VARIOUS APPROACHES OF CALCULATIONS USED IN PRIMITIVE ERA

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ABSTRACT

Have you ever think human life without calculations. What the modes of calculations in times of yore were and the way people solved their long and lengthy calculations ? Was it useful for them to figure out their numeracy tasks? It will be exciting to discern the answers to those questions. Calculations have an attention-grabbing genesis within the history of Mathematics. It played an imperative part in human life. The usability of Mathematics shows its continuation all told the realm of the individual. With the progression of your time, human has evolved diverse techniques for solving the numbers like calculator, computer and other electronic widgets. Through this paper, researcher has attempted to understand the various methods of calculations that were in use in primeval. After the hard-hitting study, it had been found that one manmade tool i.e. Abacus helped the individual of the primeval to resolve their numerals tasks effortlessly. Various civilizations developed their special kind of abacus to resolve the unbreakable chain of calculations. It made their prolonged numerical tasks trouble-free.

KEYWORDS: Calculations, Abacus, Genesis, Primitive Era.

INTRODUCTION

Arithmetic calculations are always fascinating and obliging in our lifestyle situations. But still, it ends up in trepidation and leaves a scary impression on the minds of the learners. From the dawn of civilization, people are practicing mathematics in their lifestyle activities like carpentering, engineering, homemaking, shopkeeping and other related fields. Children practice mathematics not only as an element of their school curriculum but also put into operation in lifestyle. Like, while playing games for calculating the score, while purchasing the grocery items, for budgeting their pin money, etc. because the child grows and enters the real world of education, it starts encountering various mathematical operations and such kind of assistance is indeed for

them. If you have good command over your calculations skill then it'll make your maths easy and robust. It not only helps in their numerical tasks but also enhances their cognitive structure. Abacus is one in all such manual assistance that meets the necessity of basic use extensively within the teaching or learning of Mathematics. it's a brain development program and therefore the type of training that increases the child's competence to compute correctly and smoothly without employing a mechanical calculator, digital electronic calculator, talking calculator, computer, etc. (Seethalakshmi, 2003).

Abacus could be a hand-operated machine during which numbers are represented by beads strung of rods or wires set in an exceedingly rectangular frame. It has also been called the primary manual computer within the world. The word 'abacus' comes from the Greek word "abax" from a Semitic signified dust. A play way method stimulates the senses of the scholars. It is successful in drawing the eye of the scholars towards the educational process by making mathematical learning more exciting (Pullan, 1968).

Abacus has progressed since humans started addressing numbers. Particularly, it has been widely accepted in China, Japan and therefore the Middle parts of the East (Clarke, 1971). It is older several modifications in its structure furthermore as operating. Earlier, when scripted or written numbers were not developed people made use of their hands and foot fingers for calculations. Pebbles and twigs were accustomed to copes with multiple numbers. Even so, long and lengthy calculations were a challenging task for them. Thus, Abacus was developed which restricted the prolonged calculations and make easier their numeral task. It had been believed to be originated from the amount of Babylonia within the type of clay-tablet. Other noteworthy versions within the Abacus were Line Abacus, Grooved Abacus, Suan-pan, Soroban, etc. In the present era, a modified Abacus with appropriate functioning is usually recommended. It should be an inseparable part of students learning so that learners can grasp the mathematical operations easily. The mathematical applications like additions, subtraction, multiplication, division, square roots and cube roots will be easily performed on Abacus.

Abacus is additionally an accommodating program for blind students. Its modified form named 'Cranmer Abacus' is widely used for blind students. The incorporation of Braille and Cranmer Abacus facilitates blind learners to crack their mathematical tasks effortlessly. It is a reproduction of the Japanese Soroban Abacus and it is easy to hold in an exceedingly pocket. Vijaya Sundaesh[1] elaborated that with the assistance of the abacus students can develop their keen interest in numbers. It facilitates the higher-order learning and thinking skills among students such as:

• Creativity
• Intelligence
• Spatial ability
• Listening
• Attention
• Logical and Reasoning thinking
• Problem Solving Ability
• Better retention and recall
• Higher self-confidence of computing skill
• Accuracy, etc.

