IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

DEVELOPMENT OF INSTRUCTIONAL DESIGN FOR COMPUTER BASED CONCEPT MAPPING AND ITS EFFECTIVENESS ON THE ATTAINMENT OF CONCEPTS IN SCIENCE OF SECONDARY SCHOOL STUDENTS.

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Abstract

This study was an attempt at designing an instructional strategy, using Computer Based Concept Mapping (CBCM) instruction, to study the effect of Computer Based Concept Mapping Instructional Strategy on the Attainment of Concepts in Science of Secondary School Students. CBCM is an instructional strategy of teaching that can be used in the class room by the teachers in teaching different disciplines. It enables the learner to graphically structure the knowledge in to hierarchically organized concepts through a Computer Based Software namely INSPIRATION. 'Inspiration' is widely used software for CBCM which is designed specifically for Computer Based education. The present Research was Experimental in nature involving pre-test, post-test, 2×3 factorial design. A Concept attainment test constructed by the Investigators and validated by experts was used to collect the data from the sample consisting of 72 students studying in 9th standard . The two treatment groups had student strength of 36 in each; both the groups were matched on intellectual capacity. On the basis of their intelligence, each group was further split into Above-Average, Average, and Below Average consisting of 9, 18 and 9 students respectively. The 2-way Analysis of Variance (ANOVA) was employed for the purpose of analysis of data. Findings of this research revealed that: CBCM Instructional Strategy was more effective than the Conventional Instructional Strategy in improving the Attainment of Concepts in science of Secondary School Students. The performance on Attainment of concepts of students at different levels revealed that; Above-Average students performed significantly better than Average and Average students performed significantly better than Below Average.

Keywords: Computer Based Concept Mapping Instructional Strategy, Conventional Strategy and Attainment of Concepts.

Introduction:

Technology creates real-world learning experiences to make education more effective, efficient, and engaging. Learning of Science concepts is not an easy task. Attainment of concepts requires deliberate effort on the part of the learner. Use of an appropriate strategy or method in the learning of concepts in Science helps in the accurate attainment of concepts. This study attempted to provide a unique learning experience to students, to develop Concept Maps using technology for improving Attainment of Concepts and enhance their learning outcomes in Science.

Concept maps were developed in 1972 in the research program of Joseph D. Novak at Cornell University where he wanted to follow and understand changes in children's knowledge of science. Concept maps are graphical tools used to represent the organized knowledge. They include concepts, linking line and linking words that specify the relationship between the two concepts. Concept maps are helpful to introduced new science concepts to students; they embark on a cognitive process of constructing meaning and making sense by consciously and subconsciously adding these new ideas with their previous knowledge. Concept maps provide a unique graphical view of how students organize, connect, and analyze content. Modern technology has given us an opportunity to improve traditional Concept Mapping with the help of Computer as an aid in the process of Concept Mapping. CBCM is an Instructional Strategy designed by the investigator that helps the learners to organize information through visual aids. It is a student centric learning tool and it enhances the Concept Attainment capabilities of Students. There are a number of Concept Mapping tools available today. 'INSPIRATION' is one such CBCM tool used in the present study.

Review of related literature

CBCM has been extensively used as teaching, learning and evaluating tool in different disciplines. In Science Asan, A. (2007) Conducted a research on" Concept Mapping in Science Class: A Case Study of fifth grade students." experimental group was treated through Inspiration, which is computer based concept mapping tool. The findings revealed that, Concept Mapping has a evident impact on student achievement in science classes. Kwon, S. Y. (2007) conducted a research on "Using Computers to Individually-generate vs. Collaboratively generate Concept Maps." The findings discovered that, the Students who generated concept maps by self scored more. Rao, M. P. (2004) conducted a study on "Effect of Concept Mapping in Science on Science Achievement, Cognitive Skills and Attitude of Students". The study discovered that, the experimental group performed better then the control group on the achievement test, process skills and concept attainment test.

In Biological science Chang, K.E., Sung, Y.T., & Chen, S.F. (2001) conducted a study on "Learning through CBCM with scaffolding aid." The study discovered that, the 'construct-on-scaffold' had better effect for learning biology. Mayer, J. R. (2012) conducted a study on "Effects of using the concept attainment model with inductive Reasoning with high school biology students." The results indicated that, students' understanding of the biology concepts and thinking skills increase by the use of the concept attainment model. Royer, R. & Royer, J. (2004) conducted a study on "Comparing Hand Drawn and Computer

Generated Concept Mapping." The results revealed that, the group using the computer, created more complex maps than the group that used paper/pencil. From the synthesis of the reviewed studies it is observed that, CBCM is undoubtedly an effective practice for Concept Attainment. But very little effort has been done to use CBCM in teaching Science Content in the Indian context although the teachers were aware of the present trends in Science teaching.

Objectives

1. To develop CBCM instructional strategy to enhance Attainment of Concepts in Biological Science of Secondary School Students.
2. To study the effectiveness of CBCM Instructional Strategy over Conventional Strategy(CS) in enhancing Attainment of Concepts in Biological Science of Secondary School Students.
3. To study the effect of CBCM Instructional Strategy over CS in enhancing Attainment of concepts in Biological Science of Secondary School Students in terms of Above-Average, Average and Below Average Intelligence levels.
4. To study the interaction between treatments (CBCM & CS) and levels of students based on Intelligence (AA, A & BA) in enhancing Attainment of concepts in Biological Science of Secondary School Students.

Hypothesis

$H0_1$: There is no significant difference between the CBCM Instructional Strategy and CS in improving Attainment of Concepts in Biological Science of Secondary School Students.

$H0_2$: There is no significant difference between the Above-Average, Average and Below Average Intelligence levels of Secondary School Students Attainment of Concepts in Biological Science improved through CBCM Instructional Strategy and CS.

