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IDENTIFYING AND EXTRACTING THE BASICS OF MATHEMATICS EMBEDDED IN MULTIPLE CONTEXTS

Dr. Minikumari D. Asst. Prof. in Mathematics Education, N.S.S. Training College, Ottapalam, Palakkad, Kerala.
Prof. Dr. Theresa Susan A., Professor, Dean, Faculty of Education, Former Head, Department of education, University of Kerala, Trivandrum.

Abstract: Mathematics is a science of patterns. It is a body of ideas structured by logical thinking and reasoning. The facts, concepts, principles and procedures play a vital role in the development of mathematics as a discipline. The sustaining social interest in mathematics is based on at least four major themes in its development; (1) the arithmetic of whole numbers and fractions for recording and ordering commerce and practical affairs; (2) The ideas of Algebra, Geometry, Statistics and Calculus providing valuable models in the biological and physical world; (3) the aesthetic qualities of mathematical structures embodied in art; (4) the patterns of logical reasoning in mathematical proofs carried over in many other disciplines. The aim of the present study is to identify and extract the basics of mathematics embedded in multiple contexts. Document analysis was the main method used for the present study. A considerable amount of time was spent by the investigator on observing natural and man-made contexts which could be capitalized for mathematics education. The investigator studied and analyzed the mathematical possibilities of natural and man-made contexts. It was seen that the elements of mathematics stands on the level of establishment of relationships among other disciplines also. At this position, it is unavoidable to obtain some cautions at the studies that happen later.

(KEY WORDS: Basics of Mathematics, Multiple Contexts)

INTRODUCTION

Mathematics is probably the oldest organized discipline of human knowledge, with a continuous line of development spanning over 5,000 years. It is a body of ideas structured by logical reasoning. The facts, principles and methods developed in early Mesopotamia, Egypt and Greece play central roles in the learning of the subject even today. The sustaining social interest in mathematics is based on at least four major themes in its development; (1) the arithmetic of whole numbers and fractions for recording and ordering commerce and practical affairs; (2) The ideas of Algebra, Geometry, Statistics and Calculus providing valuable models in the biological and physical world; (3) the aesthetic qualities of mathematical structures embodied in art; (4) the patterns of logical reasoning in mathematical proofs carried over in many other disciplines.

Mathematics is a method of inquiry known as postulation thinking or reasoning from carefully formulated definitions and assumptions, and deducing conclusions by the application of the most rigorous logic that man is capable of using. Mathematics is also a field for creative endeavor constructing methods of proof and employing a high order of intuition and imagination. Mathematics has provided a rational organization of natural phenomena. The concepts, methods, and conclusions of Mathematics are the substratum of the Physical Sciences. Mathematics has brought life to the dry bones of disconnected facts and served as connective tissue, binding a series of detached observations into bodies of science.

Russell (1919) the master of abstract mathematical thought has also praised the beauty of mathematics: "Mathematics, rightly viewed, possesses supreme beauty, a beauty cold and austere, like that of sculpture, without appeal to any part of our weaker nature, without the gorgeous trappings of painting or music, yet sublimely pure, and capable of a stern perfection such as only the greatest art can show. The true spirit of delight, the exaltation, the sense of being more than man, which is the touchstone of the highest excellence, is to be found in mathematics as surely as in poetry".

But Mathematics is also a body of knowledge with content that serves the physical and social scientist, the philosopher, the logician, the musician, the artist, the astronomer and the theologian. It has imperceptibly shaped the course of modern history. Mathematics has given man miraculous power over nature which presents a paradox in human thought yet to be resolved. Tracing the history of Mathematics, Kline mentions that the simple steps made in primitive civilizations were prompted by purely practical needs. The barter of necessities requires some counting. It is not surprising that primitive man used his fingers and toes as a tally to check off the things he counted. The use of the word 'digit' in English and the ten-base numeral system are evidences of it.