Abacus is one of the important tools for ages. It helps largely in eradicating the fear from the mind of the individual and breaks the quality type of training through rote. Vijaya Sundaesh (SIP AMAL franchise holder) has been an instructor for 15 years and she observed that 85% of scholars on reaching class 9th have a block about the topic. The teacher sought out other sorts of calculations to interrupt that barrier and located that the procedure of the abacus is more students friendly. When a baby starts learning maths on beads, they feel and see it as a numerical value which helps to interrupt the mystery around it (Sugathan, 2004). Abacus provides the chance to square go in arithmetic achievement and desired skills help in to create the bottom of any teaching-learning process.

A comprehensive description of the genesis of Abacus is hereunder.

[1] Vijaya Sundaesh (SIP AMAL franchise holder) has been a Maths teacher for 15 years. She observed that 85% of students on reaching class 9th have a mental block about the subject. She scrutinized the other forms of calculations to solve and remove that barrier and discovered that the Abacus method is student-friendly. When a child starts learning maths with beads, they feel and see it as numbers which help to break the mystery around it (Sugathan, 2004).

GENESIS OF ABACUS

The calculation has always been an important part of human life. While within the earliest period, the calculations were not just restricted for counting only, but also equally required for calculative operations like addition, subtraction, multiplication, and division. Therefore, to satisfy the requirement of it, humans tried to develop numerous ways in which could make the tactic of calculation less tedious. However, among all other ways of calculation, the abacus has been the foremost obligatory calculation device and its use remains within the present century.

In prior times, individuals usually tend to use normal methods of calculations like fingers, tally sticks, knots on the rope, pebbles, stones, or twigs for maintaining the accounts of their trading system (Ifrah, 2000). Principle of one-to-one [2]correspondence was the opposite approach widely employed for constructing connections between representing groups and objects. As time passes, it became difficult for primitive man to resolve lengthy calculations with pebbles or twigs. Therefore, they developed the science of counting and tried to keep up a record of every calculation. Later on, many methods emerged for writing numbers, commonly called a notation system[3]. Until the origin of the Hindu-Arabic notation system, the symbols indicating numbers were merely accustomed list the outcomes of estimation. But, Abacus was operated for the actual reckoning (Larsen, 1960).

Among all primitive instruments, the emergence of the counter Abacus is obscure. The history of the evolution of the abacus is somewhat captivating. The invention of the Abacus has justified the statement i.e. 'Necessity is that the mother of invention'. Numerous cultures have adapted it from the time it was devised. Every civilization

[2] One-to-One- Assigning a number to each corresponding object is known as one-to-one. (Thompson, 2009)

[3] Notation System: A system of figures or symbols used in a specialized field to represent numbers, quantities, tones, or values (https://www.thefreedictionary.com/Notation+system).

[4] Babylonia -A region of ancient Mesopotamia, nowadays part of modern-day Iraq (Mark, 2011)

[5]Cuneiform – It was the script firstly developed by Sumerian of Mesopotamia in 3500-3000B.C. (Mark, 2011)

gave its expressions on the historical development of the Abacus. It's as old because of the problem of counting itself. The Abacus in its initial developmental stages consisted of a flat pave i.e. either of wood or stone covered by sand. For writing the numerals thereon, a stick or finer was used. This was the cardinal style of the Abacus. It was broadly used among various countries specified Mesopotamia, Egyptian, Greek, Roman, Chinese, Indian, Japanese, and Russian. Different methods used for computation in several civilizations are discussed below.

1. Babylonian System

Babylonians[4] invented their system of calculation supported a sexagesimal or 60 bases numeric system (Ifrah, 2000). 10 or 60 were considered because of the base term. For instance, 42 was written as ten for fourfold and a unit of 1 for 2 times. Our current hour's system is additionally supported by the identical sexagesimal system. The Babylonian has pioneered primary writing. It had its own writing devices i.e. stylus and clay tablets to form easy trades in Mesopotamia. In Babylonia, all records were engraved on clay tablets that were parched to assure their eminence. Akkadian script and Babylonia language were used on clay tablets. Akkadians applied the stylus in triangular form having a trigon mark inscribed thereon. 'Cuneus' is that the Latin word used for wedge, therefore the script was referred to as cuneiform[5] (Kline, 1976). Writings of Babylonia showed that cuneiform characters were designed with the tip of the stylus joined with circular imprints fabricated from the rounded end. There have been two main systems of writing numerals i.e. wedge-shaped and circular-shaped (Sanford, 1930). The inscription was written either on the wedge or circular-shaped clay tablets. It was further baked in fire or put under sunlight to make sure its permanence. Thousand of such clay tablets are still presented in various museums everywhere the globe for study (Smith, 1923).