$H0_3$: There is no significant interaction effect between the treatments (CBCM & CS) and levels of students based on Intelligence (AA, A & BA) with reference to Attainment of Concepts in Biological Science of Secondary School Students.

Methodology / Procedures

DEVELOPMENT OF COMPUTER BASED CONCEPT MAPPING INSTRUCTIONAL STRATEGY

In this study, CBCM Instruction Material was developed by the researcher on the basis of **Joseph D Novak's Concept Mapping** by using **Inspiration Software** to improve the Attainment of Concepts in Science of secondary school students.

Characteristics of Instructional strategy

- **Online Resource:** The Instruction material makes use of Gmail server which enables a student to create Gmail account and to download the Inspiration software that is available for the free trial.
- **Computer Based:** This instruction material is completely Computer Based, so the necessary concept maps can be created using components available on internet.

- **Multimedia experience:** It allows audio, video, multimedia files and attachments to be added to the concept maps as and when required. This can be achieved with the help of the search engines available on the internet.
- **Easy and user friendly:** This is specially designed for high school students. Hence it has been designed to be easy to access and user-friendly.
- **Flexibility:** The Instructional Material is flexible and thus gives freedom to the teacher as well as pupils to perform their respective roles efficiently.
- **Variety:** A number of activities/options are available to facilitate the students to participate actively and master the technique of Computer Based Concept Mapping and complete the practical work given by the instructor.
- **Active learning:** Provision made for promoting motivation throughout the learning and hence the learner is always busy and active.
- **Practice:** Learner is lively throughout the learning session, practicing variety of activities.
- **Guidance:** The 'Inspiration' tool is so well designed that a video demonstration provides initial guidance about how to build Concept Maps. The teacher plays a role of facilitator during different sessions emancipated in the tool.
- **Self-paced learning:** Post the Introduction session, the pupils can continue self-paced learning depending upon his grasping capability. 'Inspiration' can be used anywhere anytime.

Selection of the Subject Matter

The investigator thoroughly reviewed the Science Curriculum of the Karnataka State Secondary Education Board. After going through the syllabus and text book of standard Nine and understanding the nature of the syllabus the researcher has selected an appropriate unit from the Biological Science of 9th Class. A unit on "Classification of Living Organisms" was carefully chosen for the application of Computer Based Concept Mapping Instructional Strategy.

Content Analysis

In the content analysis a unit of class nine 'Classification of Living Organisms' was classified into five Kingdoms Monera, Protista, Mycota, Plantae and Animalia. Kingdom Animalia was further classified into eight Phylums Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annilida, Arthropoda, Mollusca and Echinodermata.

Outline of Instructional Material

The CBCM Instructional strategy developed includes three types of lessons (4 **Introductory lessons** +12 **Demonstration lessons** +12 **Practice lessons** = 28 **lessons**) each lesson contains time duration1½ hr.

I. Introductory lessons: the purpose of these lessons was to introduce Concept Mapping, Creating Gmail Account which is essential for establishing Webspiration Classroom Account. This allows downloading a free trial free Webspiration Classroom through which the Construction of Computer Based Concept Mapping is done. Four Introductory lessons were planned.

Lesson 1: Introduction to Concept Mapping

Lesson 2: Creating Gmail Account

Lesson 3: Creating Webspiration Classroom Account

Lesson 4: Webspiration Classroom - Construction of Concept Maps

II. Demonstration lessons: Twelve demonstration lessons were planned as per the content analysis.

Lesson 5: Kingdom Monera

Lesson 6: Kingdom Protista

Lesson 7: Kingdom Mycota

Lesson 8: Kingdom Animalia

Lesson 9: Phylum Porifera

Lesson 10: Phylum Coelenterata

Lesson 11: Phylum Platyhelminthes

Lesson 12: Phylum Aschelminthes

Lesson 13: Phylum Annilida

Lesson 14: Phylum Arthropoda

Lesson 15: Phylum Mollusca

Lesson 16: Phylum Echinodermata

III. Practice lessons: Each demonstration lesson was followed by the practice lesson, so twelve practice lessons were planned.

Outline of Instructional material for Introductory and Demonstration lessons

The Introductory and the Demonstration lessons contained four steps: I. Initiation

II. Development III. Practice and IV. Evaluation and the approximate **time limit** for each component of the lesson on an average is 10 min, 30 min, 40 min and 10 minutes respectively

Outline of Instructional Material for Practice lesson.

Each **Practice lesson** contained two **steps:**

I. Students of CBCM Strategy group created the Computer based Concept Maps individually for each topic assigned through http://www.webspirationclassroom.com

II. Students individually filled the worksheet by choosing the correct answers from the given option

Approximate **time limit** for each step on an average is 1 ¼ hr and ¼ hr respectively.

Preparation of Instructional Transcripts

An initial draft of Instructional Material was prepared keeping the Content Analysis in mind in terms of concepts selected from Biological Science. The investigator visited various libraries, browsed through the Science classroom and Concept Mapping educational websites, interacted with Educational researches to collect literature required for the development and to collect required information to make the Instructional Material 'text and graphical' oriented. The written transcripts of 28 lessons were then refined by referring it to the experienced subject experts.

Try out of CBCM Instruction Strategy: Six trial lessons (four introductory lessons, two demonstration lessons followed by two practice lessons) were given by the researcher for Standard IX students of a selected school other than the experimental school in order to know the validity of Computer Based Concept Mapping Instructional Strategies in real classroom settings and to know the probable difficulties the researcher or students may face. This experience gave the researcher an idea regarding the approach to be followed in presenting Initiation, Development, and time required for Practice and Evaluation. It also gave an idea to calculate the approximate time limit to complete one lesson.

