A STUDY ON CONSTRUCTIVISTIC APPROACH TO ENVIRONMENTAL EDUCATION AMONG PRIMARY PRE-SERVICE STUDENT TEACHERS

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CERTIFICATE

This is certify that the research work contained in this thesis entitled ***"A Study on constructivistic approach to environmental education among primary pre-service student teachers"*** *submitted by Mr.M. Rajendran to the Maharaja Sayajirao University of Baroda, Vadodara, Gujarat for the degree of Doctor of philosophy in Education is a record of bonafide original research work carried out by him under my supervision and guidance. The results embodied in the same have not been submitted elsewhere for the award of any degree or diploma. It is further stated that the doctoral research was carried out fulfilling the requisite attendance criteria as per O.Ph.D.: 3(i) of the Maharaja Sayajirao University of Baroda, Vadodara, Gujarat. .*

December, 2012 ***Prof. S. Panigrahi***

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DECLARATION

I, Mr. M. Rajendran hereby declare that the research work reported in this thesis entitled ***"A Study on constructivistic approach to environmental education among primary pre-service student teachers"*** *submitted for the award of the degree of Doctor of philosophy in Education isoriginal and carried out in the Department of Education, Facuty of Education and Psychology, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat. I further declare that this thesis is not substantially the same one, which has already been submitted in part of in full for the award of any degree or academic qualification of this university or any other institution or examining body in India or abroad.*

December, 2012 ***(M.RAJENDRAN)***

Vadodara

Dedicated to my parents, brother and my guide…

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ABBREVIATIONS USED

B.Ed	Bachelor of Education
EE	Environmetal Education
EVS	Environmental Studies
FGD	Focus Group Discussion
GA	Group One
GB	Group Two
GC	Group Three
GD	Group Four
GE	Group Five
GF	Group Six
GG	Group Seven
GH	Group Eight
GI	Group Nine
H_2SO_4	Sulphuric acid
L	Learner
MI	Multiple Intelligence
NCERT	National Council of Educational Research and Training
NCF	National Curriculum Framework
NCFSE	National curriculum framework for school education
NCT	National Commision on Teachers
NPE	National policy on education
O_2	Oxygen
PBL	Problem based learning
SO_2	Sulphur dioxide
ST	Student Teacher
TLM	Teaching Learning Material
TTTI	Tirupattur Teacher Training Institute

1.0 Introduction

The future of the world depends largely on the wisdom with which human use science and technology. This is, in turn, depends on the character, distribution, and effectiveness of the education that people receive (Kemal & Oguz, 2007). The problems of the world in different domains increase its complexity which requires collective action. Education being an influential subsystem of society needs to change its role from preparing a better individual to group of individuals who can work together to solve emerging and future problems. But when we look at Indian education system, the existing practices of education in school and universities, knowledge is presented as primordial and no more relevant to address new age requirement. This demands a paradigm shift in education system from knowledge transmission to knowledge construction. It requires the change in role on the part of the teacher and learner in teaching learning process. In this context constructivistic approach viewed as a suitable pedagogy for today's classroom setting. Environmental Education as one of the thrust area in all levels of education in the last few decades, which engages learners with real life issues and reinforces the notion that scientific facts must be accumulated and analysed in social and cultural contexts in order to make valid value judgement.

1.1 Statement of the problem

With this background the present research work focuses on "A study on Constructivistic approach to Environmental Education among primary pre-service student teachers".

1.2 Purpose of the study

The purpose of this study is to engage the student-teachers to understand the environmental concepts through constructivistic classroom experiences and observe the extent in which the student teachers engages their learners (during practice teaching) in understanding environmental concepts / issues / problems through constructivistic classroom experiences. Based on this purpose the study explored the following research questions

1. What is the level of understanding about constructivistic approach among pre-service primary student teachers?

2. What is the level of understanding about Environmental Education among pre-service primary student teachers?
3. How well the primary pre – service student teachers and students change their perspectives on Environmental Concepts during Constructivistic approach based classroom process?
4. Do the student teachers and school students appreciate constructing environmental knowledge through constructivistic approach?

1.3 Significance of the study

Conducting a study on Constructivistic Approach to Environmental Education among primary pre-service student teachers is important as both constructivism and environmental education demands student teachers active participation in classroom experiences to understand the pedagogical value of constructivistic approach and environmental decision making of themselves as well as their learners.

Literature on constructivist teacher education argues that practices in the culture of a constructivist learning environment will help teachers to become agents of change who use knowledge of developmental theory and the ideas of inquiry and reflective teaching to learn (Kroll & Laboskey, 1996). Anderson and Piazza (1996) examined aspects that indicate students' commitment to a constructivist philosophy to lack evidence of constructivism.

