Exploratory Research on Pupils’ Ability to Add and Subtract Numbers Using Abacus: A Case Study of Papueso Presby Primary School in the Western Region of Ghana

Eric Erzuah¹, Isaac Assan-Donkoh¹, Doris Baah², Daniel Kofi Nkum³

¹Department of Mathematics and Information and Communication Technology, Enchi College of Education, Enchi, Ghana
²Department of Mathematics and Information and Communication Technology, Fosu College of Education, Assin Fosu, Ghana
³Department of Mathematics and Information and Communication Technology, Komenda College of Education, Komenda, Ghana

Abstract

Efforts are being made through the use of abacus to assist pupils to be able to solve problems involving addition and subtraction of four or five digit numbers. Elementary school children who are trained to use an abacus would perform significantly better on tests of calculation speed and accuracy as compared with those who are not so trained. The study was therefore conducted to systematically determine the effectiveness of the use of abacus in assisting basic four pupils of Papueso Presby Primary School in Enchi in the Western Region of Ghana. All the forty five (45) pupils of basic four class of Papueso Presby Primary School in Enchi were purposefully selected for the study. Test item was used to collect data from pupils. Descriptive statistics such as means, percentages, frequencies and modes were used to summarise and describe the data. The results of the study indicated that the use of abacus as a teaching and learning material (TLM) helped the pupils to improve on their ability in solving problems on addition and subtraction involving four or five digit numbers. There is the need for the Ghana Education Service (GES) to supply basic schools with appropriate and enough TLM instructional materials like abacus to improve upon the teaching and learning of mathematics in the basic schools in Ghana

Keywords

Exploratory, Mathematics, Addition, Subtraction, Abacus, Case Study, Primary School, Ghana

1. Introduction

Mathematics is part of the curriculum of the Basic schools in Ghana and it is even compulsory as a subject both at the Basic and Senior High schools. It plays important roles in many, if not all, aspects of human life. Mathematics is actually being used in many areas of our real life situation which include business, marketing and management. At the primary school level, according to [6] pupils acquire content knowledge as they will use as the foundation for the rest of their education. In the view of Carissa, upon exiting primary school, pupils should have knowledge of number facts and families and should be able to add, subtract, multiply and divide numbers [6]. It is believed that the foundation blocks of Mathematics is made up of concepts of addition and subtraction. No one can therefore put up any building of Mathematics without the solid basic foundation concepts of addition and subtraction. One’s inability to do
simple addition and subtraction can lead to his or her failure to climb the academic ladder to the topmost height.

The area of focus for this study is the use of abacus to assist pupils in solving addition and subtraction involving four or five digit numbers. During the teaching practice assessment the basic four pupils at Papueso Presby Primary School in the Western Region of Ghana the researchers observed that these pupils are unable to solve simple addition and subtraction problems involving four or five digit numbers. It is very sad because “addition and subtraction of problems involving four or five digit numbers” is a topic that the pupils might have treated in basic three. the researchers developed interest in the concept to find out the reasons for the pupils’ inability to solve problems of addition and subtraction involving four or five digit numbers from the pupils. Findings class teacher, indicate that all efforts have been put in to assist pupils to solve that problem could not work as expected. The researchers would therefore like to find out the causes of the pupils’ difficulty in solving problems of addition and subtraction involving four or five digit numbers and to determine the effects of the pupils’ inability in addition and subtraction through a scientific research. The study will also provide a framework for teachers to improve upon their instructional delivery with the use of abacus in addition and subtraction hence to modify ideas to the need of their pupils.

The researchers decided to research into pupils’ inability to add and subtract four or five digit numbers because according to [2], addition and subtraction are the basis of Mathematics. In course of the research, emphasis is laid on the use of instructional materials particularly abacus because [13] has stated that the use of instructional materials makes unique contribution to improve teaching and learning at all levels. Later after [13] came out with this view, [12] also reported that the selection of teaching aids often follows the choice of method of teaching of mathematics in primary schools. This is because primary school children are at the concrete operational stage - the stage where they learn to work with physical objects. The researchers’ observation at Papueso Presby Primary School is that teachers use various methods, strategies and techniques, however, excluding the application of teaching aids to teach Mathematics yet the basic four pupils find it difficult to solve problems on addition and subtraction involving four or five digit numbers. It is upon this that it is necessary to conduct a study to determine how abacus can be used to assist pupils to grasp the basic concepts of addition and subtraction.

The absence of proper framework in the school within which to integrate the use of instructional materials like abacus into the teaching and learning situation, although several studies have reported improvements in the arithmetic ability of children trained to use an abacus. Study is necessary to be systematically designed to determine whether the use of abacus will effectively assist the basic four pupils of Papueso Presby Primary School to overcome their inability in solving problems involving addition and subtraction of four or five digit numbers. The Purpose of the study is to determine the effectiveness of the use of abacus in assisting basic four pupils of Papueso Presby Primary School in the Western Region of Ghana in solving problems involving addition and subtraction of four or five digit numbers. The research was guided this question- To what extent will the use of abacus improve pupils’ ability to add and subtract problems involving four or five digit numbers?

