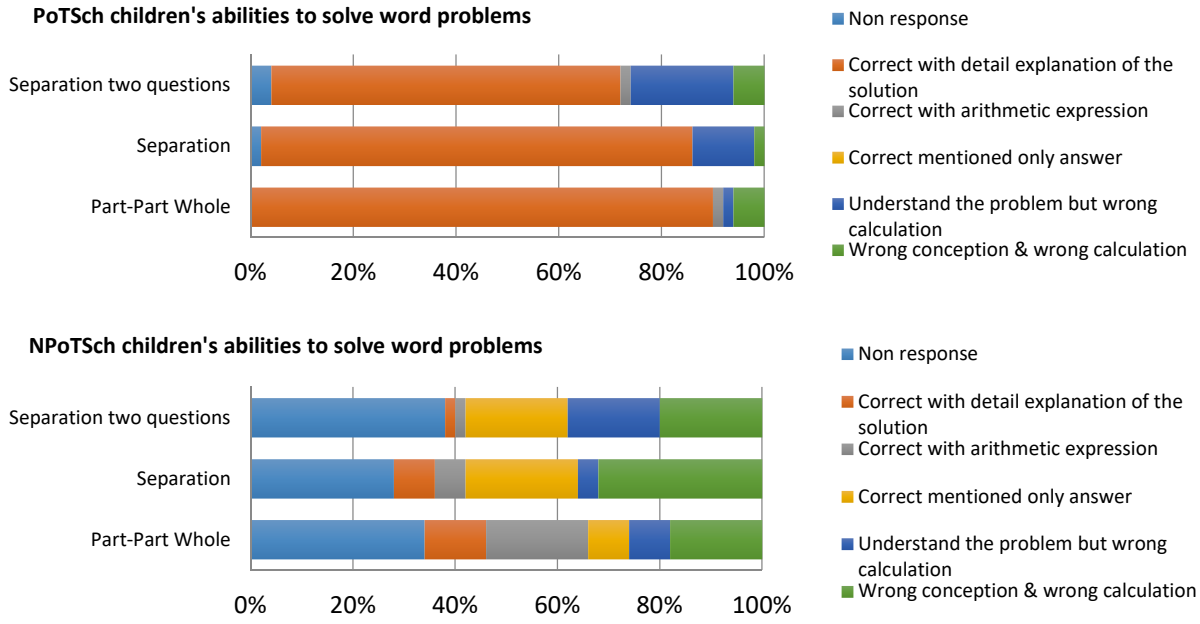
- Similar number of PoTSch children and NPoTSch children understood the problem but did wrong calculation

- Only few number of PoTSch children (3 for Part-Part Whole, 1 for Separation and 3 for separation with two questions) had a wrong conception and calculation compared to the NPoTSch children (9 for Part-Part Whole, 16 for Separation and 10 for separation with two questions).

- Few number of PoTSch children did not give a response (1 for separation problem and 2 for separation two questions) compared to an elevated number of NPoTSch children (17 for Part-Part Whole problem, 14 for separation and 19 for separation two question problem).

*Figure-3*

Potsch and Npotschchildren's Abilities to Solve Word Problems




## Conclusion

Generally, the results demonstrate that the type of teaching to which the pupils are exposed influences their school performances to a great extent.

The better performance in Mathematics can be explained because in the PoT approach to teach and learn Mathematics, students must invent their own computation techniques to solve problem situations. In doing so, they deepen their understanding of the importance of number positioning and establish solid

foundations to develop flexible and effective calculation methods. Separating the acquisition of numeracy skills and the development of the concept of positioning values, as is done in traditional Bangladeshi schools, is no longer necessary.

For example, teachers following PoT approach find it essential to teach for a good understanding of decimal system in order to consolidate children's understanding to add and subtract with regrouping. In PoT schools, children work mostly in groups and use teaching aids/materials/visual models, following the important role of semiotic mediation in learning mathematics (Wood, 2001). Pupils are invited to do math and find the strategies to solve the word problems by themselves. Because of group work, pupils in difficulty get the support of the better students of the group. Addition and subtraction are taught in an integrated way in order to relate one to another.

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## Appendices

*Table-1*

Variable for the sample

| | PoT | | Non-PoT | |
|---|---|---|---|---|
| | | % | | % |
| **Gender** | | | | |
| Boys | 22 | 44 | 21 | 42 |
| Girls | 28 | 56 | 29 | 58 |
| **Mother's education** | | | | |
| No education | 25 | 50 | 41 | 82 |
| Incomplete primary | 8 | 16 | 1 | 2 |
| Completed primary + | 13 | 26 | 3 | 6 |
| Completed JSE + | 4 | 8 | 5 | 10 |
| **Father's education** | | | | |
| No education | 28 | 56 | 42 | 84 |
| Incomplete primary | 4 | 8 | 1 | 2 |
| Completed primary + | 11 | 22 | 2 | 4 |
| Completed JSE + | 7 | 14 | 5 | 10 |
| **Father's income** | 4995.74 (BDT) | | 6014 (BDT) | |
| **Mother's income** | 517.00 (BDT) | | 865(BDT) | |

*Table-2*
**Variables used in the analysis**

| Dependent variables | Level of measure and sources | Independents variable | Control variable |
|---|---|---|---|
| Mathematical operations results | Mathematical operations test | Teaching approach | Age, gender, prior academic experience, parental occupation, parental education, father's and mother's income, etc. |
| Problem-solving results | Problem-solving test | | |

*Table-3*
**Results in the basic line (January 2014)**

| | PoT (%) | Non-PoT(%) | *P*-value |
|---|---|---|---|
| Addition | 64.597 | 70.711 | 0.104 |
| Subtraction | 54.856 | 61.983 | 0.021 |
| Problem-solving | 38.065 | 43.02 | 0.004 |