Exploring the Features of Metacognition and Achievement Goals in Process Oriented Guided Inquiry Learning Instruction (POGIL)

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Abstract:

Explosions are occurred all over the world, especially in sociological, technological and economical spheres at the faster rates. The process of education channelizes the students to acquire knowledge and skills to survive in this dynamic world. Science education needs to challenge this situation through the development of the little scientist who is able to generate, invent new ideas and concepts in the light of inquiry activities. Scientific skills which are emerging out of the effective processes are the backbone of all emerging scientific theories and investigations. Scientific skills like problem solving, critical and creative thinking etc. which incorporates self reflection and intrinsic motivation will help the learners to accomplish desired aims and objectives. Scientific process skills are broadly transferable in new situations and more permanent in nature. In the present study the researcher intend to explore the possibility of meta-cognition and goal orientation of learners which are the real facts that lead learners for the fulfilment of science process skills through Process Oriented Guided Inquiry Learning Instruction (POGIL) environment.

Keywords: *Achievement Goals, Co-operative Learning, Meta-cognition, Process Oriented Guided Inquiry Learning (POGIL), Self-management, Self-regulation, Scientific Literacy.*

I. INTRODUCTION

Science is a kind of journey in to the unknown, with all the uncertainties that new ventures entail. Doing science means using intuition; creating abstract ideas out of concrete instances and find out the reasons (Rowe, 1973). According to the psychologist Robert Gagne, the processes are common to all the various scientific disciplines, regardless of whether a scientist is a biologist or a chemist or a physicist. Both students and teachers in the educational sector are frustrated with lack of achievement and performance from elementary to higher level of learning. One of the cause behind this is students are missing the experience of science as the exchange and evolution of ideas, difficulty in understanding and applying science and transferring of skills in and across the discipline (Bodner, 1986). To address the situation the beneficiaries should recognize that education has two components namely content and process.

Science education needs to be concentrated simultaneously with both the structure of knowledge, basis of the content component, and with the development of the skills for acquiring, applying, and generating knowledge, which is the process component. Process skills become increasingly important as our knowledge base expands, as society addresses interdisciplinary and more complicated problems, and as businesses seek technological developments on shorter and shorter time scales. Under these conditions, those with highly developed process skills are those who will be most successful (Hanson, 2006).

Process Oriented Guided Inquiry Learning (POGIL) is an Inquiry learning strategy which considers the nature and the outcomes of science. It provides methodologically and structurally suitable way by identifying one's own learning styles and expanded toward the desired objectives of learning. Researches in the field of cognitive science identified that an individual construct new ideas based upon their previous knowledge and experiences, need to explore on concept formation and application, interact others with multiple presentations and reflection and assessment of all strategies followed. These elements are very critical in developing higher cognitive abilities under the category of metacognitive abilities (Memnun, 2012). Hence the concept of Metacognition is also incorporated in the design of POGIL.

II. NEED AND SIGNIFICANCE

In this world of information explosion, stakeholders of education faced several challenges related with developmental process, delivery of content and assessment of anticipated outcomes. Traditionally the rationale behind science education has been that students need to get the facts before they can apply them. This makes the subject of science more dry and passive (Zavadski, 2010). Reflections of teaching will help the students to understand the key concepts and ideas, building and extension of new ideas, team work and proper communication through verbal and non verbal means (Kussmaul & Tpirmann, 2012). For challenging these needs revisions must be starting from the structural aspect of the content. Hence a famous chemistry educationist Hanson, D.M. in 2006 proposed Process Oriented Guided Inquiry Learning (POGIL) and released an instructor's guide for implementing the same. It is a learner cantered teaching

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strategy developed for the science classroom and more specifically the Chemistry by incorporating teaching method based on cooperative learning, constructivism, and the learning cycle. Review of related studies in the field of POGIL is very few and the investigator noticed that this approach is mainly concentrated to enhance the achievement in Chemistry. The purpose of the article is to awake and aware the community about the application of POGIL and explore the connection with metacognition and achievement goals.

