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Impact of pedagogical practices on academic achievement and thinking style of learners in physical science

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Abstract
Modern theories of learning claim that the construction of knowledge occurs as students build understanding in light of experiences occurring in the world. Different thinking skills like critical thinking, creative thinking, integral thinking, analytical thinking, and synthetic thinking are greatly influenced by the pedagogical practices. The acquisition of thinking skill is reflected in the achievement of learners in scholastic as well as co scholastic area. The present study makes an attempt to investigate the influence of pedagogical practices on achievement and thinking style of learner particularly in Physical Science. The study has taken constructivism as pedagogical practice and creative thinking as the thinking skills to be investigated. The findings revels that constructivism based pedagogical practices influence the learning achievement and thinking style of learner significantly but the method has less effect on the students of lower level of intelligence.

Keywords: science education, thinking styles, creative thinking, constructivism

1. Introduction
Constructivism always lays importance on teaching through activities and experiments, by connecting students with the experience of their daily life. The experiment and activity methods preferred as the method of teaching by the Schools of philosophy such as Naturalism Pragmatism and Existentialism. Teaching the child through activity and experience is also advocated by philosophers and psychologists like Dewey, Rousseau, Gandhi, Tagore, Piaget Vygotsky, Bruner, Monteswari etc. John Dewey advocate constructivism as the development of a reflective individual, with attributes of open - mindedness, whole heartedness and responsibility. He argued for learning by doing. Piaget emphasized that learning occurs by an active construction of meaning, rather than passive percipience. Bruner laid emphasis on discovery learning and Vygotsky on the social and cultural perspectives of learning. These thinkers laid emphasis on learning environments supports multiple perspectives or interrelations of reality, knowledge construction, context rich, and experience based activities (Mishra, 2012). Performance and knowledge encoded by learners taught through constructivist approach are much ahead in overall teaching and learning activities than student taught by behaviorist approach. Constructivism in teaching significantly affects the elaboration skill, flexibility skill and creative thinking skill of students of students, but does not affect the originality of students significantly (Verma, 2012). Students in the constructivist learning environment showed better retention of almost all of the concepts related to Cantor set theory than the students in the traditional class (Narli, 2011) [7]. Questioning, problem solving, discussion, collaboration etc. skills are developed by constructivist method (Dhoot, 2010) [10]. Constructivist method brought in a great change in the outlook, attitude and vision of children and participation (Jameela, 2010) [9]. Constructivist learning approach has significant effect on student's achievement in mathematics as compared to a traditional method. The students are satisfied and show positive perception towards constructivist approach (Nayak & Senapathy, 2010). Constructivist learning is an active construction of the meanings by the learner in a wide variety of ways (Pachaury, 2008). There is a need of an equitable science curriculum, in which both the content and the pedagogy are inclusive of all students enabling them to participate in ways that are appropriate for them (Sood, 2008). Constructivism based teaching-learning situations like student autonomy, classroom interaction, cognitive exploration lead to higher order thinking skills among students (Sridevi, 2007). It has been also observed that constructivist teaching strategies may be beneficial to the creation of student-centered learning environments and assist in broadening student inquiry and investment with lessons (Heard, 2007) [3].

Pedagogy is the method and practice of teaching, especially as an academic subject or theoretical concept. It is also the science and art of education, specifically instructional theory. An instructor develops conceptual knowledge and manages the content of learning activities in pedagogical settings. Pedagogical Practices are the learning activities that support the unit of content; the instructional approach such as active learning, constructivist model, student-to-student engagement; teaching to multiple learning styles, variety of assessments. These may include the methods, strategies, and/or styles of instruction that teachers use to teach students. Pedagogical Practices are selected according to the beliefs of the teacher, the needs of the learner and the demands of the task. The area of Pedagogical Practices is very broad which includes curriculum, methods of instruction and evaluation, organizational structure and interaction of the institution, learning environment of learners in and out of the school etc. in simple words it is the system of education itself. The success of pedagogical practices of any institution is reflected from the learning achievement of the learners which are being demonstrated in their cognitive, conative, emotional and social aspect.

Keeping in mind the above rationale the present study is conducted through an experimental approach to explore the influence of pedagogical practices on the achievement and thinking style of learner in science. Hence the present study is titled as

How pedagogical practices influence the achievement and thinking style of learner?

Operational definition

Pedagogical practices: In the present study constructivism based teaching-learning practices are treated as pedagogical practices

Achievement: It refers to mental abilities along with the process skill reflected in the behavior of the individual. The present study covers the subject related learning achievement in science i.e. knowledge, understanding, application and problem solving. The manipulation with the instruments by learners in the desired way and the answers written by them will be the reflection of their learning achievement.