Primitive civilizations also invented the four fundamental operations, out of their needs. Geometry, like the number systems, was fostered to satisfy man's needs. Fundamental geometric concepts came from observation of figures formed by physical objects. It is likely that the concept of angle first came from observation of the angles formed at the elbows and knees (compare the usage of the 'arms' of a right angle). To the Egyptians, geometry developed literally from the earth and its measurement. In Greek geometry the abstract is dominant. Plato's philosophy is on exactly the same mental level as the abstract concepts of mathematics. Mathematics is indeed distinct from the physical objects it describes. Hence mathematical thinking prepares the mind to consider higher forms of thought.

LITERATURE REVIEW

Kline (1964) mentions the Mathematics embedded in painting. He points out that for several reasons the problem of depicting the real world led the Renaissance painters to Mathematics. The Renaissance artist became thoroughly familiar and imbued with the doctrine that mathematics is the essence of the real world, that the universe is ordered and explicable rationally in terms of geometry. He believed that to penetrate to the underlying significance, that is the reality of the theme that he sought to display on canvas, he must reduce it to its mathematical content. It is no exaggeration to state that the Renaissance artist was the best practicing mathematician and that in the fifteenth century he was also the most learned and accomplished theoretical mathematician.

Galileo's observation and mathematisation of the swinging of a great hanging lamp and of various mechanical devices is another landmark. Galileo had a grand plan for reading the book of nature. In essence, it offered a totally new concept of scientific goals and of the role of Mathematics in achieving them. The new goal for scientific activity set by Galileo and pursued by his successors, is that of obtaining quantitative descriptions of scientific phenomena independently of any physical explanation. This gave man much power to predict and control the course of nature.

Smith (1958) analyses the history of Mathematics in terms of the Mathematics embedded in the cosmic figures. Astronomical study shows that one of the great cosmic forms is the spiral, a curve not scientifically studied until late in the evolution of human intelligence. The heavenly bodies obey various physical laws commonly expressed in mathematical language. They tend to move in elliptic paths about some larger mass or to trace a parabola seemingly from the infinite into our solar system and back again. As they cool, we find that the minerals which compose those heavenly bodies bound to take mathematical shapes, the molecules of carbon in diamond crystal forming a regular octahedron, those of silica loaming hexagonal prisms with pyramidal ends, and those of water arranging themselves in snow crystals of certain fundamental types. From the beginning, the spiral curve and the mathematical laws of physics are found everywhere. Plato's statement that "*God eternally geometrizes*" can be illustrated by numerous phenomena of pre-organic era and can be seen in new ways even after the advent of life upon our planet.

OBJECTIVE

The aim of the study is to identify and extract the basics of mathematics embedded in multiple contexts.

METHODOLOGY

Document analysis was the main method used for the present study. A considerable amount of time was spent by the investigator on observing natural and man-made contexts which could be capitalized for mathematics education. The investigator studied and analyzed the mathematical possibilities of natural and man-made contexts. Certain items were referred from book materials also. It helped to bring out several ways of extracting the basics of mathematics from the

creative problem solving contexts. Each context includes (i) a brief account of the analysis with a short explanation and (ii) the mathematics embedded in them.

ANALYSIS AND DISCUSSION

Contextual Analysis

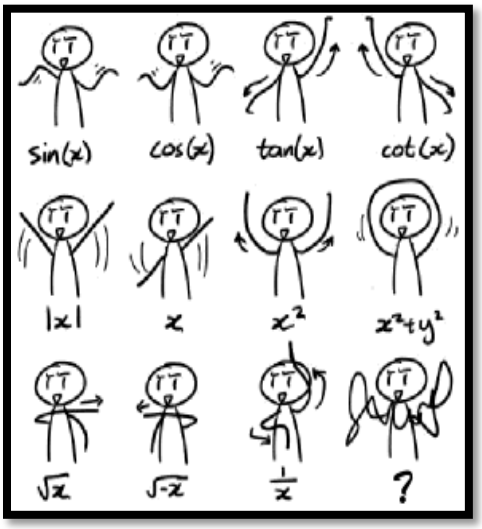
Context includes all the environmental (physical, social, aesthetic-natural and man-made) that may trigger creativity, pose problems, suggest solutions, patterns and other mathematical possibilities. It also includes the classroom climate conducive to learn mathematics in an atmosphere of security and adventure. It also includes the materials that are made by the pupils and teachers to facilitate learning, besides those that are centrally supplied and used. The teaching-learning procedures and interactions also form part of it. The physical context is more important for the very young child; it may be very relevant for even the older child who has been alienated by premature abstractions. The investigator analyzed the mathematical possibilities in natural and manmade contexts such as: Honey Comb, Portion of Ladies Finger, Pine Apple, Butterfly, Leaves, Flowers, Trees- Conifers, Different Kinds of Star Fish, Agriculture Field, Medicine , Music, Dance, Sports and Games; Sketches of Buildings, Churches, Temples, Windows, Grills, Staircases, Every Day Materials And Food Articles, Gardening, Christmas, Onam, Art and Architecture, Embroidery etc. As there are innumerable examples for these types of contexts, the list is not exhaustive.

