Constructivist Classroom Activities for Biology Learning

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Abstract

There are many learning theories which we study under Educational Psychology. Constructivism is one of them which focus on developing the learners'knowledge by constructing the world around them through experience, observation, documentation, analysis and reflection. In the classrooms of today, learners are no longer passive recipients nor are the teachers 'givers of information, knowledge and wisdom'. According to constructivist perspective, the teaching or rather more precisely learning of biology is not the search for the ultimate truth. It is the process which is of utmost importance in biology than the content. So when the learning of biology involves active construction of knowledge by children, then the classroom environment must call for more synergies rather than mere individual participation. The teachers need to develop the ability to work with children creatively to generate new ideas, new theories, new products and new knowledge. The engagement of the learner in the construction of classroom activity requires inputs from a reflective teacher and meticulous pre-planning before a unit is transacted in the class. Strategies of peer learning through group work and whole class work are important, again depending on task and the teaching objective. Learner autonomy and respect for individual learner is mandatory if real learning is to take place. Encouraging learners to reflect and question their own understanding further aids comprehension. This paper discusses some classroom activities which encourage thinking, understanding, exploration, problem solving, collaboration, analysis, observation and prediction for Biology learning.

Let us compare the biology teaching of two student teachers teaching in a secondary school.

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CLASSROOM – A

Padmaja was teaching 'Ecosystem' in her biology classroom (Classroom A). She considered science to be a body of knowledge to be learned. Her job was to "give out" what she (and the textbook) knew about science to her students. Thus, the learning environment Padamaja tried to maintain in her classroom facilitated this transfer of knowledge; the desks were neatly in rows facing the teacher and the blackboard. Lecture notes and assignments from the text were given to students. Padamaja tried to keep students quiet and working all during the class period to ensure that all students could "absorb" the science knowledge efficiently. Another consequence of Padamaja's notion of teaching and learning was her belief that she had to cover so much that she had no time for laboratory activities.

Let's look at an example that typifies Padamaja's teaching style. Padamaja's students were to complete a worksheet that "covered" the concept of ecosystem. In this worksheet students were given certain exercises on food-chains like to fill the names of organisms at certain trophic levels. Some questions like what will happen if grass is missing in the grass—deer—lion food chain were also included in the worksheet. After the students completed the worksheet, Padamaja went over the answers so the students could have the correct answers for the test later in the week. From a constructivist perspective, what opportunities did Padamaja's students have to relate the concept of ecosystem to their own experiences? Were these opportunities in Padamaja's lesson plan were provided to negotiate meanings and build a consensus of understanding? Padamaja spent one class period covering the concept of ecosystem; is that sufficient time for students to learn a concept with understanding?

CLASSROOM -B

Alka is another student teacher whose class (Classroom B), in contrast, was inspired by constructivism. This student teacher was given four topics by her school biology teacher:

(1) organisation of the living world,
(2) Nutrition,
(3) Respiration and
(4) Blood Circulation

Her classes were always student-centered and activity-based. At secondary level, she introduced students to above mentioned biology topics with short lectures, textbook readings, and confirmatory laboratories. After the introduction she would ask students what interested them about the topic and encouraged them to pursue and test these ideas. Students usually divided themselves into groups and then, conducted a library research, formulated questions/problems, and procedures to test the questions/problems. In other words, the students were acting as scientists in the classroom. In one class she was teaching students about ecosystem. Included in Alka's lessons were activities to "get the students involved". Students were shown the 'Aquarium' in the biology laboratory. They discussed:

- different food-chains in this man-made ecosystem
- how different living organisms depend on each other in an ecosystem
- use of dissolved oxygen in water by aquatic plants and animals
- what happens if any particular trophic level is missing in the food-chain?

