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সূচীপত্র

Constructivist Apporach in Teaching Life Science – an Innovative Practice in Classroom at School Level

Ujjwal Paul*

Now-a-days "Constructivist approach" is widely discussed, praised and accepted by educationists in India and abroad. National Curriculum Framework, 2005 (NCF 2005) Published by NCERT also puts emphasis on this approach to learning.

What is Constructivism?

Hein (1991) defined constructivism as the philosophy of how a person learns by constructing knowledge from his or her experience. In the process of constructing knowledge, one passes through a series of events such as questioning himself/herself and discovering answers, as well as evaluating those answers. Constructivism works on the philosophy that there is no knowledge independent of the meaning attributed to experience (constructed) by the learning, or community of learners (Fosnot, 1989). Knowledge construction means that students construct their own knowledge by actively participating in the process of learning and seeking to find their own meaning in their experiences. Literally, it can be said that learners construct, find or develop meaning in their subjective experiments, and this result becomes knowledge for them.

According to constructivist, an individual's subjective experience is just as valid as anyone else's and on one has privileged view point (Allus, 2008).

In this millennium constructivist learning has emerged as a forceful approach to teaching and learning. This approach is based on the work done by John Dewey, Maria Montessori, Jean Piaget, Bruner and Lev Vygotsky. It represents a paradigm shift from teaching-learning based on behaviourism to education based on cognitive theory.

There are several types of constructivism such as:-

a) **Cognitive constructivism:-** It discusses about the cognitive structure of an individual and its developmental process, proposed by Jean Piaget.

b) **Social Constructivism:-** It accepts that there are two parts of knowledge, individual and society. These two cannot be seen independently and influence each other.

c) **Cultural Constructivism:-** According to Vygotsky culture is the prime determinant of individual development. All new learning is based on previous learning which includes various concepts of the concerned subjects such as biological concepts or scientific

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Constructivist Approach in Teaching Life Science – an Innovative Practice in Classroom at School level

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c) Cultural Constructivism: - According to Vygotsky culture is the prime determinant of individual development. All new learning is based on previous learning which includes various concepts of the concerned subjects such as biological concepts or scientific concept. He thought that children construct their own knowledge through 'scaffolding' by the help of MKO (More knowledge others) in their zone of proximal development (ZPD.)

d) Cybernetic constructivism: - Cybernetics of self organization presents another kind of constructivism. This is based on the concept of autopoiesis (self formation) which has formulated by children cell-biologists Humberto Maturana and Francisco Varela (1980, 1987, cited in Ahmed, 2009). An autopoietic system is defined as a network of processes of production (transformation and destruction) of components that

produces the components. Although autopoiesis originally developed to describe biological cells, subsequently it was applied to a variety of disciplines covering physical, cognitive and psychic system.

e) Constructivist learning Design: - The constructivist leaning Design in science and other subject classroom emphasizes the following six important elements –

1. Developing a situation: - the teacher has to develop the situation for students about the process of their learning.
2. Grouping: the teacher has to select a process for grouping of students and learning materials.
3. Bridging: the teacher has to develop a bridge between what the students already know and what the teacher wants them to learn.
4. Questioning: the teacher should anticipate questions to be asked to the students.
5. Exhibiting: the teacher should encourage students to exhibit a record of their thinking by sharing it with others.
6. The teacher has to solicit reflection of students on their learning i.e. "reflecting".

In a word, a constructivist teacher creates activities and assignments that foster the creation of knowledge by different learning situations.

The principal investigator of Biological science curriculum studies (BSCS), Roger Bybee (cited in Ahmed, 2009), developed an instructional model for constructivist, which is called the 'Five Es' and are indicated as follows:

1. **Engage:** The student's first encounter and identity the instructional task.
2. **Explore:** Learning get directly involved with the phenomena and materials.
3. **Explain:** At this stage explanation is multidirectional.
4. **Elaborate:** Students apply their understanding to the world around them, which they had learned in the past.
5. **Evaluate:** This is an ongoing diagnostic process.