Transcripts

Twenty eight Instructional transcripts were prepared by the researcher. The sample lesson transcripts of Computer Based Concept Mapping Instructional Strategy are are given below

Sample Demonstration lesson

PHYLUM PORIFERA

CLASS: IX **DURATION: 1½hr**

……

LEARNING CONTENT: phylum Porifera

- Positive Examples
- Negative Examples
- Essential attributes
- Non-attributes
- Creating Computer Based Concept Map of phylum Porifera with the help of Inspiration software.

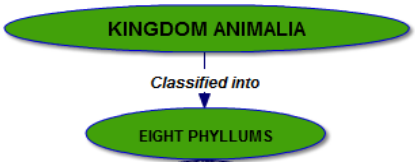
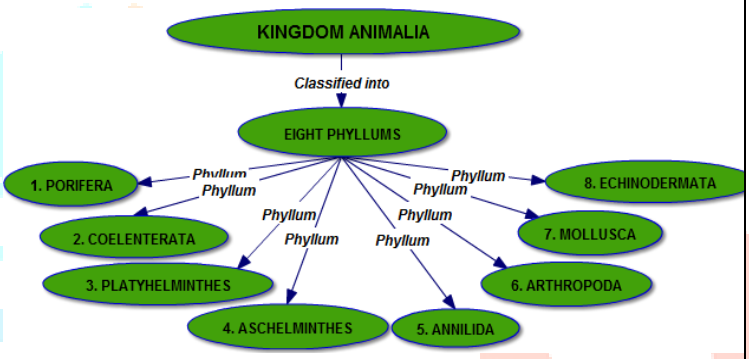
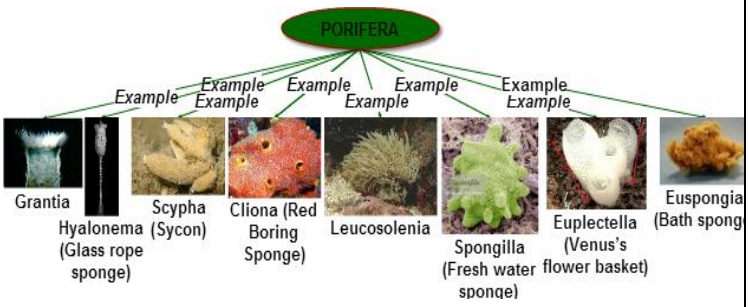
OBJECTIVES: Students will,

⇒ Acquire the concept of phylum Porifera.

⇒ Identify the examples and non-examples of phylum Porifera.

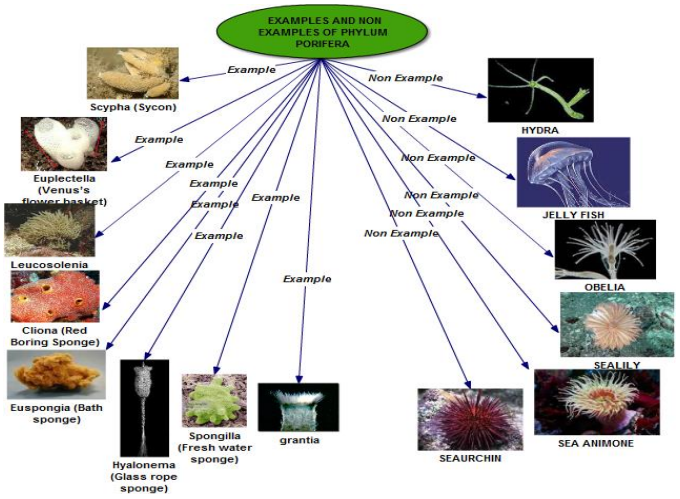
⇒ Identify the essential and non-attributes of phylum Porifera.

⇒ Create the Computer Based Concept Map of phylum Porifera with the help of Inspiration software.

INSTRUCTIONL EVENTS	TEACHING LEARNING ACTIVITY	PUPILS RESPONSE
Initiation	**Preparation of Computer Based Concept map Based on the previous knowledge.** Let us create a Concept map of 'Classification of Kingdom Animalia 'by using Webspiration Classroom. **Q:** How many phyumla's are there in Kingdom Animalia?  **Q:** Name the eight phylum's of Kingdom Animalia ?  This is the Concept Map of classification of Kingdom Animalia. Let us study about Examples, Non-example, Essential and non-essential attributes of phylum Porifera.	**Ans:** Eight phylum's **Ans:** kingdom Monera Phylum Proifera Phylum Coelenterata Phylum Platyhelminthes Phylum Aschelminthes Phylum Annilida Phylum Arthropoda Phylum Mollusca Phylum Echinodermata
Development	**<u>Examples and non- Examples of phylum Porifera</u>** **Q:** Give examples for phylum Porifera. Sponges are Positive Examples of phylum Porifera. Positive Examples Contain attributes (important character) of concept (Porifera).  **Q**: Give non examples for phylum Porifera. Hydra and Obelia are Negative/ Non- Examples for phylum Porifera because these organisms do not Contains attributes (important character) of concept	Ans: Sponges. Ans: Hydra, Obelia

(Porifera).

The following Computer Based Concept map shows more "Examples and Non-example of phylum Porifera."



Students observe and readout the names of Examples and Non-example of phylum Porifera.

Q: What difference do you find in between the Examples and Non-example of phylum Porifera in the above map?

Ans: Members of phylum Porifera have Pores on the body surface and in the non-examples pores are absent.

The minute pores present on the body surface of Porifera are called Ostia.

