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CONSTRUCTIVISM IN MATHEMATICS CLASSROOM

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Abstract

Education is at the confluence of powerful and rapidly shifting educational, technological and political forces that will shape the structure of educational systems across the globe for the remainder of this century. Constructivism claims that learners construct knowledge most naturally and completely when they are constructing some artifacts. Perkins (1986) argues that knowledge acquisition is a process of design that is facilitated when learners are actively engaged in designing knowledge rather than merely interpreting or encoding it i.e learners benefit the most from the learning process when they are the designers of the instructional experiences. Constructivism is a theory of knowledge, a philosophy of learning. Its proponents include Piaget, Vygotsky and later-day philosopher Glaser field. The constructivist philosophy has been adopted in teaching of math by many enthusiastic pedagogues and teachers in many countries. Constructivist pedagogy does not consist of a single teaching strategy. Instead, it has several features that should be attended to simultaneously in a classroom. It has been asserted that for a successful constructivist strategy, the teaching has not only to be student centered and the teacher a mere facilitator, but the teacher has the added responsibility to create a conducive classroom environment. The present paper focuses on that it is important to keep in mind that every individual can and often does use the information available to him or her to construct meanings that do not coincide with authentic aspects of reality or with well accepted, normative conceptions of information.

Experience is the result of mutual interaction between the organism and the environment. Though all experiences result in learning is a product of experience. Development is affected by learning. The entire process of growth and development that is caused by learning from experience is called education. It is rightly said by John Dewey that," since growth is the characteristic of life, education is all one with growing; it has no end beyond itself."Learning is influenced by prior experiences and ideas have led to the development of what has become the dominant view of learning. A constructivist view of learning holds that" people construct their own meanings from what they experience rather than acquiring knowledge from other sources."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 experiences, may be changing what we believe, or may be discarding the new information as irrelevant. In any case we are active creators of our own knowledge. To do this we must ask questions, explore, and assess what we know. (2004, WNET/EDUCATION) .

VIEWS OF SOME EARLY CONSTRUCTIVIST PHILOSPHERS

A) JEAN PIAGET(1896-1980)

Piaget's constructivist theory is based on analogies with biological evolution and adaptation. He believed that the child's own actions in this world were important for cognitive development. The social context was important in this development process. Cognitive structures build up from simple initial processes in conjunction with personal action and experience. The development is a form of adaptation to the environment. Later, Piaget tended to shift from the isolation of individual to a more social learning process.

B) LEV VYGOTSKY(1896-1934)

He believed that the developmental process was governed by the learning process. Pedagogy creates learning processes that lead to development. He distinguished between actual (development) and potential (learning) levels of development. Actual level is achieved independently; potential level is obtained by the guidance of an adult. In Vygotosky's (1986) scheme, in the process of constructing knowledge, the learner is not only active internally but also in a social context with the learning material. Here comes the use of "cognitive conflict". If the designed activities lead students to a framework which differs from correct scientific concepts, this creates, "cognitive conflict". This 'conflict' should be neither too easy nor too difficult. That is, the 'conflict' should neither be beyond their capabilities nor should be too easy. It should be within Vygotsky's "zone of proximal development". When a child cannot accomplish a task alone and can find a peer who possesses a slightly higher cognitive level, one within the child's "zone of proximal development", the child can complete the task with that person's assistance. In Piagetian cognitive constructivism the emphasis is on the individual constructing knowledge through a cognitive process of analyzing and interpreting. In Vygotskian social constructivism, emphasis is on the social interactions with the teacher and peers.

C) ERNST VON GLASERFELD(1917-2010)

Von Glasersfeld is known for his "radical constructivist" philosophy. According to Von Glasersfeld, knowledge is not passively received but built up by the cognizing subject. He calls his theory as "theory of knowing" rather than a "theory of knowledge".on Glaserfeld underscores the importance of active learning. Knowledge is entirely constructed out of social relations. Knowledge needs to be relevant and related to the person's interest. The teacher can create environments so that kids can act upon the basis of their ideas and discover which of their ideas lead to friction and need revision. Glaserfeld is a radical constructivist .He asserts that internationalization is a condition for learning."The responsibility of learning resides increasingly with the learner"(Glaserfeld,1989).Learners construct their own understanding .Glaserfeld also believes that sustaining motivation to learn is strongly dependent on the learner's confidence in his potential for learning. This feeling of confidence in his own competence is derived from his first hand experience with problems.

Constructivism is referred to as a scientific way as constructivist viewpoint is to think like a scientist. The individual is thought of as a scientist and can be characterized as:

- Learning outcomes depend not only on the learning environment but also on the knowledge of the learner.
- Learner involves the constructing of meaning (constructing meaning from direct experience and influenced to a large extent of existing knowledge).
- The construction of learning is a continuous and active process.
- Meaning once constructed is evaluated and can be accepted or rejected.
- Learners have the final responsibility for their learning.
- There are patterns in the types of learning students construct due to shared experiences with physical world and through natural language.

