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Mathematics in Collaboration with Science

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***Abstract*: Here, some topics in collaboration with Mathematics have been chosen. The topics were thoroughly studied in a creative way. Chemistry has concepts like atomic number, atomic mass, Valency, etc. These concepts have mathematical numbers to be taken into consideration. Also, the number of electrons in an atom play an important role in the formation of Chemical Formula. The creative and fun-filled games were constructed to make the concept learning more feasible. A strong connection of Mathematics with Biology was also discovered. Fibonacci series and numbers were seen to be included in living organisms as well. The venation patterns of some random Dicotyledonous and Monocotyledonous plants were studied and the connection of Fibonacci numbers with venation was discovered. Also, the concept of Symmetry was also studied under the domain of Biology. In order to study the above-mentioned concepts, Motley Method was used. Motley Method basically means different components brought together in a frame to understand the concepts easily.**

***Keywords*: Chemistry, Motley games, Motley method, Chem cards, Elemento cards, leaf venation, leaf mounting, Fibonacci series, Fibonacci sequence, Golden ratio.**

1. Introduction

Mathematics have been an integral part of education. It is required even in other subjects like science as well. One of the best examples I can give you is, the concept of Trigonometry being used for Space Studies by the astronauts. It is a progressive topic to understand the need for Mathematics subject in Biology and Chemistry. In Physics, it is definitely required for understanding magnitudes. Physics includes mathematical sums and theories. But what about the other branches of Science? Let us have a closure look at some of the concepts which includes Mathematics. This is directly associated with New Education Policy. In this article, a clear collaboration between two or more topics/ concepts/ subjects was studied under Motley Method of innovative teaching ideas.

A. Hypothesis

Mathematics has a vital role in the conceptual building of the other subjects.

B. Aims

To understand the collaboration of Mathematics with Science using some creative teaching-learning techniques.

C. Objectives

- To create innovative games for learning concepts in Chemistry.
- To introduce in classroom activity.
- To add and encourage STEM learning amongst the adolescents.
- To develop logical thinking in the students.
- To improve questioning skills of the students.
- To introduce Motley Method of learning (study of two concepts at a time).
- To prepare leaf slides for studying venation.
- To calculate the Golden ratio in the veins of the leaves.

2. Studying the Need of Mathematics in Chemistry

A. About the Brand

I have come up with a unique way of remembering difficult concepts. The game brand provides innovative teaching-learning environment. It is beneficial for all the middle school and high school students. Also, it can be a boon for a special student or a slow learner. It includes a variety of games. It has been initiated with a subject like Chemistry.

B. Introduction

Game Play way method has often proved to be one of the best ways of teaching. It makes teaching and learning process very interesting as well as communicative. The introvert students also can use it and get encouraged to have a conversation with the others.

Let's begin with the Methodology:

1) Elemento Cards™©

It includes the elements and some of its important details. On each card, there are the following information's given- Element, symbol, Valency, Atomic Number and Atomic weight. The students will have distributed the number of cards equally while playing. Then one by one the students must announce the unique characteristic of that element. For example, if the opponent's element card has more valency or atomic number or atomic weight, then the player needs to give away the card to him/her. Also, the other characteristics also must be taken into consideration. The player must grab maximum cards in order to win the game.

2) Chem Cards™©

This game is all about learning the molecular formula of a particular compound. The cards need to distributed equally amongst the players. The game begins by flashing a card turn by turn and forming a molecular formula. For example, if a player puts up an Oxygen card, then the opponent can put up

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Magnesium card or any card that makes a formula.

About "Wait for your turn" card: If you flash this card then you can skip a chance of the opponent.

This game is all about giving away all the cards. The one who sets herself/himself free first will be the winner. As you keep forming the molecular formula card set, you can tick or note the same. The list of the molecular formulas will be given on the card collection box and on the instruction page as well. The cards includes the Atomic number along with the electronic configuration. This makes the understanding of the formation of molecular formula easier.

Benefits of the games:

- Learning with fun.
- Caters the improvement of cognitive skills.
- Improves communication skills.
- Learning anywhere, anytime and effectively.
- Combination of creativity and innovation.
- Caters long term memory.
- Made up of Eco-friendly materials.
- During the formation of chemical formula, the concept of mathematics was also explained.

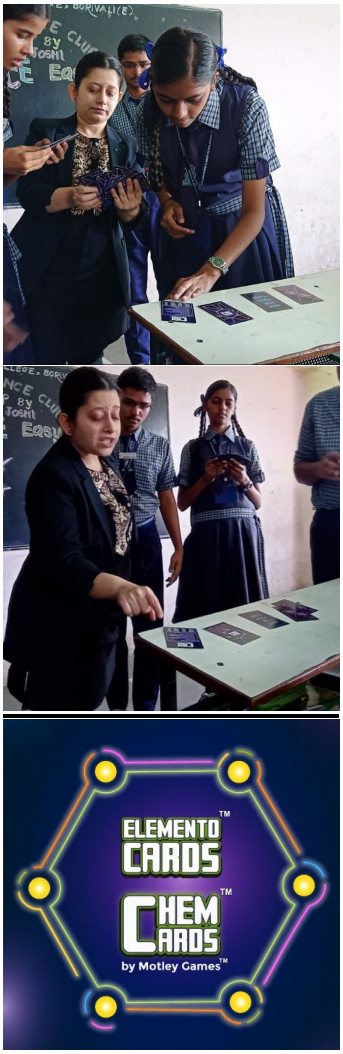

Fig. 1. Author teaching the students about playing Chem Cards and Elemento Cards

C. Mathematics in Collaboration with Biology

Fibonacci series and Golden ratio can be observed in nature. Plants and animals are prudent examples of the above-mentioned Mathematical concepts. The Fibonacci series /numbers were studied in venation of the leaves. Often the leaves themselves can be related to the Fibonacci sequence. For example, the veins of some leaves are roughly spaced by the golden ratio.