So, in a constructivist pedagogy learning should take place in authentic and real-world environments that should involve social negotiation and mediation. Context and skills should be made relevant to the learners and related to the learner's prior knowledge. Students should be assessed formatively, serving to inform future learning experience.

In a constructivist science and other subject classroom, learning should be constructivist, active, Reflective, collaborative, Inquiry based and evolving. Here, student's autonomy and initiative are accepted and encouraged. Teacher asks open-ended questions and allows wait time for responses. Students are engaged in dialogue with the teacher and with each other. The class uses raw date, primary sources, and manipulative, physical and interactive materials.

From an example we can explore what kind of teaching-learning situation may occur in a constructivist science classroom:-

Students study astronomy and science in general by using observation of telescopic plates and a computer simulation of the sky to construct and test interpretations of astronomical phenomena. **(Observation**), then relate these analysis to reference materials (**contextualization)** containing what know about astronomical objects.

The teacher initially talks through how he would analyze and interpret examples of such astronomical data **(cognitive apprenticeship**) then the students form groups to work on

some data **(collaboration),** while the teacher coaches and advises them proceed. Then the students develop their own hypotheses and test them against the astronomical data. **(Interpretation construction**) students analyses the data both within and between the groups, and such argumentation together with background readings exposes them to various ways to interpret the data **(Multiple Interpretation**).

As they proceed through the course, the students see how basic principles of astronomy, physics and chemistry can be used to make sense of different sets of astronomical data. (**Multiple Manifestation)**

Preparation of Learning Design through 5E's Model in Life Science Subject:

(according to Revised Anderson and Krathwohl – Bloom's Taxonomy, 2001)

Topic: The cardiovascular system (the normal structure and functioning of the heart, the circulation of blood in the human body, from the heart to the rest of the body and back to the heart)
Lesson Aim: understanding and learning the structure of the heart and of its mechanisms, as well as the circulation of blood
Type of lesson: acquiring new information through revised Bloom Taxonomy,2001
Types of interaction: teacher-students, student-student.

Name of the School: Class: XII Time: 45 minutes Date: 12-05-2018 Name of the Teacher:	Subject: Biology/Life Science Teaching Unit: **Cardiovascular system** **Sub-units:** 1. Blood & Lymph *2. Human Circulatory System 3. Cardiac Cycle and ECG 4. Double Circulation and Regulation of Cardiac Activity 5. Disorders of Circulatory System Today's Lesson: **Human Circulatory System**

Preparation of Instructional Material through 5E's Model:

Targeted aims	Objectives
A1- Identifying the main components of the human organs and their structure and mechanisms	**O1** – be able to identify the main elements of the circulatory system.
A2- Describing the main characteristics of tissues and systems of organs.	**O2** – be able to describe the structure of the heart using accurate and scientific terminology.
A3- Explaining some physiological processes of the human body using adequate scientific terminology.	**O3** – be able to explain the functioning mechanisms for the heart, as well as the circulation of blood from and towards the heart (the first and second order circulatory systems). **O4** –be able to explain how the electrical impulses generated by the sinoatrial/sinuatrial/sinus node travel down the myocardium and trigger the contraction of the heart.

Didactic materials: atlas of human anatomy, large illustrations of the structure of the heart, models of a section of a human heart, educational software and standard references books.
Methods: explanation, conversation, demonstration

I. Engage:

The students will first encounter and identity the instructional task through passive involvement of teacher. Here they make connections between past and present learning experiences, lay the organizational ground work for the activities ahead and stimulate their involvement in the anticipation of these activities. Asking a question, defining a problem, showing a surprising event and acting out a problematic situation are all ways to engage the students and focus them on the instructional tasks.

