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A Case For Fingering In Mental Arithmetic

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Abstract

Fingering is a technique in performing calculating tasks which involves only the use of the fingers on both our hands. In this article, we put forward our case for using the fingering technique in doing mental arithmetic by listing its strengths and advantages over the conventional pencil-and-paper algorithmic ways of computation and the calculator.

Introduction

“Fingering” refers to the use of the fingers of both our hands as a natural resource in rapidly performing calculating tasks following a decimal numerical value structure as represented by each finger. You may ask, “Why Fingering?” In this article, we shall offer the fingering technique, not as a panacea which will overcome all the difficulties that children face in doing mathematics but as an alternative to many other computational techniques, such as the abacus, the calculator, and the conventional pencil-and-paper algorithmic procedures. Although the rapid fingering technique is not included in the Singapore mathematics syllabi, it has already been taught in some Singapore primary schools for several years on the initiative of individual schools and arising out of a need to help children improve their calculative skills. It is a tool to help children compute faster and learn more effectively. It improves on children’s proficiency as a “mental calculator” and in general, help them achieve in the learning of mathematics.

Fingering as a technique involves the manipulation of the fingers on the basis of decimal or base ten representation from digits 0 to 9 which extends to larger number representation upon all of which basic operations, i.e. addition, subtraction, multiplication and division, as well as higher level mathematics can be performed. It is not our intention to teach fingering in this article but those interested to know more about it are referred to Lieberthal (1988).

The Hands as a Natural Resource

The hand with its fingers are one of the most useful parts of the human body. Much of the brainpower is used to control the functions of the hand and to direct it, not only in its processing of sensory information but also in its controlling function. A large part of both the sensory and the motor functions of the cerebral cortex is involved in controlling just the hands together with the fingers. The various highly sensitive tactile receptors in the fingertips enable the hand to discover information about objects by means of touch and muscular feedback. In many cases, the collective effort of the hand and a few or all the fingers is needed to perform manual tasks which contribute towards a piece of intellectual, artistic or aesthetic production. But in many other cases, the hand with every one of its fingers are required. For example, in playing the piano, the movements of all the five fingers of each hand must be well coordinated and executed in varying speeds in order to play a piece of music. In hand puppetry, many puppeteers maneuvering the puppets with their fingers together with their knowledge of some operatic techniques are able to bring out the movements, the expressions, the personalities and emotions of the puppets in a performance.

The base used in our number system is ten. Having ten fingers, viz. thumb, index finger, middle finger, ring finger and little finger, on both our hands is naturally a good and convenient symbolic representation to register our thoughts and to process numerical information. Incorporated with a structure that resembles the place value system, our hands can become a powerful and versatile “instrument” for calculation activities.

Since time immemorial, our hands have been used in counting. As mathematics advanced towards more sophistication and complexity, algorithmic and procedural ways have been sought and investigated to provide simplicity and shortcuts in handling calculations and mathematical problems efficiently. However, such methods are inefficient strategies especially for straightforward calculative tasks and to some children, they are not easily manageable. Thus, other simpler methods are becoming more popular in recent years. One of such methods is fingering.

Foundation in Computation

Mathematics is an important subject which has great uses and applications across the curriculum. It transcends many other disciplines, such as finance, commerce, science and technology, and research and development, which are

deemed essential in a nation of fast economic growth such as Singapore. A strong foundation in computation is a prerequisite to succeed in mathematics in schools. To be able to calculate with speed and accuracy is an advantage in achieving highly in mathematics. Of course, to do well in mathematics requires other attributes and skills as well, e.g. in mental calculation, in forming and grasping mathematical concepts, in manipulating numbers, in visualizing geometrical shapes and objects, in developing number sense, and in analyzing and solving problems. Thus, many children are not able to move up to higher levels in mathematics learning because of their inability to master the basic skills of rapid calculation. Failing in mathematics often makes children demotivated and demoralized. They develop a state of anxiety when confronted by work involving mathematics, they become fearful of mathematical formulae, they give up when given a mathematical problem, they develop dislike towards mathematics and even towards their mathematics teachers. In general, they develop a negative attitude towards mathematics. In extreme cases, they simply become mathophobic.

Mastering mental calculation is fundamental in mathematics learning. Memorizing the times-tables from $2 \times 2 = 4$ to $12 \times 12 = 144$ was one of the first tasks when learning multiplication decades ago. Frequently, a mathematics lesson would start with the recitation of the times-tables and often without a sound understanding of the mathematical concepts involved. The use of such practices is based on the rationale that repetition enables facts to be filtered through the short-term memory and the sensory memory before they are registered in the permanent storage of the long-term memory. The process involves encoding the information for storage and decoding it for retrieval on demand. Although the notion of understanding or comprehension is now greatly emphasized, many teachers and pupils alike still hold the view that memorization is still an inevitable mental activity in being “exam smart”. Unless we move away from pupils being strictly and solely assessed by written examinations, there will always be the suspicion that high achievement is being produced not entirely by talent but because of being examination-wise. A genuine mastering of rapid calculation and performing arithmetical operations with understanding of the concepts involved release children of the burden of memorizing vast amount of mathematical facts.

