APPLYING CONSTRUCTIVIST APPROACH IN SCIENCE TEACHING

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ABSTRACT *Constructivism is basically a theory -- based on observation and scientific study -- about how people learn It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. Constructivism is currently the predominant perspective within which human learning is described and explained. It emphasizes on learners being active players in the process of learning and modifies the role of teacher from knowledge transmitter to that of facilitator. It is quite unfortunate that even today learning in classrooms is rote memorized and exam oriented. Students are not interested to learn as learning is not meaningful to them. The prime reason for such a situation is the that most of the teachers continue to teach through traditional methods and do not involve students in the process of learning thus making the process of learning uninteresting for the students. Teachers cite several factors for not being able to teach using constructivist approach.The reasons will always be there. What we have to see as teachers is that how we can make the best use of our time, resources and talents to promote active learning in classrooms and make our learners self directed learners.*

Keywords: *Constructivism, facilitator*

INTRODUCTION

Constructivism is basically a theory -- based on observation and scientific study -- about how people learn. It says that **people construct their own understanding and knowledge** of the world, through experiencing things and reflecting on those experiences.When we encounter something new, we have to reconcile it with our previous ideas and experience, may be changing what we believe, or maybe discarding the new information as irrelevant. In any case, we are active creators of our own knowledge.

In the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing.

The teacher makes sure she understands the students' preexisting conceptions, and guides the activity to address them and then build on them.Constructivist teachers encourage students to constantly assess how the activity is helping them gain understanding. By questioning themselves and their strategies, students in the constructivist classroom ideally become "expert learners."This gives them ever-broadening tools to keep learning. With a well-planned classroom environment, the students learn **HOW TO LEARN**

Contrary to criticisms by some (conservative/traditional) educators, **constructivism does not dismiss the active role of the teacher** or the value of expert knowledge.Constructivism modifies that role, so that teachers help students to construct knowledge rather than to reproduce a series of facts. The constructivist teacher provides tools such as problem-solving and inquiry-based learning activities with which students formulate and test their ideas, draw conclusions and inferences, and pool and convey their knowledge in a collaborative learning environment.Constructivism transforms the student from a passive recipient of information to an **active participant in the learning process.**Always guided by the teacher, students **construct** their knowledge actively rather than just mechanically ingesting knowledge from the teacher or the textbook.

Constructivism is also often misconstrued as a learning theory that compels students to "reinvent the wheel". In fact, constructivism taps into and triggers the student's innate curiosity about the world and how things work. Students do not reinvent the wheel but, rather, attempt to understand how it turns, how it functions. They become engaged by applying their existing knowledge and real-world experience, learning to hypothesize, testing their theories, and ultimately drawing conclusions from their findings. The classroom is no longer a place where the teacher pours knowledge into passive students, who wait like empty vessels to be filled. In the constructivist model, the students are urged to be actively involved in their own process of learning. The teacher functions more as a facilitator who coaches, mediates, prompts, and helps students develop and assess their understanding, and thereby their learning.

In the constructivist classroom, both teacher and students think of knowledge not as inert factoids to be memorized, but as a dynamic, ever-changing view of the world we live in.The constructivist classroom relies heavily on collaboration among students. There are many reasons why collaboration contributes to learning. The main reason it is used so much in constructivism is that students learn about learning not only from themselves, but also from their peers. When students review and reflect on their learning processes together, they can pick up strategies and methods from one another and explore that view.

What are the benefits of constructivism?

1. Children learn more, and enjoy learning more when they are actively involved, rather than passive listeners.
2. Education works best when it concentrates on thinking and understanding, rather than on rote memorization. Constructivism concentrates on learning how to think and understand.
3. Constructivist learning is transferable. In constructivist classrooms, students create organizing principles that they can take with them to other learning situations.
4. Constructivism gives students ownership of what they learn, since learning is based on students' questions and explorations, and often the students have a hand in designing the assessments as well.
5. Constructivist assessment engages the students' initiatives and personal investments in their journals, research reports, physical models, and artistic representations.
6. Engaging the creative instincts develops students' abilities to express knowledge through a variety of ways.
7. The students are also more likely to retain and transfer the new knowledge to real life.
8. By grounding learning activities in an authentic, real-world context, constructivism stimulates and engages students.
9. Students in constructivist classrooms learn to question things and to apply their natural curiosity to the world.