Students were also involved in role-play activity where they played the roles of different plants and animals in different food-chains. They used certain

	CLASSROOM – A	*CLASSROOM – B*
Materials	Primarily textbook.	Includes Primary sources and other resources.
Learning	Based on repetition, explanation by the teacher.	Interactive and build on what the student already knows.
Knowledge	Seen as inert, to be passed on from teacher to taught.	Seen as dynamic, ever changing, to be constituted by the learner.
Teacher's Role	Giver of information, rooted in authority.	Creative collaborator, facilitator, mentor, guide who moderates, suggests, coaches.
Student's Role	Passive recipients of knowledge.	Interactive, construct their own knowledge based on previous experiences, ask questions, explore, experiment, reflect, discuss.
Transaction Strategies	Teaching facing class.	Group work and pair work, using peers as Resources.
Approach	Lecture method, teacher asking questions as well as answering them,	Construction of meaning by learner by formulating their own questions-inquiry allowing multiple interpretations and expressions of learning – multiple intelligence encouraging collaborating learning
Learning Process	Teacher led class, Students are not used as a resource for learning.	Students' full participation in learning activities such as projects and hands-on experiments. Collaboration among students, peer teaching helps them to review and reflect on their learning processes and pick up strategies and methods from one another.

props and few dialogues in the role-play activity. Few cases were also discussed where when the rain forest was cut then many of the animals became extinct due to destruction of their habitat. Then a few animal sanctuaries were discussed to highlight the importance of habitat for wild animals. Alka spent two weeks teaching this topic on *ecosystem*. Were Alka's students given opportunities to make sense of the concept of ecosystem? Were they able to use personal experiences? Whose students do you think had a deeper understanding of ecosystem?

A close understanding of the two classrooms has revealed the following points of difference between them.

As a teacher educator in Army Institute of Education, I got the privilege of supervising the biology classes of a number of students. Here I have mentioned the biology classroom teaching of only two students – Padamaja and Alka Basu.

For many years the conventional wisdom of teachers has been similar to Padamaja's teaching style: to control student behaviour so that the class is quiet. Most of the time there was an oral-expositive teacher participation Teachers in many cases is not aware of the practices or strategies to help students in *constructing knowledge*. Alka Basu believed in child-centered methods. Alka Basu in her classes never forced students to stay quiet but rather she managed the classroom in such a way that they must get ample opportunities to talk with one another and utilise collaborative learning strategies. Alka Basu encouraged students to visit school library for referring books and other self-learning materials. She encouraged students to create a small library corner in the classroom. A list of selected websites related to each topic was also given to the students before hand to provide them an idea about the content. Certain advanced organisers were also given to the students to set the pace for teaching. Students were encouraged to reflect and question their own understanding. The central point of Alka Basu's teaching was to elaborate original concepts, in an enjoyable and enthusiastic way.

What is Constructivism?

Constructivism is a learning theory based on scientific observation and research and explains how people learn. They construct their own knowledge of the world around them through reflection on their experiences. When we are faced with new knowledge, we tend to relate it to our previous experiences and either modify our ideas or discard the new information. In the process we tend to create new knowledge by asking questions, explaining and assessing what we already known.

Constructivism as applied to education is a more recent development derived from the work of development psychologist *Jean Piaget (1973)* and Russian psychologist *Lav Vigotsk y (1978).* Its underlying principles are also influenced by the developmentalist ideas of the French philosphaer *Jacques Rousseau* and later the theories of *John Dewey, G Stanley Hall* and *Arnold Gessell*.

Recent Curriculum Reform in India and Constructivism

School Education in India has been witnessing its own another reform in education with the formulation of the National Curriculum Framwork 2005 by the NCERT. In this document the constructivist approach and its implications for practice have been brought out in great detail. Some of the key principles given in this document are summarised below:

- In the constructivist perspective, learning is a process of construction of knowledge
- Learners actively construct their own knowledge by connecting new ideas to existing ideas on the basis of materials/ activities presented to them (experience).
- The structuring and restructuring of ideas are essential features as the learners'progress in learning.
- The engagement of learners, through relevant activities, can further facilitate in the construction of mental images of the relationships (cause-effect)
- Collaborative learning provides room for negotiation of meaning, sharing multiple views and changing the internal representative of external reality.

Constructivism in Biology Education

From a constructivist perspective, biology is not the search for truth. It is a process that assists us to make sense of our world. Using a constructivist perspective, teaching biology becomes more like the biology that biologists do; it is an active, social process of making sense of experiences, as opposed to what we now call "school biology." Indeed, actively engaging students in science (we have all heard the call for "hands-on, minds-on science") is the *goal of most science education reform*. Also science knowledge as accepted today in scientific communities in principle is tentative in nature and open for revision.