Students already have an idea about—

1) They know the different components of blood.
2) They know about the different components of plasma.
3) Different types of formed elements are known to them.
4) They have the basic idea about the types of blood groups, their antigens and antibodies; donor compatibility; and Rh- grouping.
5) They know the step-by-step process of coagulation of blood.
6) They have studied the lymph, its characteristics and function.

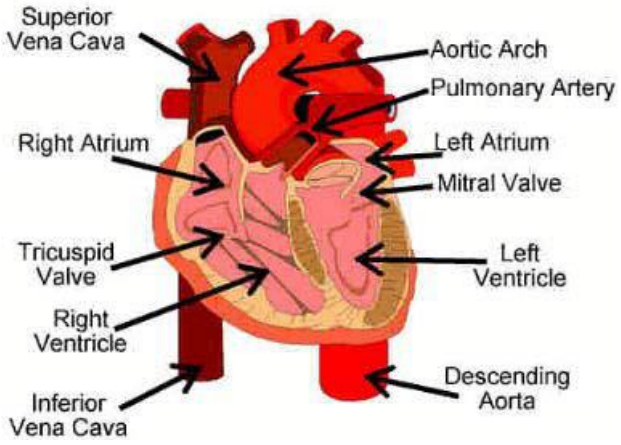


Fig.: Human Heart

II. **Explore:**

In the Exploration stage the students have the opportunity to get directly involved with phenomena and materials. Involving themselves in these activities they develop a grounding of experience with the phenomenon. As they work together in teams, students build a base of common experience which assists them in the process of sharing and communicating. The teacher acts as a facilitator, providing materials and guiding the students' focus. The students' inquiry process drives the instruction during an exploration and they will able to:

1) Define open and closed circulatory systems, pericardial membrane.
2) Name the different parts of heart, different blood vessels and valves.
3) State the location of heart in human body, location of different valves and blood vessels, Sino –atrial node (SAN), Atrio-ventricular node (AVN), Purkinje fibers, Bundle of His.
4) Describe the overall structure of the chambers of heart and valves.

III. Explain:

The third stage, Explain, is the point at which the learner begins to put the abstract experience through which she/he has gone /into a communicable form. Language provides motivation for sequencing events into a logical format. Communication occurs between peers, the facilitator, or within the learner himself. Working in groups, learners support each other's understanding as they articulate their observations, ideas, questions and hypotheses. Language provides a tool of communicable labels. These labels, applied to elements of abstract exploration, give the learner a means of sharing these explorations. Explanations from the facilitator can provide names that correspond to historical and standard language, for student findings and events. For example a child, through her exploration, may state they have noticed that a magnet has a tendency to "stick" to a certain metallic object. The facilitator, in her discussion with the child, might at this stage introduce terminology referring to "an attracting force". Introducing labels, after the child has had a direct experience, is far

more meaningful than before that experience. The experiential base she has built offers the student an attachment place for the label. Common language enhances the sharing and communication between facilitator and students. The facilitator can determine levels of understanding and possible misconceptions. Created works such as writing, drawing, video, or tape recordings are communications that provide recorded evidence of the learner's development, progress and growth. Students through explain will able to understand and explain:

1) Summarize the function of SAN and AVN.
2) Predict why of inter-atrial septum is thinner than inter-ventricular septum.
3) Compare the musculature of inter-atrial septum and inter-ventricular septum.
4) Explain the rhythmic contractile activity of heart.

IV. Elaborate:

In stage four, Elaborate, the students expand on the concepts they have learned, make connections to other related concepts, and apply their understandings to the world around them. For example, applications to real world events, such as where to plant flowers so that they receive sunlight most of the day, or how to prop up a beach umbrella for shade from the Sun, are both extensions and applications of the concept that light travels in a straight path. These connections often lead to further inquiry and new understandings.