This is one of the essential attribute of phylum Porifera

Let us see about Essential attributes of phylum Porifera

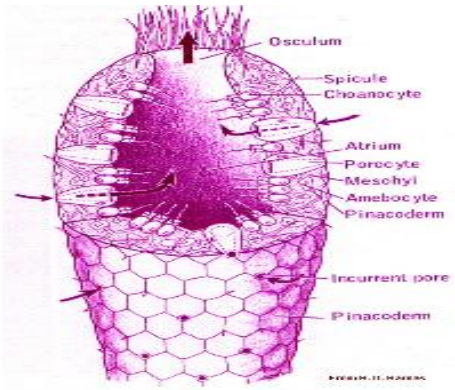
<u>Essential attributes of phylum Porifera</u>

Teacher explains what an Essential attribute is.

Identify the following parts in the given figure of Sycon-

Ostia, osculum, spongocoel, spicules, coenocytes.

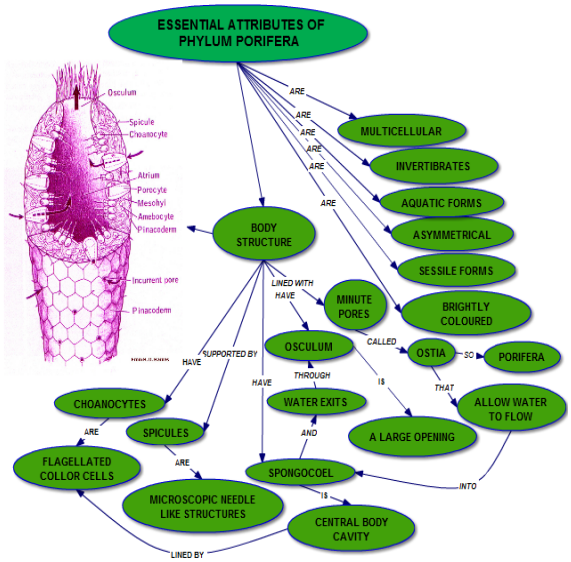
Students identify- Ostia, osculum, spongocoel, spicules, coenocytes in the given figure of Sycon



These are essential attributes of phylum Porifera. Because of these characteristics 'sycon' is included under phylum Porifera.

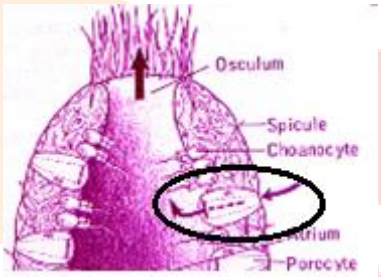
The following Computer Based Concept map shows the

"Essential attributes of phylum Porifera."



Refer the given Concept Map answer the following questions.

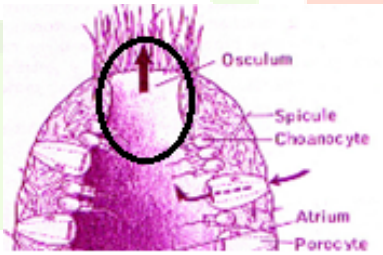
Q: What is Ostia?



Pupil answers with the help of Concept map of "Essential attributes of phylum Porifera."

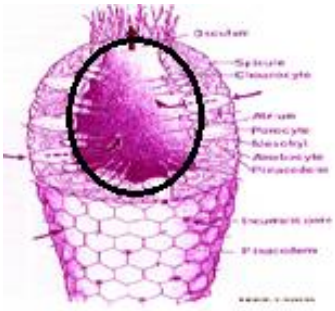
Ans: Ostia are minute pores present on the body surface of sponges through which water enters into the body.

Q: What is osculum?



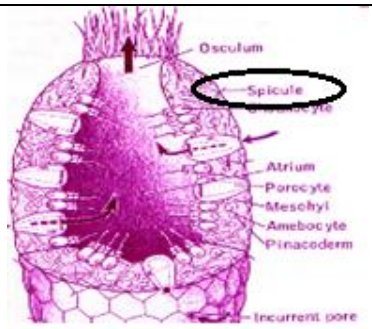
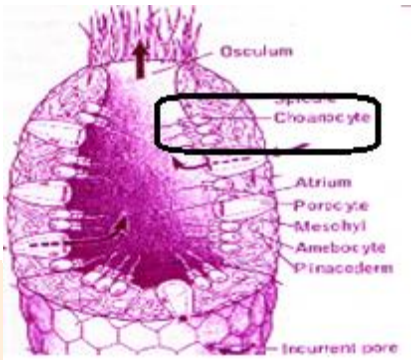
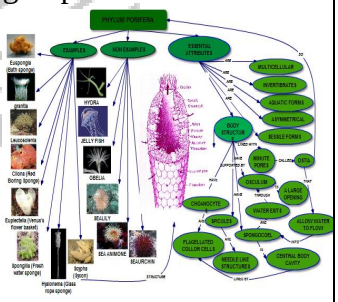
Ans: Osculum is a large opening of Sycon, through which water exits.

Q: What is spongocoel?



Ans: Spongocoel is central body cavity of sycon.

Q: What are spicules?

	 Spicules are microscopic needle like structures present on the surface of the body. Their function is protection. Q: What are coenocytes?  Coenocytes are flagellated color cells lined inside the surface of the body. Helpful in food capturing.	Ans: Spicules are microscopic needle like structures. Ans: Coenocytes are flagellated color cells.
Practice	Create a Computer based Concept Map of Phylum Porifera in groups. (Resources: text book and Internet)	Students creates the Computer based Concept Map of Phylum Porifera in groups. 
Evaluation	*** Choose the correct answer.** 1. The members of Phylum Porifera are commonly known as a. Sponges b. Fungi c. Nematodes d. Corals 2. Special stinging cells present in Phylum Porifera are a. Flame cells b. Cnidoblasts c. Tentacles	Ans: a. Sponges Ans: d. Choanocytes

	d. Choanocytes 3. In sponges the body wall is lined with minute pores are called as a. Ostia b. Osculum c. Cnidoblasts d. Choanocytes 4. A large opening of Sycon, through which water exits. a. Ostia b. Osculum c. Cnidoblasts d. Choanocytes	Ans: a. Ostia Ans: b.Osculum