DANCE

Dancing is moving your body at the rhythm of the music. Rhythm involves patterns and patterns are MATHEMATICS . Dancers are constantly making shapes with their entire bodies. They form simple shapes with their arms and legs such as circles, triangles and lines as well as more complex shapes. Dancers also make different shapes with their formations. The aesthetic of Bharathanatyam is based on geometry, in particular the human body seen as geometric ideal both in its static and moving forms. Everything in dance has to do with patterns. Dancers memorize patterns in the steps in their dances. Dancers often have to think about staying parallel to other dancers to preserve formations. They need to keep the same distance between themselves and the other dancers no matter how they move **circles are necessary to keep movement smooth.**

Dancers need to focus on the angles they make with their bodies to form the correct shapes. Dance can also be very symmetrical. Dancers are constantly moving their bodies across the stage so that it reflects the same consistent pattern. Often, formations in a dance create reflection or rotational symmetry. Also, partner dancing often uses both reflection and rotational symmetry. Dancers also have reflection symmetry in their own bodies.

MUSIC



- Pythagoras and the Pythagoreans
- Pythagoras is the first recorded mathematician to talk about the relationship between math and music Experimented with the monochord
- Motto:" "All is number
- Philosophy: music and numbers are the way to reach divine spiritual understanding and purity of soul.

Measures of Time

Time signature is a fraction whose numerator tells us how many beats make up a measure and whose denominator tells what note is assigned to that beat.

GCD in Music

The concept of Greatest Common Denominator and Addition of Fractions can be used to determine if a musician is working within the given time signature or rhythm**.**

***LCM* in Music**

The math concept of Least Common Multiple can be used to determine where the second note will fall in relation to the three-note rhythmic scale.

Definitions

- Frequency – number of vibrations per second
- Pitch – a listener's evaluation of frequency
- Tone – a sound that lasts long enough and is steady enough to have pitch, quality and loudness
- Octave – same note (tone), frequency doubled
- Scale – The pattern used to travel an octave.
- Amplitude – distance between max and min
- Wavelength – distance traveled in a cycle
- Period – time to complete a wavelength
- Loudness – listener's evaluation of amplitude
- Pure tone – constant frequency and amplitude (creates the sine wave)

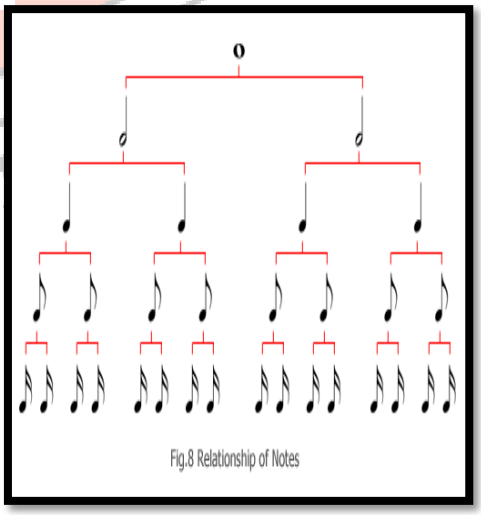
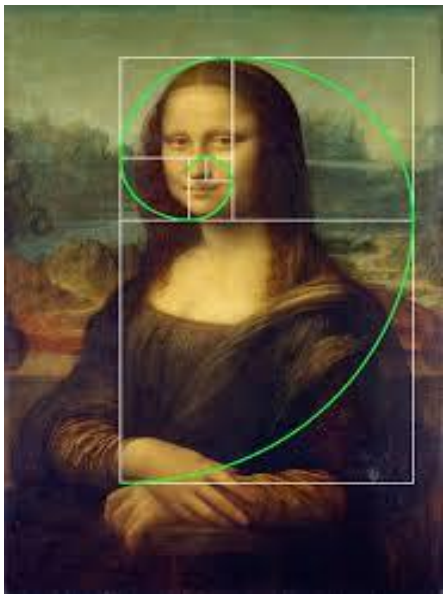