Metacognition is a skill for successful learning and it is an important predictor of academic success (Dunning et al, 2003 & Kruger & Dunning, 1999). When the learners are able to realize that they can pursue their own intellectual needs, they will discover a world of information at their fingertips and the tools needed to fully take advantage of resources (Narang & Saini, 2013). POGIL creates an awareness and understanding of how one thinks and uses various strategies during teaching/learning process.

Whenever students are in learning environments, they are believed to have certain goals towards learning, referred to as achievement goals (Dweck, 1989) and mastery goals are linked with outcomes like self efficacy, good metacognition and academic performance (Coutinho, 2007).The goal orientations which may either mastery or performance goals adopted by students also influences the effort they exhibit in learning tasks and the type of learning strategies they use (Coutinho, 2007). The present study emphasizes on Metacognition and Goal Orientation which may relate with students' academic achievement so as to depict important theoretical as well as practical implications which may serve as a foundation for the effectiveness of the teaching learning process.

III. OBJECTIVES

The researcher wants to seek answers for the following objectives.

- To explore the element of metacognition in POGIL classroom environment.
- To explore the ways of Achievement Goal Orientation in POGIL classroom situation.
- To study the possibility of POGIL method for Process Skill development for Secondary school students in Kerala context.

IV. PROCESS ORIENTED GUIDED INQUIRY LEARNING (POGIL)

Process-Oriented Guided-Inquiry Learning (POGIL) is a classroom situation in which students work in learning teams on specially designed activities that promote mastery of discipline content and the development of skills in the processes of learning, thinking, problem solving, communication, teamwork, management, and assessment. The POGIL classroom environment is appropriate for faculty who want to engage students in learning and help students develop the skills they need to be successful in courses, college, and careers. In this environment, students take on greater responsibility for their education; they learn to rely on thinking skills rather than memorization; they improve performance skills while learning subject content; and they develop positive relationships with other students and faculty (Hanson, 2006). Inquiry refers to the evidence-based process that scientists engage in to study and propose explanations about aspects of the natural world. When applied to students in science classrooms, inquiry learning generally indicates student participation in activities and thinking processes similar to those employed by scientists. POGIL is built on this research base with the idea that most students learn best when they are:

- Actively engaged and thinking in the classroom and laboratory.
- Drawing conclusions by analyzing data, models, or examples and by discussing ideas.
- Working together in self-managed teams to understand concepts and to solve problems.
- Reflecting on what they have learned and on improving their performance.
- Interacting with an instructor as a facilitator of learning.

Definition:

POGIL is a pedagogical method of instruction which incorporates the learning cycle, co-operative learning and constructivism. Two guiding principles of POGIL classroom are;

1. Guided inquiry activities designed – based on learning cycle and
2. Co-operative learning

Learning cycle of POGIL consist of the following stages. All these are carried out in co-operative learning environment.

1. Exploration. In this stage the learners are exposed to a model and questions which demand higher order thinking based on this model. This leads to the deeper understanding of the concept acquired
2. Concept Invention. Based on questions that stimulate the students to look for patterns or trends in the data. That is exploration gave a way to concept invention.
3. Application. Learners are applied this concepts in new situations.

V. PROPERTIES OF POGIL

Properties of POGIL are as follows:

Learning through Teams

Students are learned in groups containing 5 to 6 members. Group members are shuffled at regular intervals within a week or month. Mistakes are committed and solved through peaceful manner with involvement of teacher at the appropriate time. In this step questioning is also promoted in between teacher and pupil and also between peers. Through this students got chance for self reflection (Eberlien, 2008).

Guided inquiry activity

In this stage the learner passed through the above well defined stages of exploration, concept invention or formation and application. In this exploration teacher provide chance to reply answer to the questions based on their previous

knowledge. Various process skills like observation, communication, making inference and higher order thinking skills like problem solving skills, creative and critical thinking are used and applied (Hanson, 2006). POGIL questions take the form of directed to point out obvious points, convergent to synthesize relationships, and divergent with no unique answers, but all are designed to model new and unknown situations that can be analyzed and made understandable by asking questions and then finding solutions. Structured problems are found in classrooms and textbooks, unstructured problems or real-world require a new approach, and complex unstructured problems have no unique solution and may not be solvable with available information (Eberlien et al, 2008). POGIL grows the ability of students to solve problems. Mastery-level learning of concepts is encouraged in the exploration phase by presenting the material as a challenge, not too easy to be boring and not too difficult to be frustrating. POGIL activities are organized around key concepts in such a fashion that allows students to build a knowledge structure based on their Understanding of key concepts.