Sample Practice lesson

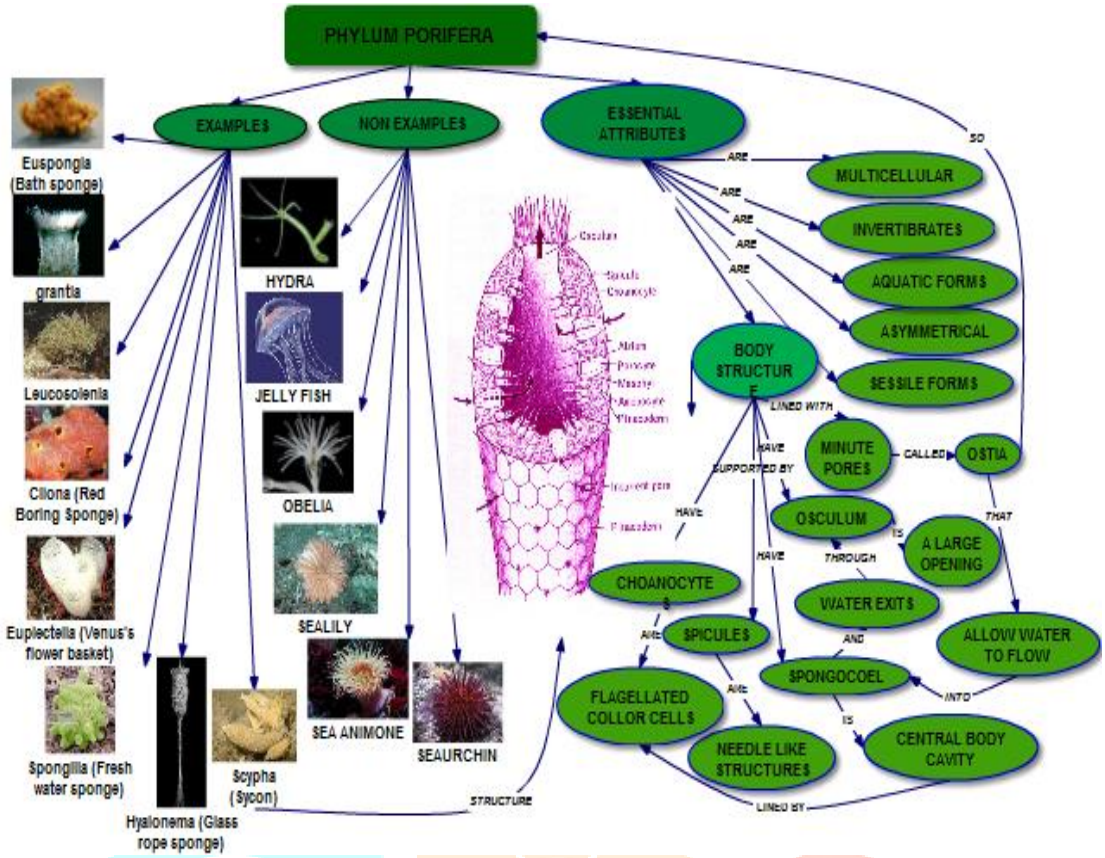
PHYLUM PORIFERA

CLASS: IX **DURATION: 1 ½hr**

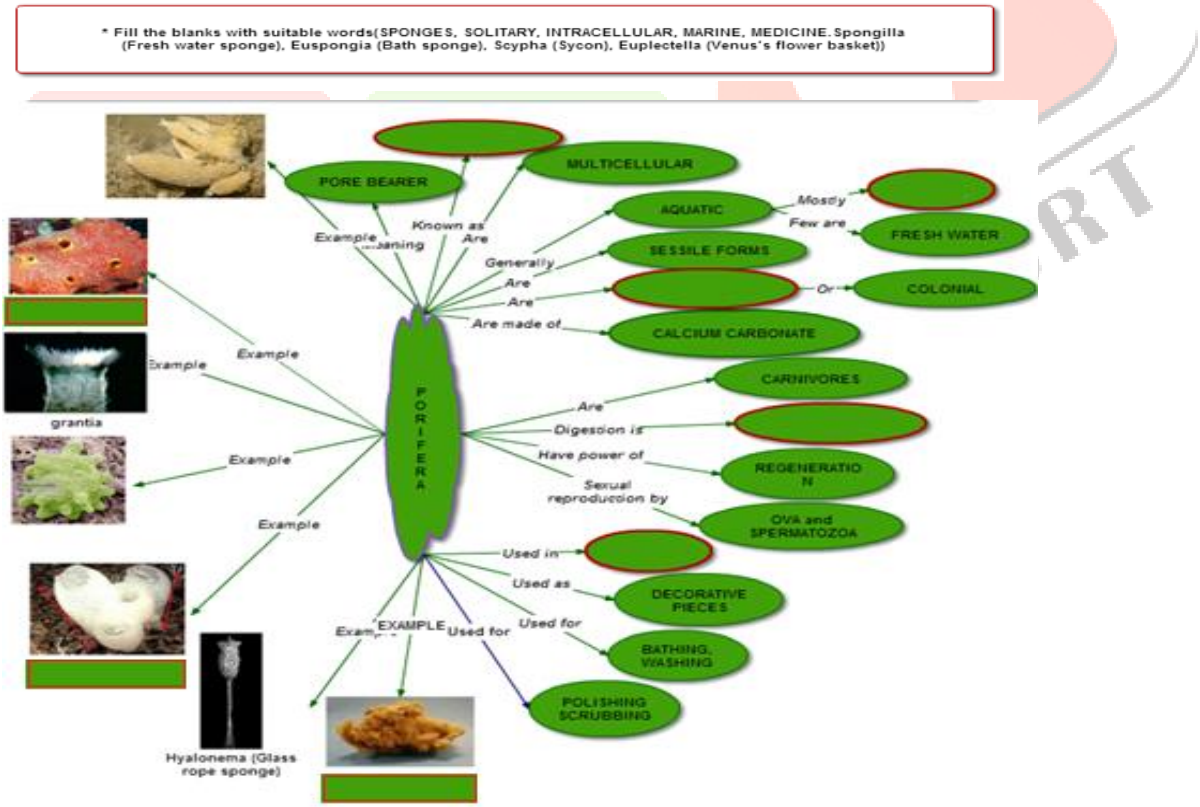
OBJECTIVES: Students will,

⇒ Create the Computer Based Concept Map of Phylum Porifera with the help of Inspiration software

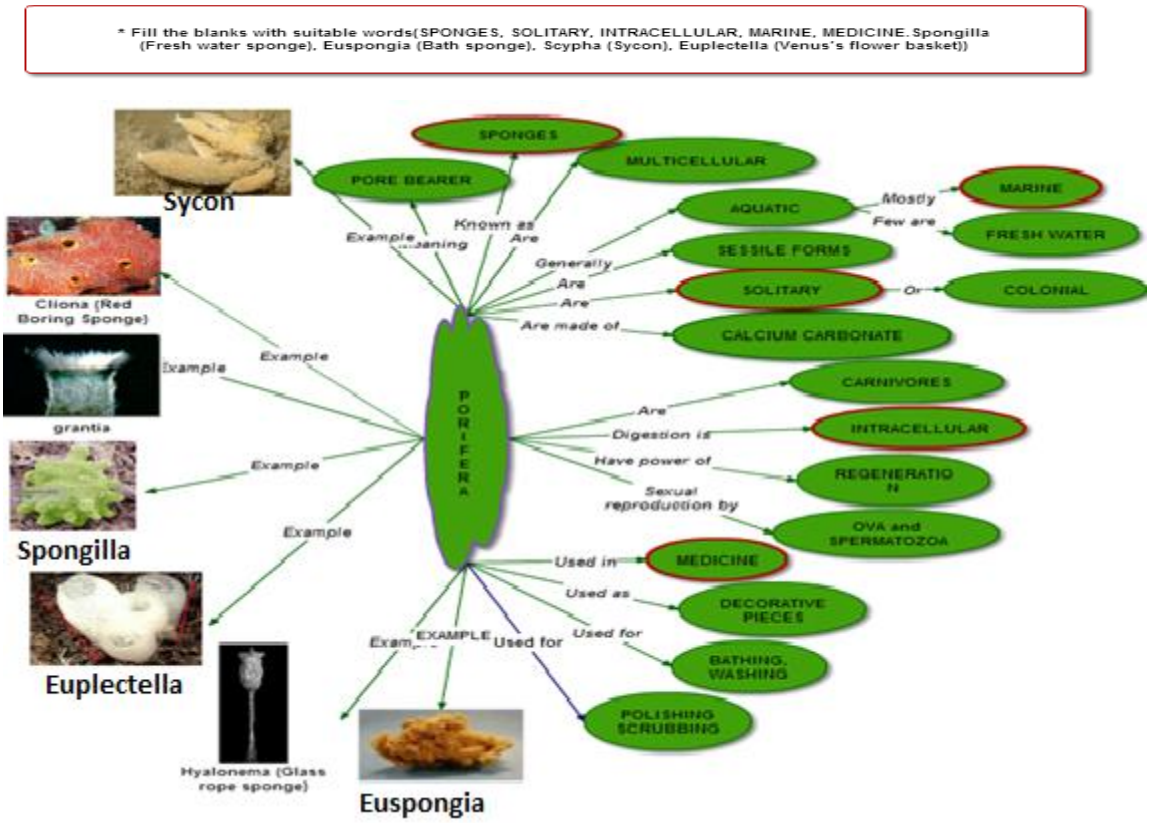
- **Activity:** Read the content related to phylum Porifera in your text book and individually develop the Computer Based Concept Map of phylum Porifera with the help of Inspiration software.
- Computer Based Concept Map of phylum Porifera should contain "Examples, Non-example, Essential attributes and Non-Essential attributes.
- Sample of Computer Based Concept Map of phylum Porifera developed by students in practice lesson.


PHYLUM PORIFERA
EXAMPLES
NON EXAMPLES
ESSENTIAL ATTRIBUTES
SO
ARE
MULTICELLULAR
INVERTIBRATES
AQUATIC FORMS
ASYMMETRICAL
SESSILE FORMS
BODY STRUCTURE
LINED WITH
MINUTE PORES
CALLED
OSTIA
HAVE
SUPPORTED BY
OSCULUM
IS
A LARGE OPENING
THROUGH
THAT
CHOANOCYTES
WATER EXITS
ALLOW WATER TO FLOW
SPICULES
AND
SPONGOCOEL
INTO
FLAGELLATED COLLOR CELLS
NEEDLE LIKE STRUCTURES
CENTRAL BODY CAVITY
LINED BY
STRUCTURE
Euspongia (Bath sponge)
grantia
Leucosolenia
Cliona (Red Boring Sponge)
Euplectella (Venus's flower basket)
Spongilla (Fresh water sponge)
Hyalonema (Glass rope sponge)
Scypha (Sycon)
HYDRA
JELLY FISH
OBELIA
SEALILY
SEA ANIMONE
SEAURCHIN