2. Review of the Literature

Mathematics is the science of numbers and...
shapes including algebra, geometry and arithmetic. Mathematics defined by [3] as a discipline that deals with the way of finding answers to problems using our knowledge of shapes and measurement in everyday life using numbers in counting and calculating. Mathematics deals with the process of abstracting, classifying, sorting, grouping and generalizing among others things. [14] opine that Mathematics is not just a mere use of facts or techniques but consists of a number of processes which together form a way of thinking. In Mathematics as a language [1] explained that no one can think mathematical terms unless he or she has first learnt the correct meaning of the words he or she has to use. With regard to mathematical thinking, [14] define mathematical thinking as what Mathematics can do. They further argue that, it is a circular definition due to the fact that, mathematical thinking implies someone who thinks mathematically. To this end, Mathematics can be explained as a discipline which deals with human activities all the time. It can therefore be said to be a way of life. There are several theories that attest to the fact that, indeed learning can take place in different levels of human life. The behaviourists' theory of thinking relies on the operand condition principle which was propounded by the psychologist B. F. Skinner and R. Gagne. They hold the view that learning takes place through stimulus response and reinforcement. They place more emphasis on the role played by the environment. That is when the environment is conducive, the child stands the better chance for learning. On the other hand, another group of psychologists also argues that learning can only take place when mental maturity of the child is considered. Simply put, children cannot learn the same way as adults due to the fact that a child's mental ability is low.

Addition is the process of adding numbers or amounts to make a total. This means that addition can be possible when pupils are taken through an activity with concrete objects. It further states that pupils should be introduced to addition by counting and thinking. [19] in the book "fundamental of Mathematics" argues that addition is the combination of two or more groups of the same kind of objects. To buttress on their view, it can be seen that one can only add or combine when the objects are of the same kind. In their view, [7] proclaimed that addition and subtraction must be taught before multiplication and division. This means that, addition and subtraction provides the basis for multiplication and division.

Abacus is a device for making arithmetic calculations, consisting of a frame set with rods on which balls or beads are moved. It was originally constructed with beans or stones moved in grooves in sand or on tablets of woods, stone or metal. In the findings of [16] abacus is a kind of counting machine used by ancient Babylonian merchants. Abacus (abunkuhs) means "dust" or "sand". It was a tool that people almost all over the world use to solve all kinds of arithmetic problems. Monroe further argues that the use of abacus is the quickest way of solving addition and subtraction related problems. Monroe in the same report stated that, using abacus is faster than an electronic calculator, when solving a problem. in a book written by [18], "Let's Investigate Numbers" reported that abacus is a board with grooves to represent the columns for units, tens, hundreds, thousands and so on with a pebble which may be placed on each column to represent a number. In referring to the findings of [13] and [18], Lorraine agreed in principle that teachers’ important role is to help pupils to understand lessons taught by collecting instructional materials relevant to the topic to be taught. The instructional materials, in this content, arouse and sustain pupils' interest.
during teaching, thus making their foundation very solid and permanent [18] also contributed to this field of research with his findings that the solution of a variety of teaching aids often follows the choice of methods of teaching Mathematics in primary schools. Primary school children are at the concrete operational stage—the stage where they learn to work with physical objects. In a research by [10] reported that, specifically elementary school children trained to use an abacus performed significantly better on tests of calculation speed and accuracy compared with those who were not so trained. Several studies including that of [5] have reported that working memory was significantly better in abacus-trained pupils. Other subsequent studies also confirmed the above findings that working memory was significantly better in abacus-trained pupils. For example, [11] confirmed that children trained to use an abacus scored approximately 7 points higher on IQ tests than did controls.

It is not surprising, based on the previous findings for [9] also to confirm that the availability and use of teaching and learning materials (TLMs) affect the effectiveness of a teacher’s lessons. The use of TLM will influence pupils’ comprehension of lessons. Before even most of the findings above were made, [4] had earlier reported that children are capable of understanding abstract ideas if they are provided with enough materials and concrete experience with the phenomenon they are to understand. Nonetheless, a contrary discovery has been made in a particular study conducted by [8]. The study discovered that learning materials did not influence poor academic performance.

3. Research Methodology

3.1. Population and Sample Selection

The target population for this study comprised all the pupils of Papueso Presby Primary School in the Western Region of Ghana. However, all forty five (45) basic four pupils were selected as the accessible population because that was the class of study. The main reason why the research was conducted at basic school four was that the researchers observed the problem of addition and subtraction in that class during teaching practice assessment. The purposive sampling procedure was used to ensure that only the entire populations of basic four pupils of Papueso Presby Primary School in the Western Region of Ghana. Basic four pupils needed enough preparation in Mathematics hence they were selected for the study. Also, such sample size was chosen because the study requires experimentation in the intervention stage.