Constructivism leads to constructing memory through constructive approach as information is processed to construct new information to existing schemas with respect to Piaget's theory of assimilation. Constructivism is a theory originated by educational theorist Jean Piaget. Piaget believed young children learn by doing, constructing knowledge from experiences rather than from adults telling them about their world. As they scoop and shovel sand into a bucket, they're learning about how much sand it takes to fill the bucket. Compare that to a teacher telling students 'Seven scoops of sand will fill this bucket.' Which do you think will be long lasting and more impactful?

According to Piaget, and others who practice what is known as Constructivist Education, the method most likely to truly educate students is one in which they experience their world. Let's see how the Constructivist model compares to traditional teaching:

Constructivist Teaching	Traditional Teaching
Teachers provide learning experiences for students	Teachers give information directly to students
Teachers give students opportunities to think through problems and find solutions	Teachers focus on one correct answer
Teachers see students' 'mistakes' as opportunities to tailor learning	Teachers view 'mistakes' as wrong
Students work with others most of the day	Students work alone most of the day
Curriculum is 'Top-Down', emphasizing the big ideas	Curriculum is 'Bottom-Up', presented in parts with stress on individual skills
Assessment is formative and used to guide teacher	Assessment is summative and used to grade student
Curriculum evolves as student learning progresses	Curriculum is fixed

As we can see, traditional teaching is based on predetermined ideas that students learn at prescribed stages in their lives, regardless of personal development. Teachers using a strictly traditional method follow a rigid plan of presenting information to students, allowing students to practice the material, then testing students on their knowledge. Constructivist teaching builds curriculum based on student interest and developmental level, guides students as they experience learning, assesses as a method to determine future teaching points, all the while encouraging students to think, explain, and investigate.

Constructivist and Traditional Teaching

The fact is, however, that few teachers these days adhere to a strict traditional teaching model. You likely see your own practice as a blend of traditional and Constructivist; maybe you use both formative and summative assessments; perhaps you're able to provide a wide variety of experiences for students to experience within the context of a specific objective. Unless you teach at a school that has adopted the Constructivist model, you're likely required to follow at least some traditional methods of instruction.

Constructivism in a mathematics classroom

There is no single constructivist strategy for instruction in the class. Different pedagogies and researches have highlighted various elements in varying degrees for the benefit of classroom

instructors. Even so, there are several common themes which can be described here. Education is a student-centered process and the teacher is only a facilitator. Learning depends on shared experience with peers and teachers. Collaboration and cooperation is a major teaching method. Students actively explore and use hands – on experience. The constructivist views knowledge as being constructed in a social context. It is an active social process. Learners cannot construct understanding alone; they do it collaboratively, through interactions. Learning is an active process; hence the learner should be encouraged for guesswork and intuitive learning.”Thinking” effectively, with focus on the problem at hand, is an important aspect of constructivist learning.” Understanding” becomes clear and strong if the learner “thinks” over the issue at hand and if he can monitor his own thinking.”Thinking” is also called “self-reflection. An expert learner thinks about his own thinking. It helps in self-questioning and self-reviewing. It is called “metacognition” or a purposeful thoughtfulness. A motivated and thinking learner tries to check his errors and tries to find why he failed in his earlier attempt.

Teacher’s Role in a Constructivist Mathematics classroom

A teacher is not an authority. He does not lecture. He is a facilitator or guide. He helps the learners .The facilitator has to create proper environment in the class so that the students are motivated, challenged and think deeply to arrive at his own conclusion. As a facilitator, the teacher has to support the learners in becoming effective thinkers. The facilitator and the learners, both learn from each other. Students should be encouraged to arrive at their own version of truth and then compare it with that of the instructor as well as with that of their fellow learners. Teachers have only to observe in the beginning of a session and assess the progress. They should pose questions to create right environment. They should intervene if any “conflict” arises or if the process of learning is going astray. An important task for a constructivist mathematics teacher is to create a “learning environment” which facilitates students thinking and motivate them to explore. An authentic learning environment is obtained if real –life complexities and a real –world situation is simulated. A mathematics teacher creates congenial learning environment when learning goals are negotiated through consensus and dialogue students. Direct instruction is not appropriate. Learning should take place by “active involvement” of the students, by “doing” ,by generating their own ideas. In a well-planned classroom environment, students learn how to learn. Learning is like a spiral. Students reflect on their past experience and integrate new experience. Teachers can use various strategies to promote and strengthen students’ capacity to think and to “think about their thinking”

Eggen, P & Kauchak, D, (2007) have suggested the following strategies for the purpose:

1) **KWL Strategy:** Teacher should teach the students to be aware of a) what they already Know, b) what they want to Learn, and c) what they have eventually Learnt.
2) **PQ4R Strategy:** PQ4R is an acronym for Preview, Questions, Read, Reflect, Recite and Review. The steps are described below:

   Preview: The leaner surveys the material.

   Question: Students ask questions on the available material.

   Read: Students read the material to ask questions.

   Reflect: The learners think about the material, relating it to the things they already know.

   Recite: The students practice remembering.