In recent learning design it may elaborate as:

1). Prepare a blood smear in a slide, Stain it and watch it under the microscope.
2). Identify the different types of blood cells.
3). Measure the blood pressure of a person.
4). Distinguish between-
- Tricuspid valve and bicuspid valve
- SAN and AVN
- Pulmonary artery and pulmonary vein

V. Evaluate:

Evaluate, the fifth "E", is an on-going diagnostic process that allows the teacher to determine if the learner has attained understanding of concepts and knowledge. Evaluation and assessment can occur at all points along the continuum of the instructional process. Some of the tools that assist in this diagnostic process are: rubrics (quantified and prioritized outcome expectations) determined hand-in-hand with the lesson design, teacher observation structured by checklists, student interviews, portfolios designed with specific purposes, project and problem-based learning products, and embedded assessments. For example, if a teacher perceives clear evidence of misconception, then he/she can revisit the concept to enhance clearer understanding. If the students show profound interest in a branching direction of inquiry, the teacher can consider refocusing the investigation to take advantage of this high level of interest. It may be done as:

1). Justify the name pacemaker and pace-setter for SAN and AVN, respectively.

2). Justify why arterial lumen is narrower venous lumen.

3). Determine the function the function of the valves.

4). Prepare a chart/model depicting the structure of human heart. Label it neatly.

Evaluation – Diagnostic Test (multidirectional)

Teacher will prepare a Diagnostic Test to test the knowledge gained by the students.

If they fail to answer the following questions, then remedial teaching will be arranged to re-teach the sub-unit.

1. What is the covering of heart called?
2. Where is bicuspid and tricuspid valve located?
3. Which blood vessel carries blood to right atrium?
4. Why the SA node is known as the pacemaker? Where is it located?
5. Why is inter-atrial septum thinner than inter-ventricular septum?
6. Draw a neatly labeled diagram of heart, showing the chambers and different blood vessels connected to the heart.

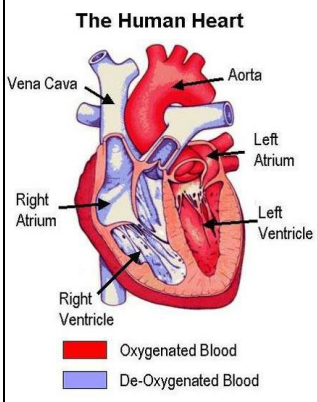
No.	Aim	Targeted aims	Teacher activity	Students' activity
1	Anticipatory set - Identifying the students' prior knowledge	A1	The teacher asks questions about some of the previous lessons (The Digestion and The Respiration); the teacher helps students make the connection with the new lesson, and also presents its title and objectives.	The students answer the questions and discuss with each other.
2	Direct instruction - Presenting the main components of the lesson	A1 A2 A3	The teacher presents the structure of the circulatory system; using the illustrations and the computer generated models, the students discover the structure of the heart, the types of blood vessels (arteries, capillaries, veins) and the connections formed between these elements. The images illustrating the positioning of the sinoatrial node and the functioning of the heart due to contractions generated by the SA node are analyzed. Finally, the	The students write down the newly acquired information and analyze the images.

			teacher draws attention to the heart as a unitary mechanism and to the way blood circulates in the body.	
3	Consolidating knowledge	A2 A3	The teacher asks questions based on the lesson just taught	Students answer the questions.
4	Guided practice		The teacher asks students to turn in their solved hand-outs.	The students solve the given exercises from the hand-outs.
5	Assessment		The teacher asks the students to design a schematic representation of the connection between the 3 systems which make nutrition possible.	The students check their solutions/answers and correct any mistakes.

