Process Based Teaching Strategies as a Gateway to Attain Learning Outcomes and Nurture Higher Order Thinking Skills – Skill Enhancement for Teachers and Teacher Educators

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Abstract- *Attainment of higher order thinking skills are the backbone to achieving 21st century learning skills. Teaching - Learning of Science must essentially include the three major dimensions. I. Science as product, II. Science as process and III. Science as an attitude for daily life experiences. To attain the aim of Science Education in all its dimensions, the teaching learning process of science needs to steer its focus on Process Based Teaching. Process based teaching ensures all round learning of science, as the right application of science processes innately ensures development of right product of science and scientific attitude. We have known strategies such as discovery learning, inquiry learning, problem-based learning and project-based learning for long as strategies that enhance science process skills. These processes are significant component of recently composed learning outcomes by NCERT.This paper focus on the science teacher's reflection on various process-based teaching strategies and its effectiveness on attaining learning outcomes and developing science process skills and higher order thinking skills. Sample of the study was upper primary teachers and DIET faculties of Tamilnadu, Karnataka and Puducherry who participated in five-day training workshop on "Process Based Teaching and Evaluation in Science at Upper Primary Level" at Regional Institute of Education, Mysuru. Data was collected from the participants through pre-test and post test conducted in each session of the training programme and personal interview conducted with the participants and the feedback obtained from them. The result shows that there is a need to practice different process-based teaching strategies in normal classroom to provide scope for development of science processes amongst the next generation students. Also, the assessment of these processes, need to shift from product assessment to process assessment. Teachers need to gain skills to measure these processes by developing Activity specific Rubrics.*

Keywords: Process Based Teaching, Learning outcomes, Higher Order Thinking Skills

Introduction

The purpose of Education is to identify the abilities and interests of the child, provided with opportunities to manipulate information in productive ways, so that the learning becomes much more meaningful. It the teacher follows process approach to learning – an approach which provides students with an abundance of projects, activities, and instructional designs that allow them to make decisions and solve problems, students will get a sense that learning is much more than the commission of facts to memory. It is what children do with that knowledge that determines its impact on their attitudes and aptitudes. A process approach to teaching science allows students to practice process skills of discipline and construct knowledge. It is one in which children do something with the concepts and generalizations they learn. It implies that students can manipulate, decide, solve, predict, and structure the knowledge of science in ways that are meaningful to them. When teachers provide opportunities for students to actively process information – particularly information related to nature, then learning becomes more child-centered. This results in attitudes, perceptions, and beliefs that the natural world can be actively explored and personally investigated – and that the environment, both near and far, is full of incredible learning possibilities along with a whole lot of fun. Carol Malnor (2011).

Process based learning is a holistic approach, learning is taken as a whole rather than teaching to specific targeted objectives. The learner decides the pace and direction of the learning and therefore the pace and direction of the teaching too. The teacher may prompt and try different strategies to elicit progress but will ultimately be guided to the learning outcomes by the student (Imray and Hinchcliffe 2014).

Different process based teaching strategies can be implemented by the teacher so that children will be benefited and they can be reach their maximum potential. It will leads to the development of science process skills and higher order thinking skills.

The learning outcomes

"The literature on 'Education for All' (EFA), in the last three decades emphasised on quality of education. Quality in education considered in terms of enrolment, retention and achievement Also, including desirable characteristics of learners, learning processes, facilities, learning materials, contents, governance and management and learning outcomes. Improving the quality of learning has consistently been in focus under the Sarva Shiksha Abhiyan (SSA), and the Right to Education (RTE) Act. All the National Curriculum Frameworks developed by the NCERT and other important government initiatives have also included quality as a prime goal. It envisaged that all children learn the basics and have opportunities to acquire the transferable skills needed to become global citizens." Learning outcomes –NCERT 2017

This necessitates setting clear and measurable goals. Hence collecting information on efficacy of system in making rational decisions. Various assessment surveys (NAS/SLAS) in this regard also need initiatives in this direction. In addition to these, different stakeholders at the school and community level also play a crucial role towards quality improvement in education.

As per the recent Global Monitoring Report (GMR)-2015, there have been impressive gains in access to education in developing countries including India but improvement in quality still remains a concern. In India, different achievement surveys such as the Annual Status of

Education Report (ASER), reported wide disparities in students' achievement of basic skills across states, which was also affirmed by the National Achievement Survey (NAS) of class III, (MHRD, 2014).