There is a shift in the goals of science teaching from students simply creating a knowledge base of scientific facts to students developing deeper understandings of major concepts within scientific discipline. For example, what is the use of detailed working knowledge of the chemical reactions of the Krebs cycle without a deeper understanding of the relationship between these chemical reactions of cellular respiration and an organism's need to harvest energy from food?

Implications of use of Constructivism in Biology Teaching are

- Tools available to a knower are the *senses*. It is only through seeing, hearing, touching, smelling and tasting that an individual interacts with the environment. With these messages from the senses the individual builds a picture of the world.

Students should be given ample opportunities for visiting bio-diversity parks, bird sanctuaries, lakes, agricultural fields, grasslands as well as ridge areas. They should be taken for nature walks.

- Experience involves an interaction of an individual with events,

objects, or phenomenon in the universe; an interaction of the senses with things, a personal construction which fits some of the external reality but does not provide a match. Students' prior science conceptions are sometimes in stark contrast to the science conceptions to be learned.

For example, when students see water droplets on the glass of water, they think that it must be coming out from inside the glass. They need to formulate a problem, hypothesise, experiment, observe and then must be able to conclude on their own Teacher's role is very important here.

- A cooperative learning strategy allows individuals to test the fitness of their experiential world with a community of others. Others help to constrain our thinking. The interactions with others cause perturbations, and by resolving the perturbations individuals make adaptations to fit their new experiential world.

Group work given in the class provides opportunities to read, express or ask to listen and to interact. Projects and activities that can be carried out by groups need to become a feature of learning in the schools.

- The process of learning should not stop at what has been learned in the negotiation of a class consensus. This process can involve accessing other learning resources such as books, videotapes, and practicing scientists.

Constructivist Classroom activities in Biology Learning

Knowledge is constructed by the learner, not received. How does knowledge construction (i.e. learning) take place? Learners come to biology learning with existing ideas about many natural phenomena? What ideas do learners'bring to biology classes?, and what is the nature of these ideas? Each individual has a unique set of ideas. How much commonality is there between learner's ideas in biology? The learners'existing ideas have consequences for the learning of biology. How do learners'ideas interact with teaching? It is possible to teach biology more effectively if account is taken of the learner's existing ideas. How should [constructivist'] teachers teach biology? There are a number of ways by which teachers can come to know about the previous knowledge of students. Some exercises are mentioned in this section:

1. ***Concept maps***—In the study of Biology, the ability to build interrelationships among concepts and related topics, and to relate newly acquired knowledge to prior knowledge, is crucial to the understanding of biological concepts and how the systems work together to bring about a coordinated response. Concept maps, diagrams and other graphic organisers are useful tools to illustrate the links between concepts and topics. Once a teacher has explained ecosystem, ask students to connect the following

terms*: ecosystem, biotic components, abiotic components, soil, water, air, decomposed organic matter, C02, N2, O2, water, climatic conditions, temperature, producers, consumers, decomposer, food-chain, energy flow, recycling of nutrients and biogeochemical cycles.* Every term should be connected with arrows labelled with a word that describes the link between the processes – example: change, causes, provides, directs, etc.

When students are able to discover the links between concepts themselves, they move away from rote or surface learning, and replace it with deep and meaningful learning, thus increasing the level of understanding and an appreciation for the subject. This encourages cooperative learning also.

2. ***Use of newspaper articles in making T-charts—***A teacher can tell his/ her students to bring newspaper articles about science. List the topics of the articles on the board as the students give a 30 second summary of their article. From this list choose 5-6 topics which are relevant for them. Make 5-6 groups of students and allocate one topic to each group.ton. Give each group instructions to make a T-chart on a large piece of chart paper. Tell them that a T-chart is a large T drawn on the paper…with the topic written at the top of the T. On one side of the T bar students will write what have you heard about the topic? On the other side they will write what questions do you have about the topic?

Now, they can discuss these T-charts either in the construction of the concept maps or can understand their previous knowledge to initiate discussions in the class.