2. **Egyptian System** s

In 3300 B.C. the Egyptian numeral symbols were ubiquitous. The numeral signs were having the bottom of 10, 100, 1000, and 10000. Hieroglyph[6] was the character

[6] Hieroglyph- A picture or symbol that represents a word used in some writing systems such as the one used in ancient Egypt (https://dictionary.cambridge.org/dictionary/english/hieroglyph)

employed in the earliest Egypt. It was engraved on monuments and tombs, which remains present in Egypt (Ancient Egyptian Hieroglyphs). The numbers were written from right to left thereon. In some cases, it was printed from left to right and vertical also. Records revealed that manuscripts were presented on Papyrus[7] and a stone monument (Sanford, 1930). The decimal scale was also utilized by Egyptians within the period. They tended to maneuver their fingers horizontally for calculations. In each line, nine pebbles consisted and the tenth pebble was placed within the next line at the left position (Cajori, 1953).

3. **Greek System**

Greeks had their numeral system referred to as 'Attic' or 'Herodianic[8]' which was utilized by Athenians. They assigned a selected value for every number. It was developed from 454 to 95 B.C. The Greek numeral system was supported by a ten, 100, 1000 base system (Heath, 1931). Like Egyptians, natives of Greek too used fingers and pebbles for calculations. Vertical parallel lines and pebbles were frequently used for performing long calculations. (Cajori, 1953). Characters of Greek Abacus may be seen on Darius Vase (Smith, 1925). Archimedes invented the structure for demonstrating larger numbers. He unveiled that there exists a system on the sand on which calculations may be drawn (Scott, 1958). Gradually, the dust Abacus was transformed into a ruled board [9] on which pebbles or counters were placed in line somewhat like checkers on a gameboard. The Greek calculator was placed on a horizontal Salamis

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[7] Papyrus- It was made by cutting thin lengthwise sections of the reed-liked papyrus plant. These sections were placed side by side. A second layer was added, the strips being at right angles to the first. When dried underweight, the sap of the plant glued the sections together and finished papyrus resembled a rough brownish paper. The writing was done with a reed pen (Sanford, 1930, p-3). Mainly two types of papyruses were used i.e. Moscow and Rhind Papyrus. Moscow Papyrus is in Moscow and Rhind Papyrus which was discovered by Henry Rhind can be found in the British Museum in London and Morgan Library, New York. Rhind Papyrus is also known as Ahmes Papyrus. (Kline, 1976)

[8] Herodianic-The Herodianic system is also known as 'Attic'. It was the Byzantine Grammarian who introduced the system of Herodianic in the second century A.D. (Heath, 1931). Variations of the system were used in the area in which the Athenian influence was present (http://www.g-morfosis.gr/theory/numerical-notation-systems-in-ancient-greece/)

[9] Ruled Board- A board on which one or more parallel ruled lines are drawn is known as the ruled board. (https://www.thefreedictionary.com/ruling)

tablet [10] and columns were stroked by the ruled line. Pebbles were operated to form movements thereon. Each pebble had a value of one. Herodotus, the Greek historian, (484-425 B.C.) (http://www.shuzan.jp/english/ history.html) stated a line Abacus in his record. As Egyptians moved their fingers from right to left within the calculation, the Greeks move it from left to right (Heath, 1921). Computation of this manner of Abacus was called reckoning "on the lines" (Smith, 1925). The shape of the Abacus employed in Greek was called 'Line Abacus'. At the top of the 18th century, Line Abacus (on table or cloth) was used for treasury tasks by exchequers (Pullan, 1968). Metal Jettons[11] and pebbles were used on line Abacus at different times to form a counter on that (Pullan, 1968). The Line Abacus may be a primitive historical tool that has been used until the date and is displaced within the Athens museum (Swain, 1959).

4. **Hindu-Arabic System**

Hindus were the successors of the Greeks within the history of Mathematics. Before 800 B.C. there was no proof of the existence of mathematics. During the amount of Sulvasutra (800 B.C. to 200 A.D.) some ancient styles of mathematics came into existence. From the 3rd century onwards, some number systems were appeared called 'Brahmi symbols'[12]. Each digit was denoted by a separate symbol. No symbol was presented for the worth of zero (Kline, 1976). Diverse forms of symbols for numerals were used during the age of Hindu rulers. Indifference to the Hindu system, the Arabian invented the symbol for zero in their numeral system (Taylor & Mills, 1961). Zero was usually known by the name of sunya and Arabic called it sifr (cipher) (Smith, 1925).