Research reveals that constructivist environments are conducive to conceptual change, student achievement, and promoting self-regulated learners (Akar, 2003).
The significance of this study is to study how constructivist practices in the pre-service teacher education and school classrooms help student teachers and students to make deeper, more meaningful knowledge constructions on environmental concepts to meet future educational and environmental challenges.

1.4 Scheme of chapterisation

Chapter I present the introduction of the study along with scheme of chapterization
Chapter II provides the theoretical framework on constructivist approach and environmental education. Chapter III present the review of related literatures of the study which provides the impetus to deem the research questions, and research objectives significant. Chapter IV details the methodology of my data collection

techniques and guiding the process. Chapter V present the data analysis in great detail about various environmental themes cutting across the objectives. Chapter VI details the researcher reflection and implications for further study.

THEORETICAL FRAMEWORK

2.0 Constructivism in education

The new paradigm, "constructivism," is a psychological philosophical perspective contending that individuals form or construct much of what they learn and understand (Shunk, 1996). It is a descriptive theory that highlights the way people learn or develop rather than the way they should learn (Richardson, 1997). The roots of constructivism can be traced from Kant through Dewey, Vygotsky and Piaget, who investigated the ways that people construct meaning from the information they receive and how they integrate this information with their existing cognitive structures. Like Dewey, the constructivists have reframed the goal of education from dispensing knowledge to creating social environments that help students construct their own knowledge (Brown, Collins, & Duguid, 1989). Piaget proposed that cognitive change and learning take place when a learner's way of thinking, or scheme, leads to perturbation instead of producing what the learner expects. This perturbation (puzzlement) then leads to accommodation (cognitive change) and a new sense of equilibrium.

The other theoretical perspectives on how students learn from interacting with others is based on the social constructivist view of Vygotsky (1978). According to this perspective, children's mental functioning develops first at the interpersonal level where they learn to internalize and transform the content of interpersonal interactions with others, to the intra-personal level where it becomes part of their repertoire of new understanding and skills. In essence, children learn by interacting with adults or more capable peers who scaffold or mediate learning so that they are able to complete tasks they could not do alone.

Definitions of constructivism vary according to the various questions being debated within the constructivist movement. The most basic arena for debate is represented by a continuum from viewing learning as an act of individual construction to seeing learning as socially constructed. This continuum is anchored on one end by a position known as radical or psychological constructivism, which describes the construction of knowledge as a process that takes place in the mind of the individual. The other end of the continuum is occupied by a position known as social

constructionism or the socio cultural position that sees "mind" as almost totally embedded in the social practices of the culture.

Based on the idea that learners construct their learning to previous learning, Limón (2001) states that research on conceptual change explored students' prior conceptions overall about scientific phenomena and instructional strategies were developed to promote conceptual change.

2.1 Conceptual change

In the constructivist perspective, conceptual knowledge includes both what students learn and how it is organized into broader principles (Grotzer, 2002; J. D. Novak, 2002). Yet, contributors to the constructivist literature do not always make it clear what level of change they are targeting when they address issues of conceptual change. Building on the work of Ausabell (1963) and Gowin (1981), J. D. Novak (2002) defined a *concept* "as perceived regularities in events or objects, or records of events or objects designated by a label (usually a word)" (p. 550). Concepts are organized into constructs, deep principles, and theories that describe their relationships and how these relationships explain how, when, and why events occur. When teachers help students attach useful labels and signs to regularities and patterns of events, they scaffold students' conceptual development. Because concepts are embedded in larger cognitive systems, their meaning is affected by their placement in these systems and their connections to other concepts and principles and the non reflective web of experience. The different names given to cognitive structures (e.g., *schema, mental models)* try to capture this broader level of meaning connected to conceptual knowledge.

When constructivists describe the process for helping students develop useful concepts, they assume that students are *changing* concepts rather than acquiring new ones. Much of the concern of educators interested in conceptual change has focused on misconceptions that prevent students from adopting concepts and principles that will more accurately explain the events they experience (Novak, 2002). To design effective learning experiences, it is important to understand that learning involves replacing an existing concept (or more likely a misconception) with a new concept or larger cognitive structure. Seeing learning as replacing an existing concept directs us to start the learning process by trying to understand the students' existing everyday

theories and help students become more aware of their own theories. If students share a misconception (if it is common knowledge), it is even more difficult to dislodge the misconception and replace it with a useful concept. Adding this step to the beginning of the teaching process increases our awareness of the common misconceptions and difficult concepts in our disciplines. The constructivist perspective challenges teachers to discover what concepts students find most difficult to understand and to identify the most common misconceptions students hold about the phenomena their discipline is organized to understand. It is important for teachers to find ways to involve at least a subset of their students in conversations that reveal their conceptual understanding of the subject matter.