Fig.8 Relationship of Notes

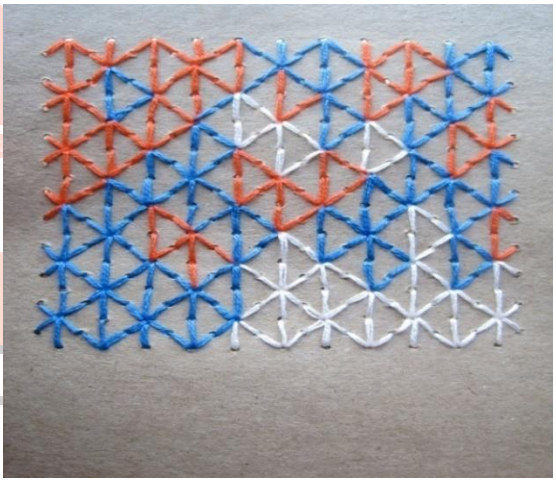
Composers use math in subtle ways to create musical compositions that are pleasing to hear. Many geometric transformations have musical counterpart.

ART



- points, lines, planes, angles, triangles , quadrilaterals, polygons, circles, etc
- ratio and proportion,
- construction of various types of triangles, quadrilaterals,
- circles and tangents
- regular polygons
- inch, feet etc
- reducing and enlarging of polynomials
- area
- plane curves-ellipse, parabola, hyperbola etc,
- plans, elevations and sections of solids,
- projection of solids- cube, prism, pyramid, alteration of ground line for new elevation, sphere, cylinder, cone, composite solid
- Application of geometry—to the setting out of schemes of ornamental patterns, surfaces for decorative purposes, construction of arch forms etc.
- isometric projection
- Golden Ratio

EMBRIODERY



- the idea of coordinate axes(X-axis and Y-axis)
- coordinate points
- linear graphs and linear equations
- equations of lines at 45^0
- The graph of the equation y=k (k is constant) is a line parallel to X-axis

- X-axis is the graph of the equation y=0
- The graph of the equation x=k (k is constant) is a line parallel to y – axis
- Y- axis is the graph of the equation x=o
- The different geometrical shapes like triangle, right angled triangle, square, rhombus, parallelogram etc. and their various properties.

CONCLUSION

The investigator studied and analyzed the mathematical possibilities of natural and man-made contexts. It was seen that the elements of mathematics stands on the level of establishment of relationships among other disciplines also. At this position, it is unavoidable to obtain some cautions at the studies that happen later. For the thinkers of earlier centuries, the theorems of mathematics were statements about the world of ideas. When later mathematicians became suspicious of such unsupported metaphysical concepts, they tried to construct "formalistic" foundations for Mathematics. Mathematics became the "science of formal systems", which consciously renounced any theory of the reality of its fundamental concepts, based on the legitimate desire to eliminate all uncertain elements from Mathematics.

The spirit of Mathematics with its elements of Problem-solving, discovery and insights fits much more closely with Gestalt psychology developed by the German psychologists Kohler, Koffka and Wertheimer. Wertheimer later migrated to the United States and his *productive thinking* is profusely illustrated with examples from mathematics. The important contribution in his analysis is the focus on the structuration or envisioning comes most naturally with geometry but extends to other fields of Mathematics as well.

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