Analysis of Learners activity and outcomes:

Unit	**Sub-Unit**	**Sub-Segment**	**Clarification**
Body Fluids and Circulation	Human Circulatory System	1. Covering and Chambers of Heart	Pericardial membrane, Pericardial fluid, 4 chambers of heart: upper left and right Atria, lower left and right Ventricles.
		2. Valves and Vessels of Heart	3 types of valves found in heart. Semilunar valve, in between Right Ventricle and Pulmonary artery; Left Ventricle and Aorta. Bicuspid valve between left atrium and ventricle, and tricuspid valve between right atrium and ventricle. Superior and Inferior Vena cava, Pulmonary vein, Pulmonary artery, Aorta.
		3. Types of nodes of heart and their functions	Sino-atrial node (SAN) - Pacemaker. Atrial-ventricular node (AVN) - Pace-setter
		4. Rhythmic contractile activity of heart	Action potentials involving Purkinje fibers and Bundle of His

Teaching Strategies for active learning through Constructivist approach:

Unit	Sub-Unit	Sub-Segment	Teaching strategies	Teacher talk	Student talk
Body Fluids and Circulation	Human Circulatory System	1. Covering and Chambers of Heart	**Lecture cum demonstration method**; 3D model of the heart to be used and four chambers to be pointed out. The four chambers of heart are to be taught using the model and charts. The location of the chambers to be pointed out. Importance of pericardial membrane to be taught. Structure of and functions of ventricles to be taught. Structure of heart drawn, Important keywords written Blackboard  	Q1: Where do you think is the heart located in the body? Q2: Which side of the chest? Q3: Like pleural membrane in lungs (previous knowledge), do you think heart is covered by a similar membrane? Q4: Why do you think inter ventricular septa is thicker than inter atrial septa.	A1: Chest, or if answered wrong, correct them A2: If cannot answer, they are told. A3: Yes. A4: Students answer that walls of ventricles are thicker since they have more volume of blood to pump throughout the whole body.

		2. Valves and Vessels of Heart	**Interactive cum demonstration method;** Diagrams to be drawn on BB to explain the features and location of the 3 types of valves. Chart to be used to point out different blood vessels attached to the heart. Functions and locations of each of the blood vessel to be explained.	Q1: How does the heart gets filled with blood?	A1: from the chart, they are able to point to the various blood vessels.
		3. Types of nodes of heart and their functions	**Lecture method.** Location and names of two nodes to be explained.		
		4. Rhythmic contractile activity of heart	**Lecture method.** Action potential of 70-75/min to maintain beating of the heart. Flow of action potential from Purkinje fibers to bundle of His and throughout the cardiac muscle.		

Developing and selecting Learning materials:

- Books used: NCERT Class XI & XI Biology book, Modern Biology Textbook.
- Chalk, Duster, Ruler/Pointer.
- Charts and 3D models depicting the structured of 4-chambered human heart.
- Laptop for showing them video clips of how blood circulation takes place in the heart.
- Simulation practical experienced material which enhance virtual practical experience.

Benefits of constructivist approach in Science classroom:

"Imagination is more important than knowledge, knowledge is limited. Imagination encircles the world." – Albert Einstein.

In a democratic environment the learners are activity involved and from this their imagination power increased. Education works best when it concentrates on thinking and understanding, rather than rote memorization. Constructivism concentrates on learning how to think and understand. This learning is transferable. This situation gives students ownership (stake holder) what they learn, since learning is based on students' questions and explorations. Students in constructivist classrooms learn to question things and to apply their natural curiosity to the world. Constructivist promotes social and communication skills by creating a classroom environment that emphasizes collaboration and exchange of ideas.

Each topic cannot be taught through constructivist approach. But if resources are available or teacher can procure on their own with ease, then constructivist approach must be used as it develops high level of understanding. In a country like India where classrooms are overcrowded by students, it is generally considered that constructivist teaching approach is so difficult to implicate in classroom. Because, constructivist pedagogy takes more time as compared to other such traditions teaching method. But in the 20^{th} century, revolutionary changes were brought about in the concept and theories of science and other subjects conventional or traditional methods are not sufficient to acquire this knowledge for the school's students. So, constructivist approach may be difficult to implicate in classroom but, it achievable.

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