VI. ROLE OF TEACHER IN POGIL

As *leader*, the instructor creates the learning environment by developing and explaining the lesson, by determining the objectives (both the content objectives and the process skills objectives), by defining the expected behaviours and criteria for success, and by establishing the organization (i.e. the goal/reward structure, the team structure, the class structure, the room structure, and the time structure).

As *monitor/assessor,* the instructor circulates through the class to monitor and assess individual and team performance and to acquire information on student understanding, misconceptions, and difficulties in collaboration.

As *evaluator*, the instructor provides closure to the lesson by asking team members to report answers, summarize the major points, and to explain the strategies, actions, and results of the team. Evaluations are given to individuals and teams regarding performance, achievement, and effectiveness, and general points are shared with the class.

Planning

Planning of POGIL involves the following elements.

- ✓ Lesson development and explanation
- ✓ Setting the objectives (both content and process)
- ✓ Explaining expectations and criteria for success
- ✓ Setting the organization and time constraints

Execution

Teacher moves throughout the classroom for monitoring the performance of individuals and teams. The "facilitator" as instructor intervenes when needed to assure understanding and progress by questioning that identifies difficulty. These questions should go from open-ended general to directed and specific.

Evaluation

Teacher evaluation is not limited to the last stage. It is cumulatively carried out and noticed as team wise and individual manner. Based on that teacher marks students progress with appropriate grade. Self reflection is the key evaluation procedure happening in POGIL classroom environment which build innate capacities among learners.

VII. META-COGNITION IN POGIL CLASSROOM

One of the interesting characteristics of people is that they not only behave, but can watch themselves behaving, and believe that they can exert a certain amount of control over how they behave. Meta-cognition refers to one's knowledge concerning one's own cognitive processes or anything related to them (Flavell, 1976). Meta-cognition can be conceptualized as having two primary components. He also suggested a model of Meta-cognition and cognitive monitoring in describing: metacognitive knowledge, metacognitive experience, goals or tasks and actions or strategies. Later Flavell (1979) expanded the concept of 'Meta-cognition' to include (i) metacognitive knowledge and (ii) regulation of cognition. Metacognitive knowledge is "knowledge about what factors act and interact in what ways to affect the course and outcome of cognitive enterprises". Metacognitive experiences or regulation are any conscious cognitive or affective experiences that accompany and pertain to any intellectual enterprise (Flavell, 1999).

Meta-cognition is used in POGIL to help students realize that they are in charge of their own learning and that they need to monitor it (self-management and self-regulation), that they need to think about their performance and how it can be improved (self-assessment), and that they need to reflect on what they have learned and what they don't yet understand (reflection on learning).

Analysis of the different components of process oriented guided inquiry learning shows that the different stages like exploration, concept invention and application provide suitable situation for the self reflection and self regulation which are the essential part of the cognitive enterprises. In exploration stage learner through observing a model forms a cognitive knowledge using visual auditory and kinaesthetic method (Zawadsky, 2010). Concept invention stage utilizes the comparison and contrasting of the cognitive characteristics with new task. Over all the application stage learner automatically reflected upon the new task and regulate the whole process with self awareness and one's own need. During these stages the learner thinks about the course and outcome, suggest alternate or better solutions which make a cognitively alert learner. The learner notices, if there any inconsistency and other possible ways to validate their procedure and results. Frequent feedback obtained from the teacher is crucial and the learners want to monitor their own learning and understanding (Eaton, 2006).

