ISSN 2278-8808 SJIF 2014 = 4.889
An International Peer Reviewed & Referred
SCHOLARLY RESEARCH JOURNAL
FOR INTERDISCIPLINARY STUDIES

OPERATIONAL DYNAMICS OF CONSTRUCTIVIST PEDAGOGY OF PRE-SERVICE SCIENCE TEACHERS AT SECONDARY LEVEL

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Abstract

Effective Teaching and meaningful Learning in Science are the two foci of imparting productive Science education. If both are to be highly qualitative, it's very important for the teachers and practitioners to realize and refine their understandings of curriculum transaction in Science. It is an accepted fact that effective teachers are usually not born but made through training, exposure and experience. Good Science teachers nurture their scientific knowledge and skills through constant and deliberate efforts. One of the prerequisite to be a good science teacher is to understand the process of teaching-learning science and effective classroom management in more depth.

It is indeed a sorry state of affairs that even today teaching is just transacting curriculum by way of direct explanation of the content for conceptual understanding by teachers where students are just passive recipients of information rather active producers of new knowledge. In the context of NCF 2005 and NCFTE 2009, which strongly advocate self-construction of knowledge, it is very significant to rethink about the dynamics of curricular transaction and redesign the pedagogic dimensions in the teaching of Science so as to enable students construct their own scientific knowledge, relate it to the immediate environment, reflect it in their personality and extend the same for problem solving in life and community for a better quality of life. More specifically learning of Science needs to be shifted from passive and conventional methods to active and innovative methods.

In this context one has to seriously think about how to make children active learners with an enhanced ability to construct their own scientific knowledge and become productive citizens of our country. There is an element of discovery, exploration, and inquiry in every child that probably lead him or her to a contributory individual in terms of scientist. In a nutshell each individual student is a budding

scientist who is only to be pulled out. This would be possible only when teachers modify their information transferring conventional classrooms into a place where students are transformed to produce new knowledge, get their scientific skills sharpened, scientific attitude is promoted, aptitude is magnified and in total the competence levels of students are boosted up. This indeed requires a new pedagogy called Constructivist Pedagogy. Teachers shall try to refine and reflect their understandings of the principles of constructivism and put conscious efforts to design a Constructivist Learning Environment (CLE) their Constructivist Classrooms.

In this context the present study finds its significance, as the researcher tries to analyze the teaching-learning process and the pedagogical dynamics of constructivist science curricular transaction when students are employing 5E model of teaching Science.

Constructivism

Constructivism is 'an approach to learning that holds that people actively construct or make their own knowledge and that reality is determined by the experiences of the learner' (Elliott et al., 2000). The passive view of teaching views the learner as 'an empty vessel' to be filled with knowledge, whereas constructivism states that learners construct meaning only through active engagement with the world (such as experiments or real-world problem solving). Information may be passively received, but understanding cannot be, for it must come from making meaningful connections between prior knowledge, new knowledge, and the processes involved in learning.
The central idea of Constructivism is that human learning is constructed and that learners build new knowledge upon the foundation of previous knowledge. This prior knowledge influences what new or modified knowledge an individual will construct from new learning experiences. (Phillips, 1995).

Constructivist Pedagogy: Any teaching strategy or approach that is based on the theory of constructivism. This pedagogy is widely accepted as a basis for thinking about teaching and learning. Constructivist teaching is not the name of a particular single teaching approach or strategy. It conglomerates a wide variety of teaching-learning approaches that ultimately lead to self-construction of knowledge by students. In a constructivist classroom, teacher intends to have his students explore concepts in an organic way focusing on teaching students how to learn, instead of just giving them information about facts

Constructive Pedagogy follows five major principles viz. 1. Students' points of view are sought and valued; 2. Designing such classroom activities that challenge student assumptions; and

3. Teachers pose relevant problems; Minor or subsuming concepts are developed around the major concepts; and Assessment of learning attainment is done contextually and continuously. Constructive Pedagogy perceives the student as an active self-constructor of knowledge but not a passive recipient of information; It designs new and challenging activities to ignite thinking, analyzing, reasoning and applying; It enables students connecting their newly constructed knowledge to life outside the school; Learning is shifted away from rote methods; Curriculum transacted goes beyond text book; evaluation is continuous, comprehensive, more flexible and non-threatening; and democratic values like equality, justice, secularism, freedom of thought and expression etc. are integrated; No constraints such as gender, class, creed; highly experiential, interactive with more scope for students expression.