Reports of Joint Review Missions for SSA in the past few years also mentioned that the learning levels of children are not up to the desirable level in spite of all the efforts made by the States/UTs in terms of timely provision of teaching-learning and resource materials, teacher

Deployment and regular monitoring. These report a decline in outcomes of reading ability as well as numerical/ mathematical ability which is a major concern at present. Keeping this in view, quality as measured by learning outcomes to be achieved by all, especially for literacy, numeracy and essential life skills is crucial. The focus of Twelfth Five Year Plan for basic learning as an explicit objective of primary education and the need for regular learning assessments to make sure quality goals are met. It is also in consonance with the recommendations of GMR-2015 and the Sustainable Development Goals. Thus, monitoring of quality through assessments of learning outcomes at regional, national, and international levels is important. At the same time a vigil at the ground level by different stakeholders such as parents and community, for their accomplishment makes the system informed and accountable to adopt corrective measures at appropriate levels.

Learning Outcomes are assessment standards indicating the expected levels of learning that children should achieve for that class. These outcomes can be used as check points to assess learning at different points of time. The learning outcomes would help teachers to understand theLearning levels of children in their respective classes individually as well as collectively. Learning outcomes should be the point of reference for conducting achievement surveys. Hence it is necessary that the defined Learning Outcomes are also shared with parents and community at large. It has now been proposed to include the defined Learning Outcomes in the Central Rules of the Right of Children to Free and Compulsory Education (RTE) Act, 2009. These Rules will be applicable to all schools including government, aided and private schools. The NCERT has developed Learning Outcomes for each class in Languages, Mathematics, Environmental Studies, Science and Social Science up to the Elementary stage. Care has been taken to develop the outcomes following consultations with States, UTs, SCERTs and education experts from organizations including civil society organizations. The Learning Outcomes developed byNCERT are the minimum levels of learning to facilitate the monitoring of students against expected benchmarks.

Most often, teachers are not clear about what kind of learning is desired and the criteria against which it could be assessed. They use textbooks as the complete curriculum and assess

children using questions given at the unit end exercises. The contextual variations in textual material andVariations in pedagogy adopted are generally not considered, for there are no criteria to assess them. The learning outcomes for each class not only help the teachers to direct their teaching-learning in the desired manner but make other stakeholders especially the parents/guardians, School Management Committee (SMC) members, community and the state functionaries be responsible and alert towards their role for ensuring quality education. So, the learning outcomes defined explicitly can guide and ensure the responsibility and accountability of different stakeholders for the accomplishment by expectations in different curricular areas.

The Science Process Skills: Science is an active way or method of obtaining knowledge; asking questions and finding answers systematically. Pollak (1993) defines science as the "study of patterns in nature" (p.157) and argues that scientific knowledge comes eventually from experience; it is not called as science when the knowledge is not rooted in experience. He stated that science cannot be considered without process; without process there is always need to go back and start from beginning. Gottlieb (1997) describes science as an intellectual activity carried out by humans that is intended to find out information about the natural world in which humans live and to determine the ways in which this information can be organized into meaningful patterns. A primary aim of science is to collect facts by systematic and organized way.

Science, more than collected knowledge, is a process which should be considered in science education. The development of science process skills should be involved in the goals of science education as well as the transmission of science concepts (Rolaid, 2004). Like riding a bike, or playing baseball, a person must be taught to 'do science' from a practical point of view (Kujawinski, 1997). Therefore, it is better for students to gain the skills of accessing and analysing the knowledge besides learning the accumulated scientific facts (Biglin, 2006; McDermott, 1991).

The ability to question, discover and inquire new ideas which are parts of process skills are critical competencies for the 21st century. Developing these skills in school will lead students to understand the dimensions of actual work of scientists and make meaningful decisions in their life. Science process skills are mainly defined as the processes that scientists use in the processes of doing science. Science education is not just about learning facts in a classroom, it's about doing activities where students put their understanding of science principles into action" (NCES 2012, p.1).

Basic Skills and integrated skills were discussed during the session – Observation, Measuring, Inferring, Classifying, Predicting, Communicating, formulating hypothesis, Identifying and controlling variables, Making and designing experiments.

Process based Strategies: Discovery learning

Discovery learning is a technique that was introduced in 1961 by American psychologist Jerome Bruner. It is a approach to learning that follows the motto that learning should be by doing. According to Bruner, "*Practice in discovering for oneself teaches one to acquire information in a way that makes that information more readily viable in problem solving*." Discovery-based learning is characterized by minimized participation of the teacher in the learning process. The idea is that the student is not given the answer but rather the means to reach it. It is a method that allows the learners to interact with the environment, explore and perform experiments. Discovery learning is also referred to as problem-based learning or experiential learning. At the time of its introduction it was seen as the "21st century learning," Discovery-based learning requires a more active approach to problem-solving situations. The learners are encouraged to ask questions, give suggestions and identify various solutions to the given task. The goal of this type of learning is to engage the learner in a self-guided exploration, where they formulate their own ideas and reach conclusions based on the given data. The learner even has the freedom to challenge a given theory and provide a better version. This is quite practical for the modern educational setting, where innovation should be fostered in any possible way. Therefore, discovery-based learning is an efficient tool to boost the confidence of learners. They learn how to manage problems and stand-behind their ideas, how to find answers and solutions in a setting that is as close to real-life situations as possible.