[10] Salamis Tablet- The table of Salamis, originally considered to be a gaming table, which is, in fact, a calculating apparatus. The original form of the Salamis table of marble has exhibited in the National Museum of Epigraphy, in Athens (Smith,1925).

[11] Jettons – It is derived from the French language word 'Jeter' that meant throw or cast. It was the metal disc counter which was earliest used in England and originated from France. It was used by the exchequer for required counters. Jettons had not their self-value. But its value depends on the position on which they lied. Some jettons are still can be seen in the Department of British and Medieval Antiquities at the British Museum. (Pullan, 1968)

[12] Brahmi Symbols- Brahmi script is the oldest writing script developed by India after the Script of Indus. It is one of the most prominent writing systems; all modern Indian scripts and several hundred scripts found in Southeast and East Asia are derived from Brahmi. (https://www.ancient.eu/Brahmi_Script/)

5. **Roman System**

Roman numbers system remains well-known all told over the globe. However, it had been supported by the decimal numeration system (10 bases) but not associated with it directly. The worth of zero wasn't included in it. Roman numerals didn't provide supporting symbols for doing arithmetic calculations. They simply use the acronym for writing the numbers. This was the rationale why merchants and accountants usually used Abacus for creating the calculations. For finishing up their numeracy tasks, Romanians usually employed depending on fingers and Abacus methods. For creating calculations on Abacus, the counter was used called 'calculi'. Romanians had done gradual progress in Abacus. The notable changes within the evolution of Abacus during Romans are hereunder:

(a) Dust Abacus

Before the invention of dust Abacus, pebbles, or similar objects were commonly used for solving the computation. Operations were dispensed on the fingers (hand or foot) further. The primary written numeral system was developed after it. The concept of drawing several parallel lines on the sand and so using them for the calculation has been evolved after the invention of a written numeral system. Thus, the dust Abacus came into existence. Gradually they started acting on a table or a board covered with sand or dust rather than ground. Papias[13] in his vocabularium (1053) also articulated the Abacus as a table covered with green sand (Smith, 1925).

(b) Wax Abacus

The wax Abacus was used for calculations in Rome (Italy). A transportable calculator that might easily be carried on the shoulder. It consisted of a little board of wood or bone coated with a skinny coat of black wax. An iron stylus was wont to draw figures, it had one pointed end and therefore the other was spoon-shaped used for erasing by smoothing the wax down again (Ifrah, 2000).

(c) Grooved Abacus

Groove Abacus had loose counters rather than lines and therefore the table had movable counters skating up and down on grooves (Kojima, 1954). Credit for

[13] Papias - An apostolic father, bishop, and author who lived 70-136 AD. He was considered one of the authorities on the knowledge of his time. (Ifrah, 2000)

developing the grooved abacus has gone to Romans. It had been made from the little metal bronze plate with a specific number of parallel slots of nine designs on that. Different numbers were designated on each slot. Pebbles and markers were used on a grove to represent the numbers in an exceedingly given place (Grossnickle, F.E. & Brueckner L.J.,1959). Grooved Abacus was also called a hand calculator because it was handy. Copy of it's still present within the British Museum, Bibliotheque National in Paris, and Museo Nazionale Romano (Pullan, 1968).

6. **Chinese System**

In ancient China during the Tang, (618-907 B.C.) rods were used for representing numerals and do computational tasks. In all civil and military establishments, it had been mandatory to require a counting-rods bag along for computational tasks. Later, during the Ming (1368-1644) Abacus had become a household device. It firstly appeared during the Han period (220 B.C. before). A check-board having bamboo rods was used for representing the numbers from 1 to 9 at the unit, tens, hundred, etc. values and for representing the worth 'zero' rod was left blank (Institute of the History of the Natural Sciences,1987). However, during this bamboo rods method, it had been an opportunity for rods mingling. Horizontal and vertical strokes were wont to overcome this problem. Tens' place was represented vertically and unit horizontally. Like, 4 was represented as 𝍠 and 22 as 𝍡 but when space was less it had been difficult to spot the real value. For creating it, clear horizontal and vertical strokes were used. Tens place was represented vertically and unit horizontally. After this, 22 represented as 𝍢. After this, it had been less chance of sprawling (Cooke, 1942).