3.2. Research Instrument

The researchers used test as the main instrument for the study. A test or an examination is an assessment intended to measure a test-takers knowledge, skills, aptitude, physical fitness or classification in many other topics [17]. Test is administered and scored in a consistent manner to ensure legal defensibility. In general, teachers use classroom test to diagnose students strengths and weaknesses, monitor each student’s progress, assign grades and determine the teacher’s own instructional effectiveness http://www.westEd.org/online pubs/ kn-01-03.pdf).

3.3. Data Collection

Data collection procedure comprises of pre-intervention (test), intervention (test) and post-intervention (test) levels of performance at different stages. During the pre-test stage, pupils' entry behaviour in terms of their ability to solve problems involving addition and subtraction of four or five digit numbers was determined. Again, a few days were set aside within the research period for the intervention. Just after the
intervention, another test (post-test) was conducted.

3.3.1. Pre-Test (Pre-Intervention)

During the pre-test stage, the researcher tried to diagnose the perceived problem before the actual intervention. During that stage, a test on addition and subtraction involving problems of four and five digit numbers was conducted to find the extent of pupils’ difficulty. The test was conducted with the help of the class teacher. Ten test items below were written on the chalkboard for pupils to answer.

1). 6246 +2653 6). 6956-2653
2). 7824 +1287 7). 7824-1287
3). 66773+2883 8). 66773-2883
4). 47590+91674 9). 91674-47590
5). 93666 +7543 10). 93666-7543

There were five questions on addition and five on subtraction of four or five digit numbers. The pupils were given 20 minutes to answer the questions. After marking pupils' solutions to the problems, the pupils exhibited lack of knowledge and understanding on the basic concepts of addition and subtraction of four or five digit numbers. The researchers used the test to seek adequate information from the pupils’ feedback.

3.3.2. Test (Intervention)

The intervention is a set of strategies planned and implemented to solve a specific problem or improve an educational practice in an immediate situation. It involves a step or procedure which is constantly monitored over varying periods of time and by a variety of mechanisms. During the intervention stage, the researchers used abacus to help improve pupils’ difficulty in addition and subtraction of four or five digit numbers. The intervention lasted for a period of four days. The researchers explained during the lesson that, the abacus consists of a units rod, tens rod, hundreds rods, thousands rod, tens of thousands rod and so on with beads on each rod to indicate the value of the number. For instance, the researchers represented 76543 on an abacus as; Red beads-units (U), Yellow beads-tens (T), Green beads-hundreds (H) Blue beads-thousands (TH), Black beads-ten thousands (TTH) and White beads-hundred thousand (HTH)

Therefore 76543 were represented as;

<table>
<thead>
<tr>
<th>TTH</th>
<th>TH</th>
<th>H</th>
<th>T</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>6</td>
<td>5</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

*Figure 1. A pupil solving a question on addition of five digit numbers during the test stage.*

Thus, from the left hand side to the right; 7-ten thousands, 6-thousands, 5- hundreds, 4- tens and 3-units

After explaining the above procedure to pupils, the researcher guided the pupils to solve a few addition and subtraction problems using the abacus. For instance, solving the following questions 1). 6578 + 2345 and 2). 6578 - 2345

**Question 1)** 6578 + 2345

<table>
<thead>
<tr>
<th>TH</th>
<th>H</th>
<th>T</th>
<th>U</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>5</td>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

**Figure 2. Pupils to solve questions on addition and subtraction of four or five digit numbers using the abacus during the intervention stage.**
The researchers asked the pupils to follow the procedure below by putting all the identical beads on their respective rods, hence:

1. all red beads on the unit rod
2. all yellow beads on tens rod
3. all green beads on hundreds rod
4. all blue beads on the thousands rod

The researchers asked pupils to exchange 10 red beads on the unit rod for 1 yellow bead that is in the box and fix it on the tens rod.

The researchers again asked pupils to exchange 10 yellow beads on the tens rod for 1 green bead that is in box and fix it on the hundreds rod.

The researchers asked pupils to count the number of beads on each rod. At the end of it, the pupils responded that they had eight (8) blue beads, nine (9) green beads, two (2) yellow beads and three (3) red beads indicating that 6578 + 2345 = 8923

Question 2) 6458 – 2385

The researcher asked the pupils to deduct using the a bit similar procedure as used in addition. The researchers asked pupils to deduct five red beads from eight red beads. Again, the researchers asked pupils to deduct eight yellow beads from five yellow beads. A pupil responded that it was impossible. The researchers then asked the pupils to borrow (remove) one green bead from the four green beads and exchange it for ten yellow beads in the box and place them on the five yellow beads making fifteen yellow beads.