THE FIVE CENTRAL TENETS OF CONSTRUCTIVISM

1. First, constructivist teachers seek and value students' points of view. Knowing what students think about concepts helps teachers formulate classroom lessons and differentiate instruction on the basis of students' needs and interests.
2. Second, constructivist teacher structure lessons to challenge students' suppositions. All students, whether they are 6 or 16 or 60, come to the classroom with life experiences that shape their views about how their worlds work. When educators permit students to construct knowledge that challenges their current suppositions, learning occurs. Only through asking students what they think they know and why they think they know it are we and they able to confront their suppositions.
3. Third, constructivist teachers recognize that students must attach relevance to the curriculum. As students see relevance in their daily activities, their interest in learning grows.
4. Fourth, constructivist teacher's structure lessons around big ideas, not small bits of information. Exposing students to Wholes first helps them determine the relevant parts as they refine their understandings of the wholes.
5. Finally, constructivist teachers assess student learning in the context of daily classroom investigations, not as separate events. Students demonstrate their knowledge every day in a variety of ways. Defining understanding as only that which is capable of being measured by paper-and-pencil assessments administered under strict security perpetuates false and counterproductive myths about academia, intelligence, creativity, accountability, and knowledge.

The 5 E's - An Instructional Model Based On The Constructivist Approach To Learning

Each of the 5 E's describes a phase of learning, and each phase begins with the letter "E": Engage, Explore, Explain, Elaborate, and Evaluate. The 5 E's allows students and teachers to experience common activities, to use and build on prior knowledge and experience, to construct meaning, and to continually assess their understanding of a concept.

1. Engage

This phase of the 5 E's starts the process. An "engage" activity should do the following:

- Make connections between past and present learning experiences.
- Anticipate activities and focus students' thinking on the learning outcomes of current activities.
- Students should become mentally engaged in the concept, process, or skill to be learned.

2. Explore

This phase of the 5 E's provides students with a common base of experiences.

- They identify and develop concepts, processes, and skills.
- During this phase, students actively explore their environment or manipulate materials.

3. Explain

This phase of the 5 E's helps students explain the concepts they have been exploring.

- They have opportunities to verbalize their conceptual understanding or to demonstrate new skills or behaviors.
- This phase also provides opportunities for teachers to introduce formal terms, definitions, and explanations for concepts, processes, skills, or behaviors.

4. Elaborate

This phase of the 5 E's extends students' conceptual understanding and allows them to practice skills and behaviors. Through new experiences, the learners develop deeper and broader understanding of major concepts, obtain more information about areas of interest, and refine their skills.

5. Evaluate

This phase of the 5 E's encourages learners to assess their understanding and abilities and lets teachers evaluate students' understanding of key concepts and skill development .

CONSTRUCTIVISM IN SCIENCE

Humans are curious by nature. This curiosity has driven them since time immemorial to explore the world around them. Over time,manipulation and controlling nature for the benefit of humans has become an objective of exploration. Science is all about exploration and children are very curious by nature. A science teacher can exploit this curiosity of learners in teaching - learning of sciences.

However, often, the investigations are carried out in a routine fashion to let the children score in examination. If conducted properly,these activities not only raise the motivation but also develop interestand curiosity to learn and try things in different ways. In their strive to answer, 'what if,' children get actively involved in different processes such as observation, discussion, collecting information, manipulation,comparing, classification, improvisation, experimentation, criticalthinking, logical reasoning, etc., thus enabling them to go through theprocesses of not only 'hands-on' but 'minds-on' as well. For example,children could be facilitated to observe natural phenomenon such as condensation, evaporation, rusting, seed germination, reflection,refraction, interference of light, electromagnetic induction, etc. Based on the observations and questions raised in the minds of children and asked by the teacher, problems could be identified and defined and hypothesis could be made. To test the hypothesis(es), experiments should be performed to validate or discard their hypothesis.

Curiosity gets aroused as a result of doubt, perplexity, contradiction, cognitive conflict, ambiguity, lack of clarity, etc. A teacher needs to create suitable learning situations for this. Science teacher must takeadvantage of natural curiosity of children by engaging them in the exploration of the ideas of the concept being transacted through scientific processes and inquiry.

WAYS OF PRACTICING CONSTRUCTIVISM IN SCIENCE

There are numerous ways in which constructivist approach can be practiced in classrooms. Discussed below are few examples.

Example 1: The teacher may probe students with simple questions such as whether water boils faster in closed container or open container. The student should be motivated to perform an activity to solve the query.

Sensing and identifying the problem: Water boils in the container faster,when the lid is placed over it than when it is not placed.

Defining the problem: Does it have a higher temperature with the lid-onthan the lid-off ?

Hypothesis: I(child) think that water will boil at higher temperature with thelid-on as the lid prevents heat loss.

Testing hypothesis: Two sets of each of the following materials wererequired for testing the hypothesis— beaker, tripod, thermometer, wiregauze and Bunsen burner. A square/circular piece of cardboard was alsotaken to make the lid for the beaker. I used two beakers that were of samesize and material. Then I put same amount of water in each beaker. The lidwas placed on one beaker. When water started boiling I noted its temperature.The lid was kept off the other beaker. Temperature of water taken in the secondbeaker was noted down when it started boiling.