Thinking style: In the present study thinking refers to creative thinking only, which is reflected as the originality, flexibility, fluency of thought of the learner during instruction and evaluation.

2. Research Questions

The study moves with following research questions which are tried to be answered empirically as well as rationally throughout the study.

1. How constructivism based pedagogical practices influence the achievement of learner in physical science?
2. How constructivism based pedagogical practices influence creative thinking of learner in physical science?
3. How constructivism based pedagogical practices influence the creative thinking of learner at different level of intelligence of learner in physical science?

3. Objective of the study

Judging the above situations the research study is very much anxious to investigate the influence of constructivism based pedagogical practices on knowledge acquisition by developing the ability of thinking among the learners. The study have following objectives.

1. To study the influence of constructivism based pedagogical practices on the achievement of learner in physical science.
2. To examine the influence of constructivism based pedagogical practices on creative thinking of learner in physical science.
3. To investigate the influence of constructivism based pedagogical practices on the achievement of learners at different level of intelligence.

4. Hypothesis

H0- There is no significant difference between the post treatment mean achievement scores of control and experimental group

5. Method of research

The present research is classroom practice of constructivism based pedagogical practices with experimental approach and also with both positivist and phenomenological perspective. The study fallows two group pre-test post design

5.1 Population and Sample

The elementary school students of Khunta block of Mayurbhanj district was the population of the study. To remain impartial towards the sample the researcher used random sampling technique to draw the sample school from the population. Both the control and experimental group had thirty students who are selected through intelligence test and achievement test followed by a matching to make both of the group equivalent.

5.2 Tools and Techniques for Data Collection

In the present study the researcher had made use of 3 types of tools for the data collection. These were (1) instructional tools (2) testing tools- these were used test students ability before the treatment, at the time of treatment and after the treatment (3) observation

The study tried to investigate the influence of pedagogical practices on achievement and thinking style of learners in science in the following lessons of physical science.

Lesson-1 Conductor Insulators Electric Conduction
Lesson - 2 Separation of Liquid Mixture
Lesson-3 Forms of Carbon
Lesson-4 Melting & Boiling
Lesson -5 Acid and Base

5.3 Analysis of data

In experimental research it is a very common belief that, the change what appears at the end as product is the result of the process through which the samples have gone through. So attempt has been made to analyze the data in two ways as-

1. Process analysis where phenomenological approach is used
2. Product analysis where positivist (objective) approach is used.

5.3.1 Process analysis

Lesson 1- The objective of this lesson was to develop some basic concepts regarding electric conductor, insulator and flow of electricity. In pretest it was noticed that students idea regarding these concepts was not concrete. For example, students were not able to identify conductors or insulators from a mixed list. They were unaware about the condition required for owing current in a circuit. In this teaching learning process, a circuit containing two LED bulbs was given to them. Students were asked to glow light by completing the circuit. With different materials available to them like pen, pencil, cloth, paper, cycle spoke, aluminum wire, copper wire, rubber, graphite, refill, stone, etc. (There was a gap of few centimeter between the two poles of circuit.) Every student was given opportunity to manipulate with the circuit. The time required to glow the bulb by them was being noted in front of them. This created a competitive mind among the students and they were trying with great interest. No instruction was given to them during the activity. Full freedom was given to them and they were being asked about the reasons of various observations (meta-cognition). By this a good discussion platform was created. At the end of the activity, students were given a question paper which was related to their observation. Questions were aimed to check their ability of discriminating between conductors and insulators, giving example of them drawing circuit diagrams and making

definitions, etc. At last It was found that students were successfully able to achieve those objectives. They were facing a little difficulty to form own definition from their observation. Still they were close to it.

In the control group all direct instruction were given on the above topic. When their cognition was assessed It was found that they were easily writing definition as told earlier but facing conceptual confusions regarding discrimination between conductors and insulators, circuit diagrams. They were confused that which one is conductor from pencil and graphite of pencil. But no such problem was encountered by the students of experimental room who had completed circuit by using graphite of a pencil along with other conductors.