The Abacus and the Calculator

The abacus as a tool for calculation has been tried as a pilot project in selected primary schools in Singapore. If found effective, abacus lessons will be introduced in schools to supplement existing techniques for teaching and learning mathematics. The calculator is also being used in mathematics lessons in primary

schools although it is still not allowed in examinations. Both the abacus and the calculator are ways that could help children improve on their calculative ability. However, these instruments need to be manipulated and operated on by the use of fingers and they need to be available at the time when the calculations are being done. Fingering technique, on the other hand, makes use of no other instruments except the hands themselves which are limbs of the human body always around in a normal person. In this case, the fingers are utilized directly on the calculative tasks rather than as a tool to operate on the abacus or the calculator.

Conventional Algorithms

The conventional pencil-and-paper algorithmic ways of computation based on columnwise processing of numbers are alien to young children in learning mathematics. Among them are right-to-left and the left-to-right approaches, decomposing and regrouping, distributing, and factoring procedures, etc. All these algorithms are in a sense not natural as ways of calculation. Algorithmic procedures include the involvement of the concept of place values, mathematical structures, carrying over or borrowing. In columnwise processing, addition and subtraction are based on the operation of digits having the same place value and the concept of carrying over to or borrowing from a higher value digit. In the case of multiplication, each digit in the multiplier is taken separately before multiplying the number by such individual digits. In the final stage, the different products, after taking into consideration their different place values, are added up to get the result. Likewise, the process in division also involves a column-by-column procedure.

e.g. Addition

(1) no carrying over

$$\begin{array}{r} 35 \\ + 24 \\ \hline 59 \end{array}$$

(2) with carrying over

$$\begin{array}{r} 87 \\ + 18 \\ \hline 105 \end{array}$$

Subtraction

(1) no borrowing

$$\begin{array}{r} 35 \\ - 24 \\ \hline 11 \end{array}$$

(2) with borrowing

$$\begin{array}{r} 87 \\ - 18 \\ \hline 69 \end{array}$$

Multiplication

$$\begin{array}{r}
 27 \\
 \times 14 \\
 \hline
 108 \\
 27 \\
 \hline
 378
 \end{array}$$

Division

$$\begin{array}{r}
 \underline{149} \\
 4 \overline{)596} \\
 \underline{4} \\
 19 \\
 \underline{16} \\
 36 \\
 \underline{36} \\
 0
 \end{array}$$

To some people who have a good facility with memorization, it is easy as it is a matter of memorizing the algorithms and following the procedural steps to obtain the answer whether it be addition, subtraction, multiplication or division. To many, it is a difficult task to master. Often times, the conventional ways get confusing because there are rules which do not sometimes follow from logical reasoning. The rules work and therefore, they can be used.

Current Research on Fingering

It is our opinion that the fingering technique is worth further investigation. We, the authors, have embarked on a research project which involves the following five aspects:

1. It investigates into the effects of rapid fingering in terms of speed and accuracy in calculating with numbers involving the four basic arithmetic operations (cognitive and psychomotor domains).
2. It studies the motivational and confidence-building value (affective domain) of rapid fingering.
3. It compares calculation by rapid fingering with the use of calculator.
4. It compares its effectiveness among school levels and among different ability levels of children.
5. It studies into the feasibility of its integration into the teaching and learning of mathematics in school.

Data collected and analysis done so far from the research project have indicated that the fingering technique may prove to be very promising for effective learning of mathematics not only in the cognitive but also in the affective domain.

Conclusion

Fingering is a simple and easy-to-learn technique in that there are no complicated mathematical formulae or concepts involved nor do they need to be memorized. It does not require any mathematical “tricks” to aid in calculation. The structure involved is straightforward and consistent in the sense that once it has been learnt, it can be applied to any operations without any further changes. Fingering does not rely on rote memorization nor depend on any external instrument. It exploits the various faculties of children, such as psychomotor, visual, tactile, vocal and verbal, and stimulates the creative part of the brain. By mastering the fingering technique, pupils enjoy success in learning mathematics which gives them confidence and in turn motivates them to further achieve.

Reference

Lieberthal, E. M. (1988). *The complete book of Fingermath*. Souvenir Press.