The leaves were boiled in water, immersed in methanol, stained with Safranine and mounted on a slide for observation. The venation patterns were studied thoroughly. With the help of portable dissecting microscope, the series were precisely observed.

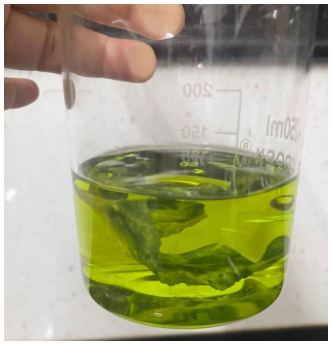

Fig. 2. Leaf kept in the Methanol

Fig. 3. Author observing the venation pattern

Fig. 4. Dicotyledon leaf showing Fibonacci sequence

D. Fibonacci Series and Biology

The Fibonacci series is the sequence of numbers (also called Fibonacci numbers), where every number is the sum of the preceding two numbers, such that the first two terms are '0' and '1'.

In the above pictures of the leaves, the Fibonacci series can be observed in the venation patterns of the leaves. Fibonacci sequences are given as: 0, 1, 1, 2, 3, 5, 8, . . . In a Fibonacci series, every term is the sum of the preceding two terms, starting from 0 and 1 as first and second terms. In some old references, the term '0' might be omitted.

We find applications of the Fibonacci series around us in our day-to-day lives. It is also found in biological settings, like in the branching of trees, patterns of petals in flowers, etc. Let us understand the Fibonacci series formula.

It can be thus be observed that every term can be calculated by adding the two terms before it.

Given the first term, F0 and second term, F1 as '0' and '1', the third term here can be given as, F2 = 0 + 1 = 1

Similarly,

F3 = 1 + 1 = 2

F4 = 2 + 1 = 3

And so on.

E. Fibonacci Sequence and Golden Ratio

In mathematics, the Fibonacci series and Golden ratio are closely connected. Golden ratio (G.R.) is often denoted by the Greek letter ϕ or τ, which is approximately equal to 1.618.

Formula of G.R.:

$$\emptyset = \frac{1+\sqrt{5}}{2}$$

$$\emptyset = 1.618$$

This ratio is present in the nature which is explained with the help of various leaf samples. Measurements of the leaf vein spacing was done using portable dissecting microscope for a precise reading. The ratio of the spacing between the secondary veins is calculated in the below samples.

G. R. and Venation Patterns: The leaf venation patterns have proved to display a prominent example of G. R. According to the example given below,

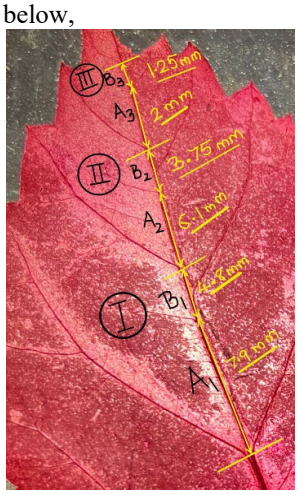

Fig. 5.

The veins of some leaves are roughly spaced by the golden ratio.

Sample 1(G. R. shown in Dicotyledon leaf):

I) A1/B1= 7.9mm/4.8mm= 1.64

II) A2/B2= 6.1mm/3.75mm= 1.62

III) A3/B3= 2mm/1.25mm= 1.60

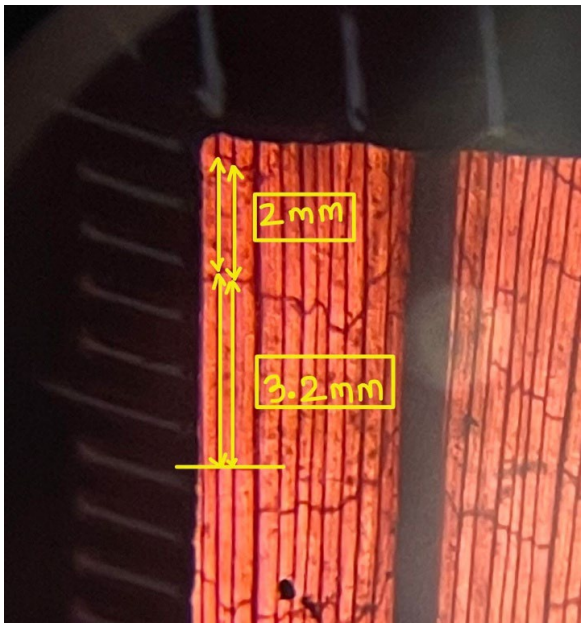

Fig. 6.

Sample 2 (G. R. shown in Monocotyledon leaf):

I) 3.2mm/2mm= 1.60

3. Conclusions

- Mathematics have great impact on the other subjects such as Science. Mathematics is a mandatory part of Chemistry. In understanding the components of an atom, mathematics plays a vital role. This can be learnt in a very innovative way with the help of Chem Cards and Elemento Cards.
- Even in Biology, the Dicotyledon as well as Monocotyledon leaves display Fibonacci sequence and Golden Ratio. The venation patterns show Fibonacci series and the vein spacing shows Golden Ratio.
- It can be hence concluded that Mathematics has it's deep roots collaborated with other subjects. The interrelationship between Mathematics and Science was profoundly observed and proved.

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