Lesson-2- The objective of this lesson was to enhance students understanding about evaporation of components of solution along with basic concepts related to evaporation. In the experimental group students were asked to prepare water solutions of sugar & salt. When they were asked about the technique of separating the components, they told that it can be done by putting the solution on sunlight. Than they were told that they have very less time (about 20 min.) to collect salt from salt solution. For a few moments they were confused how to achieve the task. After this they were shown apparatus for like sprit lamp, conical flask, test tube, band tube etc. Than the students started manipulation with the instruments. Students are divided in to 2 groups. First group was performing & second group was observing. Within 10 minutes the members of the first group collected salt from salt solution. The second group students were asked to prepare sugar solution and they were assigned the task of separating both the components from the solution. They were also confused about the condensation of vapor in to water. So the condensation was demonstrated to them. Than students continued the activity & collected the water from the solution. At last the sugar was left in the conical flask. In the end of the process they have performed. The students were asked to give more examples of evaporation. They had a belief that evaporation is only possible at sunlight. They were asked to bring a water pot (matka) full of water and the port was kept in dark. On the next days it was found that the water level was decreased. The reason behind this observation was discussed & student concluded that evaporation is possible even without sunlight. These concepts were thought to the control group students by discussion and black board work. In the evaluation it was found that the performance of experimental group students was better. It was also noticed that control group students were not sure regarding the use separation technique to a particular case. All most all control group students think that evaporation occurs only in the sunlight even after they were told that its possible without Sunlight.

Lesson -3 The objective of this lesson was to strengthen students' concepts regarding different from of carbon and their uses. In the Experimental group student were provided deferent materials like leaf, different woods, paper, refill, plastic etc. and where asked to burn them. It was observed by the students that whatever they burnt ultimately resulted in black residue. It was told to them that this black residue is carbon. Different structures of carbon were shown in figure. Two important from of carbon was sugar charcoal & lamps blacks. This time the experimental group was divided in to 3 sub-groups. The first group was given the required apparatus for preparation of sugar charcoal like sprit lamp, test tube, test tube holder, sugar etc. and was asked to prepare sugar charcoal. Student performed the activity with great interest. The rest members were in an active discussion regarding the different observation of the experiment. To enhance scientific responsibility there was very less interference from the instructor. Students were asked to clean the apparatus they used, which give them a more comprehensive idea regarding the substance they have prepared. The second group was given a lamp watch glass and forceps. The students were asked to collect the smoke of the flame on the water glass. It was told that the collected substance was lamp black. Then the third group was given the collected lamp black and was asked to prepare a solution from that. Students mixed different solvents like kerosene oil, alcohol, water etc. to get the solution. Though the solution was not perfect, when the use of the solution was discussed, students were in an excitement to use the solution as ink (preparation of ink was a complex process and was told to them). There was a open discussion regarding students experience on different forms of carbon and their used. In the control group the concepts were taught to the students and uses were discussed by the teacher.

In evaluation it was seen that the retention of these concepts in the students' mind of control group was less. They were not able to remind the process of preparation of lamp black or sugar charcoal. Whereas the students of experimental group were comfortable in these areas.

Lesson-4- The objective of this lesson was to enhance students' concept regarding melting and boiling deferent substances. The control group students were divided in to 5 groups & provided Ice, alcohol, butter, water, sugar solution. The groups were provided thermometer, boiling tube, sprit lamp and were asked to report the melting point & boiling point. The result was discussed among the peer member. The conclusion drown by students was as following.

The state of matter changes with tamps. Solid substance first stands melting then boiling the m.p. is less than B.P., when a solute in added to any solute in the added to any solvent its boiling point increases. They prepared the meaning of melting and boiling in their own words. In the control group these concepts were discussed by the teacher with black board work.

In evaluation it was seen that the performance of experimental group students was quiet good, control group student tiled many conceptual contusions for example there was a question.

Which of the fooling has higher boiling point?

. River water

. Sea water

All the students of experimental group written sea water but most of the students of control group writer river water, control group students faced problem to different between the process of matching & boiling.

Lesson-5- The objective of this lesson was to strengthen students understanding regarding acid & base. In experimental group students were given some edible acid & base to test & touch like (lemon, Emli, curd, alcohol, baking powder & antacid liq.). The feeling of students regarding the test was disused. This helped students to construct the basic, primary idea about the properties of acid a base. Than litmus paper was shown to the students & they were asked to demonstrate the colour change when it comes in contact of acid, base and water. After this every students were given

two litmus papers (blue & red). 7 there unknown liquids of same color were placed in front of them. They were asked to detect the liquid with the help of water the activity & discuss the result. In this way they understand the litmus test.

Students were in to two groups to concretive students' idea about the uses of acid & base first a small battery was put in front of the student. 1st group students were asked to bring some liquid from the battery by a dropper & to repent what was the substance? By doing litmus test student became conformed the substance used in battery was an acid similarly the second group students conformed that the substance found in washing powder/shop solution was buses. Than the used of acid & base was discussed by the pear members.