➢ WORK SHEET


* Fill the blanks with suitable words(SPONGES, SOLITARY, INTRACELLULAR, MARINE, MEDICINE.Spongilla (Fresh water sponge), Euspongia (Bath sponge), Scypha (Sycon), Euplectella (Venus's flower basket))
MULTICELLULAR
PORE BEARER
Known as
Are
Example
AQUATIC
Mostly
Few are
FRESH WATER
SESSILE FORMS
Generally
Are
Or
COLONIAL
Are made of
CALCIUM CARBONATE
Example
grantia
Example
CARNIVORES
Are
Digestion is
Have power of
REGENERATION
Sexual reproduction by
OVA and SPERMATOZOA
Example
Used in
Used as
DECORATIVE PIECES
Used for
BATHING, WASHING
POLISHING SCRUBBING
Hyalonema (Glass rope sponge)
PORIFERA

➢ SOLVED WORK SHEET



Research design

The pre-test, post-test, 2×3 factorial design was used in the study. It is diagrammatically represented below.

Table 1: Schematic Representation of Treatments and Levels

Factor (F_A) Treatments → / Factor (F_B) Levels ↓		Intelligence		
		L1 (Above-Average)	L2 (Average)	L3 (Below Average)
Instructional Strategy	CBCM Instructional Strategy. (T_1)	n(9) $T_1 L_1$	n(18) $T_1 L_2$	n(9) $T_1 L_3$
	Conventional Instructional Strategy. (T_2)	n(9) $T_2 L_1$	n(18) $T_2 L_2$	n(9) $T_2 L_3$

Sample

The sample consisted of 72 students within the age group 14 to15 studying in Standard Nine. Based on their Intelligence Scores, matched pairs were identified and distributed into two treatment groups with 36 cases in each group. On the basis of their intelligence each group was further divided into 3 levels as Above-Average, Average, and Below Average consisting of 9, 18 and 9 students respectively.

Tools used

- **Standardized Intelligence test** developed by J C Raven, was used for the classification of groups and levels of students (Above-Average, Average and Below-Average).
- The data was collected by using the **Concept Attainment test** developed by the researcher. It consisted of 40 items. The content validity was constituted by expert rating. The coefficient of consistency found

by the split half method was 0.95. The concurrent validity co-efficient of 0.64 was found against the external creation, the concept Attainment test developed by Anuradha Joshi.

Procedure of the study

Both the groups were taught by a single teacher on the same dates to avoid the inter-personal and intra personal variation. The two groups were pretested on Attainment of Concepts in Biological Science. The experimental treatment involved in the teaching of a selected unit in Biological Science namely, "Classification of living organisms" of standard nine. Each lesson was of one and half hour time period. The total fifteen lessons were taught by using CBCM Instructional Strategy to the experimental group of students. Meanwhile, the students of Control group were taught the same lessons by using CS. Immediately after the completion of the treatment both the groups were Post- tested on Attainment of Concepts in Biological Science.

Delimitations

- CBCM Instructional Strategy can be applied to any subject, at any level. In the present study, the background of the investigator has enabled its application to Biological Science at Secondary School level.
- CBCM Instructional Strategy can be applied for different types of instruction. In the present study, it is applied to Group instruction as it is suitable to the Indian context.
- The study was confined to the teaching of Science for 9th standard students of English medium.
- CBCM Instructional Strategy involved the use of software namely 'INSPIRATION'.

Results and Discussion

In order to test the hypotheses, 2-way Analysis of Variance was used. Since the samples were of equal size, F_{max} test was employed to test the Homogeneity of Variance for each criterion variable under consideration. As the obtained F_{max} value (2.8) is less than the Tabled value (6.4) at 0.01 level, it implies that the groups are Homogeneous.

Further application of 2-way Analysis of Variance involved the calculation of degrees of freedom and F-ratio. The following Table-2 gives the summary of Analysis of Variance pertaining to Attainment of Concepts in Science.

Table –2: Summary Table of ANOVA Pertaining to Attainment of Concepts

Sources of Variation	Df	SS	MS (SS/df)	F	Significance P<0.01
Treatments (A)	2-1	2875.35	2875.35	287.03	Significant
Levels(B)	3-1	349.46	174.73	17.44	Significant
Interaction(A X B)	1 X 2	39.68	19.84	1.98	Not Significant
Within Groups (Error)	71-5=66	661.17	10.02		
Total	72-1	3925.66			

1. **Instructional Strategy (Treatment F_A)**

The obtained F-value with respect to Factor F_A is found to be 287.028 and the corresponding table value is 7.051 with df 1 and 66 at 0.01 level. Since the obtained F_A value is greater than the tabled F-value, the value is significant and hence, the null hypothesis ($H0_1$) is rejected. Thus, the alternative hypothesis H_1 is accepted.

H_1: There is a significant difference in between the effect of CBCM Instructional Strategy and CS on Attainment of Concepts in Science of Secondary School Students.

From the above Table -2, it is revealed that: There is evidence at 0.01 level that the levels of the group, type of Instructional Strategies differ. Therefore, treatment groups lead to statistically significant results on the test of Attainment of Concepts in Science. The following table is used to interpret the results.

Table–3: Group Means and Grand Means on Gain Scores of Experimental and Control Groups of Above-Average, Average and Below Average students on Attainment of Concepts in Science

Treatment groups → / Levels ↓	CBCM	CS	Grand Mean	Mean Difference
L_1 (Above Average)	25.33	13	19.17	12.33
L_2 (Average)	22.22	8.28	15.25	13.94
L_3 (Below Average)	18.22	7.89	13.06	10.33
Grand Mean	**21.92**	**9.72**	**15.82**	**12.2**

There is strong evidence at the 0.01 level that the Instructional Strategies differed in how effective they were. The F- value indicates a statistically significant difference, but it did not indicate which method led to better test scores. Observing the overall means, the CBCM Instructional Strategy has a grand mean score difference of (21.92-9.72=12.2) 12.2 units higher in comparison with the CS group.