Constructivist Teacher – An extreme Facilitator: While employing the constructive pedagogy in classes, teachers shall perceive themselves as extreme facilitators and are expected to play their role to the core. Any constructivist strategy, technique or approach they employ shall give optimum scope for, knowledge construction by students and not knowledge reproduction; providing multiple representations of reality; emphasizing authentic tasks in a meaningful context rather than abstract instruction out of context; motivating students for thoughtful reflection on their classroom learning experiences; experiential learning and not conventional teaching; extended learner autonomy and initiative; encouraging inquiry among students; nurturing learners natural inquisitiveness; taking into account the learner's mental model at optimum; involving learners in real world situations; supporting co-operative learning; and in total learning should be a joyful experience of self-construction of knowledge.

An Illustrative model of Constructivist Learning – 5 Es' Model: In this regard, One of the most popular and quiet often used instructional model based on constructivist theory, **Five E's (5Es) model**, was developed by **Roger Bybee**. This model for implementing constructivism in the classroom suggests that constructivists' lessons should engage students, allow them to explore, aid them in explaining their experience, learning is elaborated, and the lesson includes evaluation. The dynamics of learning in this model is pivoted on active participation of students through continuous interaction with peer members, with learning context and of course with the teacher too, who is a facilitator. This enterprise percolates and cuts across five identified and labelled integral dimensions of constructivist learning viz. **Engage – Explore – Explain – Elaborate – Evaluate**. Several instructional strategies are evolved using this model.

Methodology of the study

Title of the Study: An analytical study of the Dynamics of Constructivist Pedagogy of Pre-Service Science Teachers at Secondary level.

Objectives of the Study: In the present study efforts are made to study how the pre-service Science teachers tried to execute constructive pedagogy after they were theoretically oriented with Constructivist approach of teaching by the researcher followed by a series of demonstrations by practitioner teachers.

The main objectives of the study have been,

1. To study the impact of theoretical orientation and practical demonstrations on Constructivist approach and the attainment of Constructivist Pedagogic skills of pre service teachers.
2. To analyse the dynamics of Constructivist Pedagogy when teachers employ 5Es model of teaching Science.
3. To analyse the application of 5Es model of teaching Science at Sec. level
4. To study the feasibility of 5Es model in the teaching of Science at Sec. level
5. To study the reaction of both students and pre-service teachers towards using of 5Es model for constructivist teaching and learning of Science

Population, Sample and Sampling Procedure: The population of the study is the Pre-service Science teachers. The sample for the present study includes 43 student teachers of Science Pedagogy studying in Sarada Vilas Teachers College, Mysore during the academic year 2014-15. All students of Science pedagogy were considered for the study.

Construction of Tools and Collection of data: An observation Schedule for classroom interaction analysis was developed by the researcher to follow the track of the teachers regarding creating constructivist learning environment; their attempts to make students learn constructing their own knowledge; involving them in engaging, exploring, explaining, and elaborating/applying; how teacher evaluates during and at the end; Learners' behaviour, teachers' way of handling students' responses etc. The schedule was constructed considering three integral dimensions of Constructivism – Constructivist teacher behaviour, Executing constructivist learning strategies and designing constructivist classroom. It consisted of 32 parameters for which one score was allotted to each making a maximum score of thirty two and a minimum zero.

In total, the observation schedule was specifically developed to analyse the following:

- ✓ Whether Students are not passive recipients of information or active "producers of new knowledge"
- ✓ Were there stresses on "knowledge construction" and not "knowledge reproduction".
- ✓ Whether teachers provide opportunities for "multiple representations" of reality.
- ✓ Was there emphasis on authentic tasks in a meaningful context rather than abstract instruction out of context?
- ✓ Whether the teachers encourages thoughtful reflection on multi-sensory experiences
- ✓ Whether students were context and content dependent to be able to construct new knowledge.
- ✓ Whether more importance given on students learning and not teaching,
- ✓ Were teachers encourage learner autonomy and initiative
- ✓ Whether learning was a process and not a product, i.e., it's more a process than a product
- ✓ Were teachers encourage learners' inquiry that leads to autonomous learning
- ✓ Were there continuous efforts to nurtures learners' natural curiosity or inquisitiveness
- ✓ Whether teachers designed tasks/ experiences that lead to self-learning considering learner's mental model into account.
- ✓ Was there involvement of learners in real world situations that may lead them to extend classroom learning to real life situations at required times.
- ✓ Was there enough scope for students' co-operative learning in a conducive classroom atmosphere?
- ✓ Was there emphasis on performance and understanding when assessing learners
- ✓ Were there continuous efforts by teachers to nurture natural instincts of Enthusiasm and Inquisitiveness of students with Self-Learning environment?