These concepts were told to the control group by teacher with required black board work.

In evaluation it was found that the control group students were not sure regarding the change of colour of litmus paper when it comes in contact with water. They were also confused during the use of acid and base. Whereas, the concepts of experimental Group students were found to be concrete.

From the process analysis of the above five lesson it is clear that the students of experimental group has demonstrated more focused in activity, conceptual Clarity, Insight in thought, fluency, flexibility and originality in idea which are the indicators of creative thinking

5.3.2 Product analysis

In order to analyze the product, quantitative data obtained from the experiment is analyses.

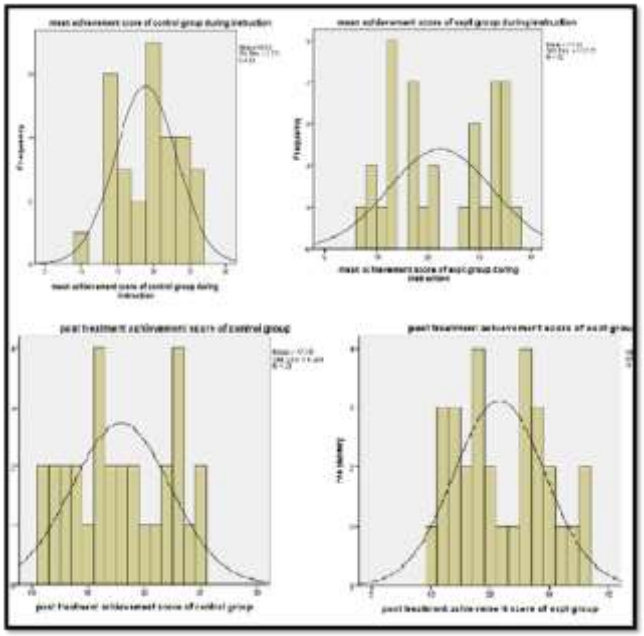

Fig 1

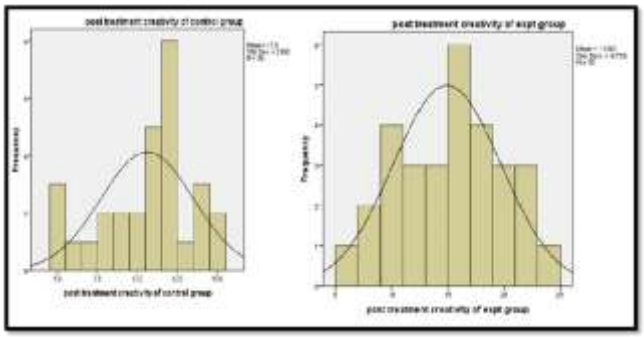

Fig 2

Table 1: Test for significant mean difference between pre-treatment achievement and creative thinking score of control group.

Paired Samples Test						
		Paired Differences		t	df	Sig. (2-tailed)
		Mean	Std. Deviation			
Pair 1	Pre ach con – post ach Con	-2.467	4.158	-3.249	29	.003
Pair 2	Pre creat. Con – post creat.Con	-.267	3.172	-.460	29	.649

The above table clearly indicates that there is significant difference between the pre-treatment and post achievement scores of control group but the difference between that of creative thinking is not significant.

Table 2: Test for significant mean difference between pre-treatment achievement and creative thinking score of experimental group.

Paired Samples Test						
		Paired Differences		t	df	Sig. (2-tailed)
		Mean	Std. Deviation			
Pair 1	Pre-treatment ach. expt - post treatment ach. expt	-5.833	5.440	-5.873	29	.000
Pair 2	Pre-treatment creat. expt - post treatment ach. expt	-11.167	6.114	-10.003	29	.000

From the above table we conclude that there is significant difference between the pre-treatment and post achievement scores creative thinking of experimental group. This difference in mean score is an indication of positive influence of the constructivist approach based pedagogical practices.

Table 3: Test for significant mean difference in mean achievement scores of experimental and control group during instruction.

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	Df	Sig. (2-tailed)	Mean Difference
mean achievement	Equal variances assumed	52.183	.000	-1.726	58	.090	-3.433
	Equal variances not assumed			-1.726	39.212	.092	-3.433

The above table indicates that the mean achievement scores of control group and experimental group during the experiment differs significantly. This means the experimental group students were more involved in learning process than the control group.

Test for significant mean difference in post treatment achievement and creative thinking scores of experimental and control group during instruction

Hypothesis

H0- There is no significant difference between the post treatment mean achievement scores of control and experimental group.