3. ***Scenarios***—Students are discussing homeostasis in living organisms. The students are now part of a multi-disciplinary team put together to design the perfect animal that can survive and reproduce successfully under the following conditions: an environment that is very hot and dry during the day, but turns cold and windy at night, and that has many fast and aggressive predators. In their design of this animal, they should consider integument, body support, reproductive strategy, excretion and mode of locomotion.

In this exercise students need to think, work in a group, discuss and apply already covered/taught topics like adaptations, thermoregulation, morphological features, life-processes, defense mechanism etc. This requires structuring and restructuring of concepts which is possible only with good understanding of concepts. Learning benefits from multiple views of a subject area.

4. ***Graphs***—After studying human growth, teacher can ask students to draw a graph of average growth after birth showing the relationship between heights (in cm.) and age (years). Once they have made this graph then she can tell them to plot a graph of male and female comparative growth rates showing

the relationship between change in height (cm/year) and age (years).

This graphical representation helps in better understanding and interpretation.

5. ***Brainstorming***—While reviewing thermoregulation, teacher can ask students to come up with five ways in which snakes can prevent overheating on a hot summer day.

6. ***Observations/Predictions***—When teacher is about to explain the hormonal control of female reproductive system, she can show an illustration of hormonal control of female reproductive system and ask students to make a list of six observations. When teacher discusses the positive and negative feedback systems controlling the production of estrogen and progesterone by the ovary with the students, they have already spent time studying the names of different glands involved and hormones produced by them and will be more receptive to learn more about the role of hormones in ovulation and menstruation. Then, teacher can ask students to predict what would happen to the endometrium if progesterone level does not fall during the last days of the menstrual cycle?

This exercise helps in developing thinking skills, structuring and restructuring of conceptual knowledge.

This exercise will help students in observation, comprehension, analysis, interpretation and prediction.

7. ***Problems***—This problem is designed to help students understand the functioning of the circulatory system in the human body. Suppose somebody is staying on the second floor of the building and due to low pressure of the water, the water reaching second floor's taps is not sufficient. Then he is advised to install water pump at his house. Predict:

- What will happen?
- What if there is any blockage in the water pipes supplying water to his house taps?
- What will happen if he now shifts to the ground floor flat?

This activity provides an analogy to understand circulatory system in human beings. This helps in better understanding of the organ system (circulatory system) as well as its functioning.

8. ***Use of Cartoons***—Use of cartoons in classroom teaching can make learning joyful. One page cartoons can be shown to the students like a cartoon showing a small boy holding his stomach with both hands and his face is looking very painful. On one side of the boy is shown the inner view of his stomach. Inside the stomach a lot of bacteria are jumping and releasing a lot of gas. Now, teacher can ask questions like:

- what is happening in the stomach of this boy?
- name that part of the digestive system in which these bacteria are present.

- name the foods which are likely to produce more gas
- how can we avoid flatulence/ stomach discomfort?

This exercise helps in making learning an enjoyable experience. The engagement of learners, through relevant activities, can further facilitate in the construction of mental images of the relationships (cause-effect).

9. ***Songs for Teaching Biology***— There are many songs which can be used for promoting learning in a joyful manner.

Conclusion

Constructivists claim that they have no access to an objective truth and that all knowledge is subjective and dependent on the learner. From a constructivist perspective, science is not the search for truth. It is a process that assists us to make sense of our world. Using a constructivist perspective, teaching biology becomes more like the biology that biologists do -it is an a*ctive, social process of making sense of experiences*. It is an enjoyable activity and the role of the teacher is very challenging.

Learning in classrooms is facilitated by well designed activities. These activities offer the opportunity to examine the problem from a variety of perspectives and also to collaborate. Listening to the multiple views on the subject makes the understanding better. Through different classroom activities, students get an opportunity to reflect and build on and consolidate existing knowledge. Students get an opportunity to construct knowledge.

We need more teachers like Alka who can engage students in activities. Engaging students in activities brings tremendous richness to the classroom processes. Certainly, doing activities requires that time be spent in planning and preparing for activities. Initially, teachers need to make an effort to establish the classroom culture for activities and to establish the rules that will govern the space and use of materials.

Just as teachers have to learn how to teach from a constructivist point of view, so too must students learn how to learn. Educating students to be effective learners is an important priority in establishing environments conducive to effective learning of biology.

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