Collecting data :I did the investigation as described above. I pierced ahole in the cardboard lid to insert thermometer to take the temperature. Ilet the water boil for one minute before taking the observations.

Recording data
Temperature
With lid 99.5 oC
Without lid 99 oC

Interpreting data: The two readings were almost same.

Drawing conclusion: I think that there is no difference in the temperatureof boiling water with or without lid-on the beaker.

Making generalisation: I think fast boiling of a liquid does not mean hightemperature of the liquid, that is why its boiling point does not change.

Further questions : Why do we cook food in closed vessels, rather thanin the open ones? I read on the LPG slip that cooking with the lid on savesfuel. How does it save fuel? How the food gets cooked faster in the pressurecooker?
The problem may either be posed by the student or the teacher. It mayalso arise as an idea during discussion. The teacher need not providethe whole plan to carry out the investigation, but should involve childrento evolve the plan through discussion. She may help children to workin groups to carry out the investigation. Some children might be tryingto heat water in beakers of different sizes/materials. Some might useunequal amount of water in the beakers. There could be variations intaking the temperatures, readings of the thermometer, etc. Throughquestioning, discussion and sharing the work mutually and with thewhole class, the children may be trained in this approach over a period.This can help them develop the skills of scientific process and inquiry.
Example 2:A discussion on natural satellites was going on in Class XI when a student asked, "what would happen if there is no moon in the sky?" Rohit, the teacher directed this thought provoking question to the whole class. Students came up with a number of answers— some relevant, some irrelevant. Rohit listened, called a student to write all answers on the blackboard without labelling them as right or wrong. Some of the responses were, *"our earthwould spin faster;" "days and night would be shorter;" "we would get lesstime at school/to watch TV/to sleep;" "there will be complete darkness inthe night;" "whom with the poets would compare the beauty;" "wind wouldblow faster;" "life would not have existed on the earth;" "centre of mass ofthe earth would have been different;" and "the axis of rotation of the earthwould be different."* Later Rohit discussed with them the probable answers and asked students to collect more information related to the question and justify their answers through the group project work in the class.
Creativity is doing or seeing the things differently. It cannot be taught, but developed in children by using planned strategies and techniques. Emphasis should be given on providing appropriate
concrete experiences which nurture creative traits in a learner, viz. curiosity, ability to fantasise, playfulness, as well as cooperative and helpful attitudes in teaching-learning of science.
Example 3: Angela, a teacher is transacting the concept 'what dissolves in water andwhat does not' in Class VII. She forms small groups of students and asksthem to see themselves which of the following materials dissolve in water.
Sugar ,Wooden shavings, Salt , Lemon juice, Iron filings , Mud/Sand, Coffee powder , Sharbat
She helps the students to think about the following questions and discussamong themselves in groups.
Q.1 Which of the substances in the above list dissolve in water?
Q.2 What happens to a substance when it is dissolved in water?
Q.3 Try to dissolve four teaspoonful of sugar in a glass of water. Observethe level of water. Does it rise?
Q.4 Do you see some undissolved sugar at the bottom? How can youdissolve it in water?
And the list of questions goes on with students' added questions.The students perform the activities in groups and enter into argumentationamong themselves about the observations and the reasons for suchobservations. In the process they

- listen to other students and discuss with them;
- express their point of view justifying their statements;
- accept/reject and acknowledge other student's point of view;
- make other students understand their point of views; and
- mutually arrive at the correct reason.

They interact with the teacher and students of other groups to arrive atscientific explanations .

Example 3: Air is everywhere' is a statement that every school child learns. Studentsmay know that the earth's atmosphere consists of several gases, or thatthere is no air on the moon. We might be happy that they know somescience. But consider this exchange in a Class IV classroom.

Teacher: Is there air in this glass?

Students (in chorus): YES!

Theteacher was not satisfied with the usual general statement, 'Airis everywhere.' She asked the students to apply the idea in a simplesituation, and found, unexpectedly, that they had formed some 'alternativeconceptions'.

Teacher: Now I turn the glass upside down. Is there still air in it?

Somestudents said, 'Yes', others said, 'No', still others were undecided.

Student 1: The air came out of the glass.

Student 2: There was no air in the glass.

InClass II, the teacher put an empty glass over a burning candle andthe candle went out!The students had performed an activity whose memory had remainedvivid even two years later, but some of them at least had taken away anincorrect conclusion from it. Aftersome explanation, the teacher questioned the students further—Is there air in this closed cupboard? Is there air in the soil? In water?Insideour body?Inside our bones? Each of these questions brought up new ideasand presented an opportunity to clear some misunderstandings. This lessonwas also a message to the class: do not accept statements uncritically.Ask questions. You may not find all the answers, but you will learn more.