Concept attainment Model: Concept Attainment Model is given by Jerome Bruner. This model requires a student to figure out the attributes of a category that is already formed in another person's mind by comparing and contrasting example (called exemplars) that contain the characteristics (called attributes) of the concepts with examples that do not contain those attributes.

Examplars: Essentially the examplars are a subset of a collection of data or a data sets. The category is the subset or collection of examples that share one or more characteristics that are missing in the others. It is by comparing the positive examplars and contrasting them with the negative ones that the concept or category is learned.

In the present study CAM is used as a tool to help the students to attain the concepts of English Grammar.

Components of Concept Attainment Model

(a) Syntax

In Concept Attainment Model phase one involves presenting data to the learner. Each unit of data is a separate example or non-example of the concept. The units are presented in pairs. The data may be events, people, objects, stories, pictures or any other discriminable units.

In phase two, the students test their attainment of the concept, first by correctly identifying additional unlabeled examples of the concept and then by generating their own examples.

In phase three, students begin to analyze the strategies by which they attain concepts.

Problem Based learning: Problem-Based Learning (PBL) is a teaching method in which complex real-world problems are used as the vehicle to promote student learning of concepts and principles as opposed to direct presentation of facts and concepts.

Problem Based Learning (PBL) implies a learning process where outcomes are attained from the process of solving problems. Therefore, problems are both in context and a motivation for learning; the problem-solving process is the tool for obtaining the learning outcome.

Any subject area can be adapted to PBL with a little creativity. While the core problems will vary among disciplines, there are some characteristics of good PBL problems that transcend fields (Duch, Groh, and Allen, 2001):

- The problem must motivate students to seek out a deeper understanding of concepts.
- The problem should require students to make reasoned decisions and to defend them.
- The problem should incorporate the content objectives in such a way as to connect it to previous courses/knowledge.
- If used for a group project, the problem needs a level of complexity to ensure that the students must work together to solve it.

  The problems can come from a variety of sources: newspapers, magazines, journals, books, textbooks, and television/ movies. Some are in such form that they can be used with little editing; however, others need to be rewritten to be of use. The following guidelines from The Power of Problem-Based Learning (Duch et al, 2001) are written for creating PBL problems for a class centered on the method; however, the general ideas can be applied in simpler uses of PBL:

- Choose a central idea, concept, or principle that is always taught in a given course, and then think of a typical end-of-chapter problem, assignment, or homework that is usually assigned to students to help them learn that concept. List the learning objectives that students should meet when they work through the problem.
- Think of a real-world context for the concept under consideration. Develop a storytelling aspect to an end-of-chapter problem, or research an actual case that can be adapted, adding some motivation for students to solve the problem. More complex problems will challenge students to go beyond simple plug-and-chug to solve it. Look at magazines, newspapers, and articles for ideas on the story line. Some PBL practitioners talk to

professionals in the field, searching for ideas of realistic applications of the concept being taught.

- The problem needs to be introduced in stages so that students will be able to identify learning issues that will lead them to research the targeted concepts. The following are some questions that may help guide this process:
    - What will the first page (or stage) look like? What open-ended questions can be asked? What learning issues will be identified?
    - How will the problem be structured?
    - How long will the problem be? How many class periods will it take to complete?
    - Will students be given information in subsequent pages (or stages) as they work through the problem?
    - What resources will the students need?
    - What end product will the students produce at the completion of the problem?
- Write a teacher's guide detailing the instructional plans on using the problem in the course. If the course is a medium- to large-size class, a combination of mini-lectures, whole-class discussions, and small group work with regular reporting may be necessary. The teacher's guide can indicate plans or options for cycling through the pages of the problem interspersing the various modes of learning.
- The final step is to identify key resources for students. Students need to learn to identify and utilize learning resources on their own, but it can be helpful if the instructor indicates a few good sources to get them started. Many students will want to limit their research to the Internet, so it will be important to guide them toward the library as well.

Need and significance of the study

Most often, teachers depend completely on text book for curriculum and unit end exercises as assessment. This tends to make learning memorization more than a meaning making process. This assessment fails to gather information on learning progress of student and learning processes embedded in discipline. It also ignores contextualized pedagogy and rich knowledge innate in learner as there are no criteria to assess them.

The learning outcomes for each class not only help the teachers to direct their teaching-learning in the desired manner but make other stakeholders especially the parents/guardians, School Management Committee (SMC) members, community and the state functionaries be responsible and alert towards their role for ensuring quality education.