Teacher and students together can evaluate whether the formulated objectives are achieved or not, suitability of strategies and reflection on how those strategies can be improved (Hanson, 2006). Metacognition produces an environment for continual improvement. Students can be asked to assess their own work and that of each other; instructors also monitor the teams and provide help students identify needed improvements. In order to encourage self-assessment, peer assessment, and support assessment by the

instructor, an atmosphere must be established in which such assessments are safe, positive, and valued by all. Feedback to individuals, teams, and the class when appropriate in order to improve skills and must be made between assessment and evaluation (Eberlien, 2008). Feedback provided during daily learning experiences should be given in the form of assessments, while course examinations provide the evaluation. Individuals need to recognize what they know, what they need to know, how well they can do something, and what they need to do to improve. From the analysis of the various researches in this field it is clearly indicated that POGIL classroom for the acquisition (Zawadsky, 2010).

VIII. MOTIVATION IN POGIL CLASSROOM

Motivation can be defined as "what gets people going, keeps them going, and helps them finish tasks" (Pintrich & Schunk, 2002). Goal theory focuses on goals or purposes perceived for learning. Essentially students are concerned with reasons for doing the task. Research has indicated that the motivational orientations and affective variables are important factors influencing learning achievement in secondary stage of education. Possibly, there is a close relationship between motivation, the goals set by the students, the strategies they employ and their subsequent achievement. Based on literature and research findings, it is anticipated that achievement goal orientations would be prominent determinants of students' motivation and achievement behaviour. Mainly there are two goal orientations labelled as learning (mastery) and performance goals (Dweck & Leggett, 1988), with learning goals reflecting a focus on increasing competence and performance goals involving either the avoidance of negative judgments of competence or attainment of positive judgments of competence. In POGIL classroom, during the formulation of objectives the teacher specified about the goal of lesson as the mastery of concept which is prescribed to teach. Exploration and concept invention stages of learning through teams also meant to strengthen the individual attainment through collaboration. During sharing and reporting of findings, the instructor supervised each team's inquiry facts and corrected the false findings. At the same time POGIL method not demarking the concept of grading or any type of assessment because at every stage of this strategy the instructor provide frequent feedback and it can be used for the further developmental process (Eaton,2006). So the concepts of performance oriented goals are relevant in POGIL but greater stress upon mastery oriented achievement goals.

IX. POSSIBILITY OF POGIL IN KERALA CONTEXT

The detailed analysis of research works based on POGIL points that, through this instructional strategy student take their own responsibility of their own learning. When we look upon the procedural aspect of this method from the viewpoint of teacher, it is quite difficult to encounter the specific roles. In this the teacher is expected to supervise and make all arrangements starting from the formulation of objectives to the mastery level attainment of the content.

Barriers from the part of teachers for implementing this strategy are

- ✓ Lack of time to plan, execute and evaluate the whole process in the prescribed time limit.
- ✓ Availability of suitable resources in addition to the conventional sources for guiding students.
- ✓ Attitude and appreciation of teachers towards the process oriented methods than product oriented tasks.
- ✓ Frequent assessment and evaluation by the teacher made a laziness approach and they can't rely upon high achieving students.
- ✓ Teachers need to reflect upon current advancement in science in order to incorporate with this mode of instruction.
- ✓ Thinking upon the various activities suitable for the development of science process skills with lower and higher order cognitive skills.

X. CONCLUSION

Process Oriented Guided Inquiry Learning (POGIL) is an instructional method in which students play key role through a cooperative atmosphere of learning teams towards a task which need guided inquiry process. Several researchers in this field shows that it is more suitable for science teaching especially chemistry since the researcher belongs to this faculty. In this strategy, students are constructing not only knowledge but also science process skills, that are used by the scientists for discovering novel concepts and theories in science. From the analysis of different steps and characteristics of this instructional model, it will surely lead to the self analysis, self assessment and self reflection of the learners. So cognitive strengthening of students in the form of Meta-cognition, in which learners are aware and think upon why, how and what about their own challenge, help learners to perform successfully. Also motivation is an essential aspect of teaching- learning process, and if the motivation is arousing intrinsically it make learners to increase their perseverance, mastery oriented than measuring students against specific values or grades.

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