This indicates that the CBCM group led to better test scores on Attainment of Concepts. Hence, the experimental treatment proved to be significantly more effective. Thus it can be concluded that, Computer Based Concept Mapping Instructional Strategy is more effective when compared to that of CS of teaching Science in improving Attainment of Concepts in the students of Standard nine.

2. **Students' Level (Levels L_1, L_2, L_3 – F_B)**

The obtained F-value with respect to Factor F_B is found to be 17.44 and the corresponding table value is 4.96 with df 2 and 66 at 0.01 level. Since the obtained F_B value is greater the tabled F-value, the value is significant and hence the null hypothesis ($H0_2$) is rejected. Thus, the alternative hypothesis H_2 is accepted.

H_2: There is a significant difference in the Above average, Average and Below Average levels of students in improving Attainment of Concepts of Secondary School Students.

From the Table- 2, it is revealed that:

There is sufficient evidence at the 0.01 level that the three levels of students differed. Therefore, there is a statistically significant difference in the test results between Above Average, Average and Below Average group of students.

From the Tables- 2 and 3, it is noticed that:

⇒ There is evidence at the 0.01 level that the Above Average, Average and Below Average group of students differed in their performance on Attainment of Concepts. The F-value indicates a statistically significant difference, but it does not indicate which group is better in its performance. Looking at the grand means it is noticed that the Above Average (L_1) group mean (19.17) is greater than that of the Average (L_2) group mean (15.25) and Below Average (L_3) group mean (13.06). Hence, it is concluded that the Above Average performed significantly better than Average and Average performed significantly better than Below Average students in Attainment of Concepts.

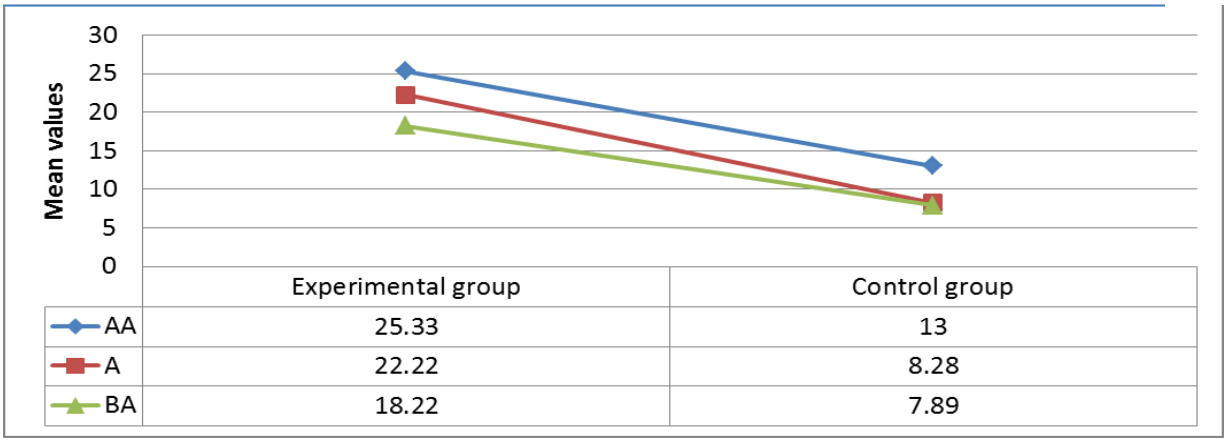
3. Interaction effect: (F_{AB})

⇒ The obtained F-value with respect to Factor F_{AB} is found to be 1.98 and the corresponding table value is 4.96 with df 2 and 66 at 0.01 level. Since the obtained F_A value is less than the tabled F-value, the value is not significant and hence the null hypothesis ($H0_3$) is accepted.

From the Table 2, it is revealed that:

⇒ There is no evidence for interaction between treatments and levels at the 0.01 level that is, an interaction between the type of Instructional Strategies and levels of students.

⇒ The interaction between 'treatments' and 'levels' of students is not significant. In other words, when 'treatments' and 'levels' of students are allowed to interact, they are significantly not effective. The non-significant interaction indicates that the groups changed in the same way in improving Attainment of Concepts for the three levels of students.



	Experimental group	Control group
AA	25.33	13
A	22.22	8.28
BA	18.22	7.89

Major findings

1. Computer Based Concept Mapping Instructional Strategy is more effective when compared to that of CS of teaching Science, in improving Attainment of Concepts of Secondary School students of Standard nine.
2. The performance on Attainment of Concepts of students revealed that;
   - Above Average performed significantly better than Average; and
   - Average performed significantly better than Below Average.
3. The difference between Computer Based Concept Mapping Instructional Strategy and CS of teaching Science is independent of the levels (Above Average, Average and Below Average) of students in improving Attainment of Concepts.

Conclusion and Implications of the study

Education is a process of gaining knowledge. The innovative method like CBCM instructional strategy offers benefits to both students and teachers. Concept maps allow students to think deeply about science by helping them to better understand and organize what they learn, and to store and retrieve information more efficiently. Computer-Based Concept maps are also valuable tools for teachers because they provide information about students' understanding. Teachers can examine how well a student understands science by observing the sophistication of their concept map.

Present study has proved that CBCM Instructional Strategy is more effective when compared to that of CS in improving Attainment of Concepts in science. This study has implications for student centric learning. It has been found to be a systematic strategy to improve classroom instruction across various disciplines and hence its inclusion in the teacher education curriculum will be a major step in making its application possible at the grass root level. The teachers of all levels need sufficient training to use CBCM software's like 'Inspiration' to improve Attainment of Concepts in their students. Efforts in this direction will surely bring in improvement in student performance.

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