Chinese Abacus was derived from the Chinese language word 'suan' which implies calculations and 'pan' mean 'board'. Thus, the Chinese Abacus was called 'suanpan' which means counting board. It had been the foremost widespread method for doing calculations in the account, banking, hotels, trade, mathematics, etc. for doing the calculations quickly. The use of innovative Abacus still exists in China. With time, modified and variant forms of Suanpan were used in China (Ifrah, 2000). Chinese prefer to exercise Abacus for computation rather than paper and pencil (Tchen, 1987). Chinese Abacus frame is divided into two parts i.e. upper and lower. Bars of each frame were linked together with the help of sticks arraying a series of corresponding

columns. Each of the vertical bars in the Abacus has five beads on the lower part (worth one unit) and each of the two on the upper part (worth five units). The arithmetic operations beads were slides from either side towards the central position (Institute of the History of the Natural Sciences, 1987).

7. Japanese System:

In the 16th century, the Soroban form was adopted by the Japanese which was the modified form of Chinese Suanpan. Mori Kambei was the first Japanese Mathematician who brought the Chinese Abacus to Japan. Soroban was extensively used during Mori days. He circulated the knowledge of Soroban in Japan. With the help of Soroban people could solve their day-to-day numerical problems easily (Mikami, 1913). Bamboo sticks were being used for computation purposes. Numerals were usually performed on a square frame surface like a chessboard (Cajori, 1953). Nowadays Soroban is being used throughout the world. Present-day Chinese suan-pan and ancient Japanese Soroban resembled in their structure. Both had two beads above the beam and five below. The second bead of the upper deck was removed from Soroban in the middle of the 17th century (Institute of the History of the Natural Sciences, 1987). In 1920 one bead was excluded from the bottom and it gave the present day of Soroban (Kojima, 1954). By using this Soroban, long-lasting calculations can easily carry out.

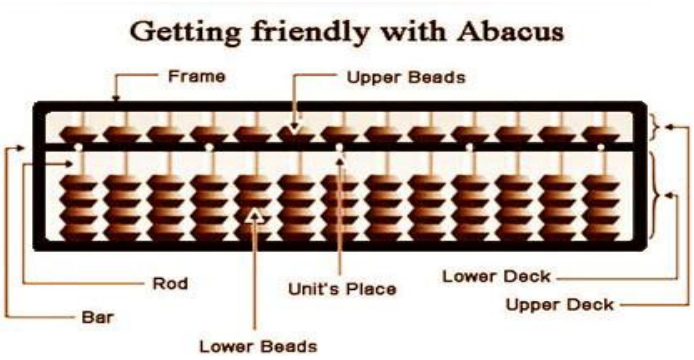

Fig No. 1: Soroban (Source: www.mastermindabacus.com)

8. Russian Abacus (Schoty)

Schoty came into the 16th century in Russia. It was well-known for performing computation tasks. Records revealed that Schoty was not much popular. The function of Schoty is horizontal rather than vertical which made it different from other types of Abacus. There is commonly a single slanted deck with ten beads in each wire. On the unit rod value of each bead is assessed as one, 10 on tens rod and so on (Hudgins

2004). The fourth rod of the Schoty is called 'Rubble' also known as Russian currency. The two middle beads in each row are in dark-color. The value is zero when the beads move towards the right side of the frame. To demonstrate the numbers beads are moved from left to right. This model of Abacus is commonly used in modern Russia.

CONCLUSION

Each of the civilizations in ancient times developed their numeral systems. It is very knotty to judge the origin of computation. Abacus was prevalent among Babylonia, Egypt, Greek, and Rome, etc. Roman Abacus appeared to be the most advanced as they improved in Abacus from time to time. Romanians have done a major progression in the development of Abacus such as Dust Abacus, wax Abacus, and grooved Abacus. With the help of this succession, it became popular among learners as it fetched their interest in mathematics. After the invention of 'zero', this work became easier and new modes of Abacus were developed, such as Soroban and Suanpan form of Abacus. It is not merely boosting the calculation skills of the learners but also bumps up their confidence to solve the problems free handily and laid a solid limestone for learning.

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