Example 4:**Traditional way:** The teacher may take an aqueous solution of $CuSO_4$ in a beaker and dip a strip of Zn in it. She leaves the beaker undisturbed for sometime. Then, the teacher asks the students, what do you observe? The students may reply that blue colour of the solution fades and a brown coating appears on the strip of Zn. Teacher then explains that this is because zinc is more reactive than copper, it displaces copper from its salt solution.

Constructivist Way: The teacher may take two beakers and label them as 'A' and 'B'. In beaker 'A,' she takes aqueous solution of $CuSO_4$ and calls a student to dip a Zn strip in it. In beaker 'B,' aqueous solution of $AgNO_3$ is taken and a Cu strip is dipped in it. She suggests to the class, "Let us keep the two beakers undisturbed for sometime and observe what happens."

Students observe that blue colour of the solution fades and brown coating appears on Zn strip in beaker 'A.' She draws attention of students to beaker 'B.' Students observe and state that colour of solution changes from colourless to blue and a shiny coating appears on Cu strip.

Student 1: Why do these changes occur in beakers 'A' and 'B'?Teacher encourages the class to think about it. Students come up with some responses.

Student 2: I think that Zn being more reactive than Cu. Therefore, Zn displaces Cu from $CuSO_4$.

Teacher: Yes, you are right. And Cu being more reactive than Ag, displaces it from $AgNO_3$. What type of reaction do you think is occurring in this activity?

Student 3: Displacement reaction.

Teacher: Which metal in this experiment is most reactive? How can we arrange the three metals involved in this activity in the order of their decreasing reactivity?

Student 2: Zn > Cu > Ag.

Teacher: Now, think about a situation, where we can store a solution of $ZnSO_4$ in a copper container.

Student 4: Yes, we can. Because it will not react with copper.

Teacher: Do you now think that the reaction taking place is a displacement reaction? Here a more reactive metal displaces a lesser reactive one from its salt solution.

Student 5: Yes, now I understand well.

Student 2: Can we arrange metals on this basis in the order of their decreasing reactivity?

Student 6: Yes, I have seen it in the book. Various metals are arranged as reactivity series. Because of reactivity, it is safe to store a salt solution of a metal in a container made of a lesser reactive metal.

Example 5:

Following is an example of activity that can be conducted in the class engaging students in teaching–learning of science.

Concept

Solubility of common salt/sugar in water

Observation

1. If sugar is added into still water, it takes longer time for dissolution.
2. Salt/Sugar dissolves fast in water on stirring or heating the mixture.

Inquiry

1. What is the reason for fast dissolution of salt/sugar in water?
2. Whether volume of solvent increases on forming solution?

Hypothesis

1. On increasing kinetic energy of particles, either by stirring or by increasing temperature, the components of solution intermix fast.
2. Volume of solution increases, because solute particles also occupy space.

Experimentation

1. Take 100 ml of water each in three beakers 'A,' 'B' and 'C.'
2. Put one teaspoonful of salt/sugar in each beaker
3. Do not disturb beaker 'A.'
4. Stir the mixture of beaker 'B' with the help of a glass rod.
5. Heat the mixture of beaker 'C' on the tripod stand with the help of spirit lamp/burner.
6. Record the time for complete dissolution of salt/sugar in beaker 'A,' 'B' and 'C'.
7. Measure the volume of solutions in beakers 'A,' 'B' and 'C' with the help of a measuring cylinder.

Conclusion

1. Complete dissolution of salt/sugar in beaker C takes the least time. Time taken for complete dissolution of salt/sugar in beaker 'A' is maximum out of the three cases.
2. Volume of solution in each case remains 100 mL.

Comments

Hypothesis no. 1 is correct, but hypothesis no. 2 is incorrect, since, there is no change in the volume of solvent on forming solution. There is a need to alter the hypothesis no. 2. The correct reason is that the solute particles occupy the spaces available in the solvent itself, called intermolecular spaces. No new space is occupied by the solute particles.

CONCLUSION

When a teacher enters into a classroom she is expected to be well equipped with the content knowledge as well as the pedagogical principles of teaching –learning. For constructing the knowledge of a learner, she has to adapt and adopt various strategies of teaching – learning that come in the purview of constructivist pedagogy. The teacher should motivate a learner to pursue inquiry by exploring things in his surrounds. Mostly teachers cite lot of reasons for not being able to practice constructivist approach in class. It is to inform teachers that they necessarily don't need to engage their students in performing high end experiments which perhaps needs a lot of sophisticated instruments and a lengthy protocol to follow. Even a simple experiment can satisfy the doubt, query and curiosity of a learner. Teachers should judge the previous knowledge of a learner correctly. Learners always have some doubts, misconceptions and curiosity about nature in their minds . Teachers should take these doubts seriously and encourage learners to come up with an answer to their by performing simple activities. Learning can then become meaningful for them as they themselves involved in constructing knowledge about the world around them.

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