2.2 Guiding principles for constructivist classrooms

In a constructivist classroom, the teacher searches for students' understandings of concepts, and then structures opportunities for students to refine or revise these understandings by posing contradictions, presenting new information, asking questions, encouraging research, and/or engaging students in inquiries designed to challenge current concepts. The following five overarching principles are evident in constructivist classrooms.

2.2.1 Teachers pose problems of emerging relevance

Constructivist teachers by acknowledging the central role of the learner, structure their classroom experiences (subject areas) that foster the creation of personal meaning.

2.2.2 Teachers build lessons around primary concepts and "big" ideas

Structuring curriculum around primary concepts is a critical dimension of constructivist pedagogy. When designing curriculum, constructivist teachers organize information around conceptual clusters of problems, questions, and discrepant situations because students are most engaged when problems and ideas are presented holistically rather than in separate, isolated parts.

2.2.3 Teachers seek and value their students' points of view

Seeking to understand students' points of view is essential to constructivist education. The more we study the learning process, the more we understand how fundamental this principle is. Students' points of view are windows into their reasoning.

Awareness of students' points of view helps teachers challenge students, making school experiences both contextual and meaningful. Each student's point of view is an instructional entry point that sits at the gateway of personalized education.

2.2.4 Classroom activities challenge students' suppositions

Learning is enhanced when the curriculum's cognitive, social, and emotional demands are accessible to the student. Therefore, some sort of relationship must exist between the demands of the curriculum and the suppositions that each student brings to a curricular task. If suppositions are not explicitly addressed, most students will find lessons bereft of meaning, regardless of how charismatic the teacher or attractive the materials might be.

2.2.5 Teachers assess student learning in the context of daily teaching

Constructivist teachers don't view assessment of student learning as separate and distinct from the classroom's normal activities but, rather, embed assessment directly into these recurrent activities.

2.3 Becoming constructivist teachers: descriptors

2.3.1 Constructivist teachers encourage and accept student autonomy and initiative

Autonomy and initiative prompt students' pursuit of connections among ideas and concepts. Students who frame questions and issues and then go about answering and analyzing them take responsibility for their own learning and become problem solvers and, perhaps more importantly, problem finders. These students— in pursuit of new understandings—are led by their own ideas and informed by the ideas of others. These students ask for, if not demand, the freedom to play with ideas, explore issues, and encounter new information.

2.3.2 Constructivist teachers use raw data and primary sources, along with manipulative, interactive, and physical materials

The constructivist approach to teaching presents these abstractions (concepts, theorems, algorithms, laws and guidelines) through real-world possibilities to students, then helps the students generate the abstractions that bind these phenomena together. When teachers present to students the unusual and the commonplace and ask

students to describe the difference, they encourage students to analyze, synthesize, and evaluate. Learning becomes the result of research related to real problems.

2.3.3 When framing tasks, constructivist teachers use cognitive terminology such as "classify," "analyze," "predict," and "create."

Frming tasks around cognitive activities such as analysis, interpretation, and prediction—and explicitly using those terms with students— fosters the construction of new understandings.

2.3.4 Constructivist teachers allow student responses to drive lessons, shift instructional strategies, and alter content.

As educators, we have each experienced moments of excitement in the classroom, moments when the students' enthusiasm, interest, prior knowledge, and motivation have intersected in ways that made a particular lesson transcendental and enabled us to think with pride about that lesson for weeks. We recall the gleam in our students' eyes, their excitement about the tasks and discussions, and their extraordinary ability to attend to the task for long periods of time and with great commitment. If we were fortunate, we encountered a handful of these experiences each year, and wondered why they did not occur more frequently.

The students' thinking drove these experiments, and the teacher's mediation framed the processes that followed. The curriculum content—exploration of the scientific method—was addressed faithfully in a different manner for each student.

2.3.5 Constructivist teachers inquire about students' understandings of concepts before sharing their own understandings of those concepts.

It's hard for many teachers to withhold their theories and ideas. First, teachers *do* often have a "correct answer" that they want to share with students. Second, students themselves are often impatient. Some students don't want to "waste their time" developing theories and exploring ideas if the teacher already knows that they are "on the wrong track." So teachers sometimes feel great pressure from students to offer the "right" answer. Third, some teachers adhere to the old saw about knowledge being power. Teachers struggling for control of their classes may use their knowledge as a behavior management device: when they share their ideas, the students are likely to be quiet and more attentive. And fourth, time is a serious consideration in many

classrooms. The curriculum must be covered, and teachers' theories and ideas typically bring closure to discussions and move the class on to the next topic.
Constructivist teachers, the caveats presented in the preceding paragraph notwithstanding, withhold their notions and encourage students to develop their own thoughts.