The researcher then asked the pupils to take away eight yellow beads from the fifteen yellow beads remaining. Again pupils were asked to take away three green beads from three green beads remaining. The pupils were asked to take away two blue beads from six blue beads.

This implies that 6458 – 2385 = 4073

After the researchers had used the abacus to guide the pupils in solving problems, he gave them two questions each on addition and subtraction and asked them to use the abacus to solve them as he went round to assist those in difficulty.

3.3.3. Post-Test (Post-Intervention)

The post-test was conducted to find the effectiveness of the use of abacus in the teaching and learning of the concept with "addition and subtraction of 4 or 5 digit numbers". Ten (10) questions test items 1 below

1. 6246 + 2653
2. 7824 + 1287
3. 66773 + 2883
4. 47590 + 91674
5. 93666 + 7543
6. 6956 - 2653
7. 7824 - 1287
8. 66773 - 2883
9. 91674 - 47590
10. 93666 - 7543

were written on the chalkboard and the pupils were made to solve them in a given time frame. The test was conducted with the assistance of the class teacher.

3.4. Data Processing and Analysis

Tests (pre- and post-tests) were conducted to determine pupils' strengths and weaknesses before and after the intervention stage. Ten questions comprising five each of addition and subtraction of four and five digit numbers were given to pupils to answer during each stage. Scoring within 0-2 was considered to be "very weak", 3-4 was also considered to be "weak", 5-6 was considered to be "average", 7-8 was considered to be "good" and 9-10 as "very good". Frequencies, modes and percentages were used to analyse the data.

4. Results and Discussions

This section consists of the data analysis and discussion of the study. The data collection after the pre-test and the post-test revealed the following results that has been analysed below.

4.1. Results of a Pre-Test

Table 1. Performance of Pupils in the Pre-Test (n=45).
This section described the performance of pupils in the pre-test. The data in table 1. above showed that 9 pupils (20.0%) scored 2 marks or below indicating a very weak performance. The single marks range with the highest number of pupils (64.4%) was 3-4 marks also showing that the majority of pupils were weak. Only 7 pupils (15.6%) put up an average performance. No pupil (0.00%) scored 7 marks or more. The results showed that 38 pupils (over 84.0%) were either weak or very weak.

4.2. Results of a Post-Test

The data in Table 2 showed that no pupil (0.0%) scored 2 marks or below. Only 9 pupils (20.0%) exhibited weak performance by scoring either 3 or 4 marks. Little over twenty four percent (24.4%) of the pupils put up average performance. Almost 50% of them scored 7 or 8 marks which fell within the classification of good performance. Four (4) pupils (8.9%) did put up very good performance. Interestingly, 36 pupils (80%) scored 5 marks or more out of the maximum 10 marks.

Table 2. Performance of Pupils in the Post-Test (n=45).

<table>
<thead>
<tr>
<th>Marks out of 10</th>
<th>Number of pupils</th>
<th>Percentage %</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-2</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>3-4</td>
<td>9</td>
<td>20.0</td>
</tr>
<tr>
<td>5-6</td>
<td>11</td>
<td>24.4</td>
</tr>
<tr>
<td>7-8</td>
<td>21</td>
<td>46.7</td>
</tr>
<tr>
<td>9-10</td>
<td>4</td>
<td>8.9</td>
</tr>
<tr>
<td>Total</td>
<td>45</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Almost all the pupils indicated some levels of improvement in their ability in solving problems involving addition and subtraction of four or five digit numbers. The researchers, during the intervention stage guided the pupils to grasp the basic concepts of addition and subtraction with the use of activity based method. The abacus, as suggested by [10], was used as the main source of teaching and learning material. The researchers were therefore not surprised when they realised such an appreciable improvement in the pupils' performance where 80% scored 5 marks or more during the post-test as against 0% scoring the same marks during the pre-test. That went to confirm the assertion made by [9] that teaching methods that teachers adopt during instructions in class will greatly influence the learning of students.

5. Conclusion and Recommendation

Most of the pupils were either weak or very weak in solving problems involving addition and subtraction of four or five digit numbers before the researcher intervened to assist pupils to overcome their problem. Pupils' weak performance was attributed to the existing method of teaching which was much more traditional and less activity based. The use of abacus as TLM helped the pupils to improve on their ability in solving problems on addition and subtraction of four or five digit numbers correctly. The researcher, during the intervention stage
guided the pupils to grasp the basic concepts of addition and subtraction with the use of activity based method and pupil-centred approach. The Ministry of Education (MOE) through the GES must supply basic schools with appropriate and enough TLM and textbooks. The MOE should strengthen the Monitoring and Supervision Department of GES to enable personnel in that department visit schools regularly to supervise the work and performance of headteachers and teachers.

References