The multiple roles of teachers were also observed and analyzed to see whether they are truly Constructivistic in their approach and how they designed their Constructivist Classroom

- ➢ Whether the teacher is one of many resources that the student may learn from and the primary sources of information.
- ➢ Whether the teachers engage students in experiences that challenge previous conceptions of their existing knowledge.
- ➢ Whether the teachers allow student responses to drive the lessons and seek elaborations of students' initial responses.
- ➢ Whether the teachers give sufficient time for students for their own thinking and pose questions.

- Whether the teachers encourage the spirit of questioning by thoughtful and open-ended questions.
- Whether the teachers encourage thoughtful discussions among students.
- Whether the teachers use cognitive terminology such as 'classify', 'analyze', and 'create' when framing tasks.
- Whether the teachers encourage and accept student autonomy and initiative.
- Whether at times, be willing to let go of classroom control.
- Whether teachers use raw data and primary sources, along with manipulative and interactive physical materials.
- Whether the teachers insist on clear expression from students.
- Whether enough scope was given to students to communicate their understanding.
- Whether the teachers try to promote student leadership, collaboration and creative thinking
- Whether the teachers encourage the use of alternate sources for information both from written materials and electronic media when required.
- Encourage students to challenge each other's conceptualizations to promote interactive learning
- Whether teachers gave sufficient opportunities students apply their constructed knowledge in solving real-life problems.

Methodology of the Study: 43 student teachers of Science Pedagogy (28 Physics-Maths and 15 Chemistry-Biology combination) studying in Sarada Vilas Teachers College, Mysore were taught NCF-2005 comprehensively with a special focus on Constructivist learning. They were taught intensively on becoming a constructivist teacher; modifying routine classrooms into constructivist classrooms and creating constructivist learning environment. This was followed by a special orientation on 5Es model and finally they were given sequel demonstrations by Science teachers who were trained by the department of Sec. Education on the application of 5Es model. They were also trained on developing Lesson transcripts based on 5Es model.

The student-teachers involved in the study taught concepts in Physics, Chemistry and Biology prescribed in 8th and 9th standard Science text books of Karnataka State Syllabus. Two lessons of each student teacher in Physics, Chemistry and Biology were observed. 56 Physics lessons of 28 Physics –students and 30 Chemistry plus 30 Biology lessons of 15 Chemistry – Biology combination students, in total, about 116 lessons were observed and analyzed using the researcher developed Lesson Observation Profiles. In the first cycle, one lesson from each student on each subject was observed and amalysed. The lesson was followed by Reflective feedback and

suggestions so as to enhance the impact of constructivist components in the II cycle. Again the second lesson was observed and analysed to see whether any impact of the orientation and feedback.

1.Findings of the Study:

Finding-1: It was found that, there was a low impact of theoretical orientation and Practical Demonstration on Constructivist approach on the attainment of Constructivist Pedagogic skills among a very few teachers (6 out of 58): average impact on a little more number (10 out of 58) of teachers and high impact was observed among more number of teachers (42 out of 58).

Subjects	Impact Levels			
	N	Low	Average	High
Physics	**28**	2	5	21
Chemistry	**15**	2	3	10
Biology	**15**	2	2	11
Total	**58**	06	10	**42**

Finding-2: In most of the cases, sufficient care was taken to see that the students are actively participating in generating their own thoughts rather than being passive in anticipation of information. Consistent trials by teachers were seen to ascertain the "knowledge construction" and not "knowledge reproduction "by students. Students were context and content dependent to be able to construct new knowledge. Teachers encourage learners' inquiry that leads to autonomous learning. There were continuous efforts to nurtures learners' natural curiosity or inquisitiveness

Teachers used to provide opportunities for "multiple representations" of reality in terms of providing learning contexts close to real life situations. Teachers provided sufficient multi-sensory experiences consistently to encourage students to have thoughtful reflections

More importance was given on students learning than just teaching. In fact it was more a facilitation exercise for teachers as teachers encourage learner autonomy and initiative through continuous elicitation and reflection. Learning among students was more as a process and not as a product. Teachers designed tasks/ experiences that lead to self-learning considering learner's mental model into account.