2.3.6 Constructivist teachers encourage students to engage in dialogue, both with the teacher and with one another.

One very powerful way students come to change or reinforce conceptions is through social discourse. Having an opportunity to present one's own ideas, as well as being permitted to hear and reflect on the ideas of others, is an empowering experience. The benefit of discourse with others, particularly with peers, facilitates the meaning-making process.

2.3.7 Constructivist teachers encourage student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of each other.

If we want students to value inquiry, we, as educators, must also value it.

2.3.8 Constructivist teachers seek elaboration of students' initial responses.

Students' first thoughts about issues are not necessarily their final thoughts nor their best

2.3.9 Constructivist teachers engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion.

Cognitive growth occurs when an individual revisits and reformulates a current perspective. Therefore, constructivist teachers engage students in experiences that might engender contradictions to students' current hypotheses. They then encourage discussions of hypotheses and perspectives. Contradictions are constructed by learners. Teachers cannot know what will be perceived as a contradiction by students; this is an internal process.

But teachers can and must challenge students' present conceptions, knowing that the challenge only exists if the students *perceive* a contradiction. Teachers must, therefore, use information about the students' present conceptions, or points of view, to help them understand which notions students may accept or reject as contradictory.

Students of all ages develop and refine ideas about phenomena and then tenaciously hold onto these ideas as eternal truths. Through experiences that might engender contradictions, the frameworks for these notions weaken, causing students to rethink their perspectives and form new understandings. Through elaboration, students often reconceptualize and assess their own errors.

2.3.10 Constructivist teachers allow wait time after posing questions.

In every classroom, there are students who, for a variety of reasons, are not prepared to respond to questions or other stimuli immediately. They process the world in different ways. Another reason students need wait time is that, as we have discussed, the questions posed by teachers are not always the questions heard by the students. Teachers take sensitive leadership over the orchestration of classroom dialogue and provide opportunities for all students to participate in different ways while encouraging students' intellectual autonomy with regard to concept formation.

2.3.11 Constructivist teachers provide time for students to construct relationships and create metaphors.

Metaphors help people to understand complex issues in a holistic way and to tinker mentally with the parts of the whole to determine whether the metaphor works. And all of this takes time.

2.3.12 Constructivist teachers nurture students' natural curiosity through frequent use of the learning cycle model.

First, the teacher provides an open-ended opportunity for students to interact with purposefully selected materials. The primary goal of this initial lesson is for students to generate questions and hypotheses from working with the materials. This step has historically been called "discovery." Next, the teacher provides the "concept introduction" lessons aimed at focusing the students' questions, providing related new vocabulary, framing with students their proposed laboratory experiences, and so forth. The third step, "concept application," completes the cycle after one or more iterations of the discovery-concept introduction sequence. During concept application, students work on new problems with the potential for evoking a fresh look at the concepts previously studied. These 12 descriptors highlight teacher practices that help students search for their own understandings rather than follow other people's logic. The

descriptors can serve as guides that may help other educators forge personal interpretations of what it means to become a constructivist teacher (Brooks & Brooks, 1999).

2.4 Constructivism: implication to teacher education

The key implication of the constructivist paradigm for teacher education is that student teachers should have time and encouragement to reflect on what they are learning. Because of the short duration of pre-service programs there is a tendency to think we must "give them the theory" while we have the chance, leaving them to work out the implications as they teach. This is an unfortunate approach, however, not only because it models transmission pedagogy but because it gives the students inadequate opportunity to assess and adapt theory (Fosnot, 1989; Tom, 1997; Wideen & Lemma, 1999). Fosnot (1996) maintains that, to achieve a constructivist teacher education program, field experiences must take place in settings that are conducive to experimentation and in which curriculum is approached "in an integrated, learner-centered fashion with emphasis on learner investigation, reflection, and discourse".

2.5 Common methods and strategies used in constructivistic approach

The common methods and strategies used in constructivistic approach are:

2.5.1 Cooperative Learning

Johnson, Johnson, and Holubec (1993) define CL as "the instructional use of small groups so that students work together to maximize their own and each other's learning"

2.5.2 Collaborative learning

Collaborative learning is an approach to teaching that is built on philosophical positions like Dewey's, Vygotsky's, and Habermas', which assert that knowledge is socially constructed within a community of learners. If knowledge is socially constructed in learning communities, an important feature of any method of teaching within this framework is to promote meaningful dialogue among students.