Table 4

		Levene's Test for Equality of Variances		t-test for Equality of Means			
		F	Sig.	t	df	Sig. (2-tailed)	Mean Diff.
post treatment score	Equal variances assumed	16.254	.000	-2.253	58	.028	-3.633
	Equal variances not assumed			-2.253	46.205	.029	-3.633
creative thinking score	Equal variances assumed	9.361	.003	-4.235	58	.000	-4.333
	Equal variances not assumed			-4.235	47.648	.000	-4.333

It is clear from the above table that there is significant difference between the post treatment achievement and creative thinking scores of control group and experimental group. The mean of experimental group are higher than that of control group which is the indication of superiority of experimental group over the control group. Hence the null *hypothesis H0- There is no significant difference between the post treatment mean achievement scores of control and experimental group- is rejected at 0.01 level of significance*. This is another proof of positive influence of the pedagogical practice on achievement as well as creative thinking.

Test for significant mean difference in achievement and creative thinking score of high and low intelligent learners of experimental group.

Table 5

		t-test for Equality of Means			
		t	df	Sig. (2-tailed)	Mean Difference
post treatment score	Equal variances assumed	8.354	28	.000	12.846
	Equal variances not assumed	8.572	27.777	.000	12.846
creative thinking score	Equal variances assumed	6.068	28	.000	7.176
	Equal variances not assumed	6.278	27.981	.000	7.176

The above table shows the significant difference between the achievement and creative thinking scores of high and low intelligent students of the experimental group. This means the pedagogical practice is not significantly influencing the performance of learners of lower intelligence.

6. Discussions

The findings indicate that the performance of students was affected by the treatment provided to the experimental group. The finding was similar to that of Mishra (2013), Jameela (2010) [9] and Verma (2012). The students were learning by doing with a constructivist approach. They were trying to trap the essence of the activity performed by them. The researcher was working as a co explorer in the knowledge construction. The design of teaching learning material was done in such a way that the activity would be objective in terms of establishing direct relation with the concepts. The learning was joyful in experimental group in changed environment. Students had learnt by discovering the concepts by themselves during the activity. The maximization of senses in experimental group was reflected in the performance of students. Students were learning by trial and error method and due to this students were more comfortable in learning. There was also significant difference between the pre and post treatment achievement of the control group. But the change in mean score of experimental group was much greater than that of the mean score of control group. It means that the treatment provided to the experimental group was much effective than that of control group, and students were involved in the teaching learning process.

The combined result of the study indicates that the activity method was significantly effective on the learning achievement of students. Similar result was found by Hemalata (2002) Kipnis & Hefstein (2008), Heard (2007) [3] and Folashade & Akinbobola (2009) [4]. In the activity method the knowledge constructed was found to be more permanent in nature. This was because students were actively participating in the learning process in experimental group. The knowledge was constructed and evaluated by the peer group. The cooperation between the peer members had made the method more effective. In the activity method verbalism was less and learning was purposive. Students were getting motivated by the success of other students in activity. (Bandura) Here the artificial dilemma created by the researcher was facilitating learning. That dilemma was working as secondary reinforcement and was found to be more effective (Dollard and Miller). The retention of the scientific concepts in the cognitive map of students was

more frequently seen in experimental group than that of control group. Direct instructions were given to the control group because of which their performance in the formative tests was good. But experimental group students had constructed their knowledge by themselves, which reflected in their result of summative test. This retention was due to the activity. For example when acid base concept was the topic, no definition of acid and base was told in experimental group. Some edible acid and bases were given them to test. After it the properties and definition were discussed by the students. This concept was retained till the post treatment test. They had learnt the litmus test by performing it. So when they were asked to demonstrate the litmus test as a part of process skill evaluation most of the students of the experimental group were successful. In the post treatment achievement test they had also written the correct answer regarding it. The control group students were provided theoretical idea of litmus test. At post treatment it was found that they were confused with the colour change, and had made mistake in the post treatment test. Even the conceptual problem was more serious when students of control group were asked to perform it. Similarly the students of control group had faced difficulty to choose the good conductor of electricity between pencil and the graphite of pencil. But the experimental group students learnt the concept by making circuit complete with the help of various materials including graphite. So with being provided direct information, no conceptual confusion was seen.

7. Conclusion

It was observed that the students of both the control and experimental group were taking part in the discussion. But the quality of discussion was more objective in the experimental group. Students were always interested to perform activity. The learning was joyful for them. It was surprised to observe that the students of the experimental group were learning without instruction and their performance was better than the control group students in most of the classes**.** Class control in the experimental group was much easier than that of control group. Students of experimental group had learnt the skill of working in a group and leading the group.

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