Awareness in science process skills, strategies to develop these skills and their assessment in this context is essential feature for successful attainment of learning outcomes. As initiative to effectuate awareness on these process skills which are inherent part of learning outcomes drafted, training workshop was conducted at RIE Mysuru for teachers and DIET faculties of southern region. Since the workshop dealt with imparting skills to participants on teaching learning strategies in process based approach, it planned to conduct various formative assessment for check efficiency of programme implementation. Researchers could see scope to study various aspects the programme and generate implications for future such programmes.

Research Questions

So, with research questions regarding "What is the efficacy of Planned activities to:-

- Enhance participants understanding of science process skills and its role to develop higher order thinking skills.
- To let participants perform activities in science and identify skills they need to use in performing these activities and connect it to prescribed learning outcomes.
- Develop competence amongst participants to analyze their respective content (from text books) and identify appropriate process skills for corresponding content forms amongst the learners.
- Develop competence amongst participants to assess learning outcomes of Science process skill.
- Develop ability amongst participants to create rubrics to assess learning outcomes.
- Collect reflections from participants on their disposition to implement process skills in their teaching learning program.
- Collect suggestions from participants for improvement of the program.

Objectives of the study

- To study the awareness of participants regarding process based teaching strategies, science process skills and assessing their learning outcomes.
- To study the Awareness of participants about role of science process skills to develop Higher order thinking skills.
- Enhance participants understanding of science process skills and its role to develop higher order thinking skills.
- To study participants ability to identify skills they need to use in performing activities and connect it to prescribed learning outcomes.
- To study participants willingness to implement Process based approach and collect feedback for improving training programme

Methodology

This study focus on science teacher's reflection on various process based teaching strategies and its effectiveness on attaining learning outcomes and developing science process skills and higher order thinking skills.

Sample of the study was upper primary teachers and DIET faculties of Tamilnadu, Karnataka and Puthuchery who participated a training programme on "Process based teaching strategies and its assessment" conducted in Regional Institute of Education, Mysuru. Data was collected from the participants through the pre test and post test conducted in each session of the training programme and personal interview conducted with the participants and the feedback obtained from them. A five day training programme was planned with sessions to facilitate understanding, Strategies, and skill for "Process based teaching approach and its evaluation."

Sessions majorly included

1. Discussion on Aims and objective of teaching science – "What and why of science?" It came with major reflections in specific importance to science process skills in science education and role of learning outcomes to assess these skills.
2. Pre discussion on teacher's appraisal of attainment of attainment of learning outcomes and transactional strategies and assessment practices.
3. Discussion cum Demonstration session on Content analysis. It covered identifying content form, learning processes leading to formation of this content forms, and their specific outcomes.
4. Discussion cum Demonstration session on Science Process Skills.
5. Discussion cum Demonstration session on learning outcomes for science process skills.
6. Brain storming on Pedagogical shift – Is there a need to change the way we teach? From product to process learning and learning outcomes and higher order thinking skills
7. Teachers engagement in science activities and identifying process skills involved
8. Demonstration of lessons using various process based teaching strategies and model like Concept attainment model, inquiry training model, Problem based learning, problem solving method and Guided Discovery. Participants were asked to analyse process skills used through these strategies. After identifying each skill they had to specify how they can assess if learner is engaged in the above identified process skills and grade it using rubric.
1. Participants were asked to redesign the unit plan they did before training program in context ofThe "process based approach".

The training includes various sessions focusing on the following areas such as importance of pedagogical shift in the area of teaching science, understanding the science process skills, understanding and demonstrating of the various process based teaching strategies such as discovery method, inquiry method, problem based learning and project based learning, and tools and techniques included in the assessment of process based teaching.

Suggestions and Recommendations

Similar training programmes can be held for various teachers and teacher educators to enhance skills of practicing process based strategies and evaluation.Online program in this context can enhance the reach across geographical and time boundariesIt is recommended that for successful implementation ofIn view of proposal to include the defined Learning Outcomes in the Central Rules of the Right of Children to Free and Compulsory Education (RTE) Act, 2009, it is imminent that in service teachers be strengthened to practice process based teaching learning and have clear understanding of learning outcomes. Its role and significance to achieve the much coveted quality education. To improve the status failing status of elementary skills it is pertinent to provide scope to learners to practice these skills than mere memorization, which will also enhance their higher order thinking Skills.

Conclusion

Enhancement of the theoretical perspectives on Process Skills, is needed to implement process based learning. A general discussion of the Science Process Skills, as given by various experts, reveals that the Science Process Skills fit the premise of understanding and collectively contribute to the establishment of the skills as operational outcomes whose mastery should be regarded as foundational to the understanding of Science. The current emphasis on 'Process Approach' to school Science teaching transcends national boundaries and has become the practice of a growing number of Science teachers particularly in Secondary Schools. The training workshop adopted by researchers to study its suitability proven to be effective.

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