Learners were given real world situations that lead them to extend classroom learning to real life situations at required times. There was enough scope for students' co-operative learning

through inter personal communication / discussion. Teachers put continuous efforts to nurture students' natural instincts curiosity and Enthusiasm

Finding-3: The constructivist approach of teaching is best reflected while using 5Es model. The syntax of the model has both 'Linear approach' (for Mono-Conceptual lessons) where the teachers follow a given sequence rigidly and 'Blended approach' (for Multi-Conceptual lessons) where the different stages are conglomerated as per the learning experiences planned and designed. The lessons taught by the sample pre-service teachers were carefully observed to analyse which approach was predominantly used and how the prescribed stages such as Engage (both – physical and mental), Explore, Explain, Elaborate (Extend from classroom to outside life / apply in required situation) and Evaluate. Using the researcher developed Observation Schedule, the degree of adherence to the 5Es and how stage-specific complementary learning strategies were designed and employed.

5Es Stages		**Engage**		**Explore**		**Explain**		**Elaborate**		**Evaluate**	
Subjects	**N**	**C-1**	**C-2**	**C-1**	**C-2**	**C-1**	**C-2**	**C-1**	**C-2**	**C-1**	**C-2**
Physics	**56**	48	52	36	42	40	52	32	36	52	56
Chemistry	**30**	26	28	24	26	18	22	20	24	27	29
Biology	**30**	24	28	26	28	24	26	22	28	28	30
Gen. Science	**116**	**98**	**108**	**86**	**96**	**82**	**100**	**74**	**88**	**107**	**115**

It is evident from the summary table that the number of pre-service teachers who strictly adhered to the prescribed stages and how these stages were objectively employed was comparatively more in cycle-2 than cycle-1. It may be inferred that it's by and large the impact of immediate feedback and constructivist suggestions given and monitored to ascertain the adherence in the II cycle. It was true when individual subjects were considered and also when Gen. Science in total was considered. Even the modes of constructivist approach with 5Es model were analysed (Linear and Blended).

Finding-4: Researcher had a focused discussion with the demonstrators, pre service teachers, and cooperative science teachers of the schools and even with the secondary science students of the experimental schools about the compatibility and feasibility of 5Es model for teaching Science at secondary level. By and large it was opined that 5Es model is very appropriate for igniting

inquisitiveness, enthusiastic learning, participatory learning, cooperative learning and self-learning. In a way it reflects all the dimensions and parameters of scientific learning, discovery learning with more of inductive approach. It was also opined that not all lessons in science can be taught using this model as it's difficult to plug in the first four stages, difficult to complete the contents within a stipulated time that is 40-45 minutes. Not all teachers can employ this as it requires training for systematic planning and execution. The same opinions were reflected through the reaction scales administered on students and teachers

Conclusions: High knowledge explosion is a predominant feature of the 21st century. The new world witnesses a huge population of new generation of students who live in knowledge and skill driven society and who are hungry of higher level knowledge and skills. It's high time to anticipate the academic requirements of the next-gen students, who will definitely have enormous urge and instincts for knowledge and skills added with high achievement motivation.

It is indeed becoming a growing challenge for teachers to manage the hyper inquisitive learners of the present world in their schools and classrooms If teaching becomes dry and drab with the same conventional method and approaches, it's sure that this new generation learners may get disappointed, loose interest, get demotivated and move away from teachers and formal schooling. So it's the ethically bound duty of teachers to rediscover themselves and employ innovative strategies and approaches. This needs to be immediately addressed and attention has to be on making classrooms and schools-the epicenters of knowledge explosion. Constructivist pedagogy would definitely empower the teachers with constructivist competencies that fulfil the learning needs of the next-gen students.

There is a scientist among every student. The role of the teacher is to pull out the scientist from the student. Teachers must be facilitators who create such learning situations which enable students construct their own knowledge. They shall not be passive recipients of information but rather, active producers of new knowledge.

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