   Review: The students review the material and ask questions.
3) **IDEAL Strategy:** IDEAL is an acronym for Identify,Define,Explore,Act,Look.To facilitate effective thinking ,the teacher can teach each of these metacognitive skills to students, identify potential difficulties ,and define these problems. Then ,students explore to find solution. Finally, they have to look and note which actions lead to solutions.
4) **The 5 E Approach** This approach was introduced by Roger Bybee, of The Biological Science Curriculum Study (BSCS). The 5 Es are Engage, Explore, Explain, Elaborate and Evaluate.

- **Engage**: This stage assess the previous knowledge of the learner and helps them become engaged in a new concept through the use of short activities that promote curiosity and elicit prior knowledge. The aim is to organize students' thinking toward the learning outcomes of the current activities.
- **Explore**: Expose the students to a variety of experiences at this stage. These experiences may involve observations of events or objects, manipulations of materials, work with simulations, examinations of representations, viewing a short video, or reading. These experiences provide a common basis for all students that the teacher can use to assist them in identifying and developing concepts and skills.
- **Explain**: Here students are provided with opportunity to explain their understanding of their experiences from the explore phase. The questions and discussion lead students to patterns, regularities, and/or similarities and prompt them to describe concepts or skills in their own words.

- **Elaborate**: The next phase challenges students to extend their understandings or skills and/or to practice them. Through new experiences at this time, students develop deeper understanding, an extended conceptual framework, and improved skills. Some of the tasks, such as reading an article, may be done as homework and discussed during the following class period.
- **Evaluate**: The final phase of the instructional model encourages students to assess their understanding and abilities and provides opportunity for the teacher to evaluate student progress toward achieving the learning objectives for the activity. The tasks may involve writing summaries, applying concepts and skills to novel situations, constructing a concept map, or taking a quiz.

Planning for Constructivist Teaching

Though Constructivist teaching may look like the teacher just allows the students to 'play,' there is the same amount of planning going into these lessons as traditional ones. Educators intentionally guide students in their learning, which takes specific planning. Though methods of Constructivist teaching are different than traditional, teachers still rely on a plan based on asking questions, determining outcomes, planning materials, engaging students, and giving students opportunities to explore and explain. Take a look:

Standards	List teaching standards lesson is geared towards.
Essential Question	Guiding question students will attempt to answer.
Resources	Materials, supplies, and other resources you'll need for students during learning.

For example: TOPIC: 2D AND 3D SHAPES

ENGAGE: Teacher will *engage* the students in taking pictures of various geometrical shapes that they could see in their surrounding and in their school campus.(by showing some flash cards and video clips)Students will then be asked to classify and categorize these figures on the basis of some common attributes.

EXPLORE: Teacher will give different dimensions to the students which they are supposed to explore in order to make the concept of 2D and 3D shapes more clear. Teacher will then ask the students to draw all these figures on their notebooks and write down their sides, sum of angle , diagonals , edges , faces , vertices if any on the basis of these dimensions and categorization done above. Teacher asks the student to draw conclusions. Teacher will divide the students into groups and ask them to discuss the topic with other group members and explain their solutions before class.

EXPLAIN: If on dividing the students into groups, the students are not able to understand the concept completely then teacher will assist them to re-analyze the previous results. Teacher will then explain that 2D shapes are flat figures they do not have height. In 2-D figures we can find vertex, sides, angles, diagonals etc.

ELABORATE: Activity -1 Teacher will ask the students to identify 2D and 3D Figures (from the given worksheet).

Activity-2 Teacher will divide the class into 2 groups, she will name members of one group with the name of different geometrical shapes and members of other group with the examples related to that geometrical shapes. Then she will ask the student to find their correct match and pair with it. (By showing chart)**.**By doing so students will learn in a play way method.

EVALUATION: 1) What is the difference between square and cube?

2) Is it possible to find out the perimeter of cylinder?

3) Find out the volume of rectangle. If not possible then give reason why?

Collaboration and Scaffolding in a Constructivist Classroom:

Students are encouraged to work together to discuss a 'controversy', and to ask each other questions. Students should be allowed for 'reciprocal' learning. A Less-skilled child may be 'tutored' by a more-skilled child. Such cooperative learning and group discussion definitely create great interest and motivation among the students. Some experts have also recommended the organization of "jigsaw" techniques. In a jigsaw technique, students are divided into groups and one member from each group is taught new skills. This "expert" member then goes back to his original group and teaches the new skills to his group members. A particularly weak student may be given greater help and support by his teachers or even by his peers. This level of support may be changed, increased or decreased, as needed by that student. This is called "scaffolding".

Conclusion:

Teachers generally offer resistance to adopting constructivist position. The reason is simple. Firstly constructivist strategy is time consuming. Students have to be given ample time for "reflecting", group discussion and so on. Teachers are generally worried about covering the syllabus within a limited time. The time factor has placed great practical constraints on the implementation of constructivist learning. Secondly, teachers are not trained in constructivist methodology. Generally, teachers are averse to creating learning environments as it entails "waste" of time. To conclude, it can be said that constructivist pedagogy is a very effective means of mathematics teaching. However, the success of this pedagogy is a very effective means of science teaching .However, the success of this pedagogy presupposes that the

teachers should not only be well trained in a constructivist approach, but that they should also be dedicated enough to follow its requirements' patiently.

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