2.5.3 The unification of Collaborative and cooperative learning

While comparing collaborative and cooperative learning Panitz (2009) in his ebook cites Ken Bruffee identification of two causes for the differences between the two

approaches. He states: "First, collaborative and cooperative learning were developed originally for educating people of different ages, experience and levels of mastery of the craft of interdependence. Second, when using one method or the other method, teachers tend to make different assumptions about the nature and authority of knowledge." (p12) The age or education levels as a distinction have become blurred over time as practitioners at all levels mix the two approaches. However, what determines which approach is used does depend upon the sophistication level of the students involved, with collaborative requiring more advanced student preparation working in groups.

In the collaborative model groups would assume almost total responsibility for answering the question. The students determine if they had enough information to answer the question. If not they identify other sources, such as journals, books, videos, and internet. The work of obtaining the extra source material would be distributed among the group members by the group members. The final product is determined by each group, after consultation with the teacher. The means of assessment of the group's performance would also be negotiated by each group with the teacher.

In the cooperative model the teacher maintains complete control of the class, even though the students work in groups to accomplish a goal of a course. The teacher provides additional articles for the students to read and analyze, beyond the text, and then asks the students to work in groups to answer the question. He/she might require a specific product such as a term paper or report, class presentations, and an exam at the end of the topic. The students do the work necessary to consider the material being covered but the teacher maintains control of the process at each stage. In general with cooperative learning's origins in a concern that competition can impede learning, collaborative learning began with a concern that the hierarchical authority structure of traditional classrooms can impede learning.

For the present study collaborative learning is used for student teachers and cooperative learning is used for learners in this school.

In the present study Co-operative/Collaborative problem-solving discussion is directed towards the exploration of a particular topic or the resolution of a problem. A problem-solving discussion consists of one or more meetings between a small group /

whole class of students who communicate with each other, often face-to-face, in order to achieve one or more goals such as increased understanding, the coordination of an activity, or the solution of a shared problem (Galanes & Adams, 2007).

2.5.4 Problem based learning

Problem-Based Learning (PBL), as a general model, was developed in medical education in the early 1970's and since that time it has been refined and implemented in medical schools and it has been adopted in other subject areas (Savery & Duffy, 1995). Henk (2000) in his article states that, PBL stresses the use of real - life problems as a stimulus for learning. In PBL, students work in small groups on these problems, and, in the course of discussing them, formulate goals for self-directed learning. The learning resulting from these activities is constructive and contextually meaningful. Students using PBL build teamwork skills as they learn from each other and work together to solve the problem. For this reason, PBL is ideal for classes with a range of academic abilities. Students in each group can work on different aspects of the problem. Similarly, students from diverse backgrounds will see different aspects of the problem and have varying ideas that could lead to solutions. The PBL process generally includes four main steps: (1) introducing the problem, (2) exploring what students do and do not know about the problem, (3) generating possible solutions to the problem, and (4) considering the consequences of each solution and selecting the most viable solution. The structure of PBL process followed in the present study is given Table 2.1**.** **Table 2.1: The structure of PBL**

Facts	Need to Know	Learning Issues

Possible Solutions	New Learning Issues

Defendable Solution(s)

The student proceed with itemise all the facts they have been given in the problem. This helps them begin to identify what they know. Then the students need to make a Need to know list. Here they list all the information they would like to have to

better understand the problem and their role in resolving the problem. From the Need to Know list, students should begin to derive a Learning Issues list, comprised of the things they need to look up, research, or explore in order to move forward with problem resolution. Then they work out plan of action and exploration and students should list down their possible solutions. This list will have ideas about how to resolve the problem and require the development of a New Learning Issues list. This new list is used to gather additional information that will allow the students to rule in or rule out the possible solutions they created which will be written in defendable solution(s) (Lambros, 2004).

2.5.5 Inquiry learning

Inquiry learning implements a constructivist approach so that students interact with the content by asking questions to increase understanding and comprehension and at the same time construct their own knowledge. In inquiry, the teacher poses question and then allows time for the students to consider possible solutions, plan an investigation, and go about solving the question posed to them. It helps students focus on the development of key skills such as hypothesis development, planning procedure for activities, data collection, data analysis, and drawing conclusions. In the classroom, inquiry-oriented learning can take many forms. As the teacher, one can help scaffold and build upon the inquiry process by assisting and encouraging students to ask questions related to the topic being investigated. Students then have the responsibility to identify and define their own individual procedures for answering these questions to make the content personal and meaningful to them.

Inquiry learning focuses on teacher asking questions on a consistent basis to ensure that the students understand the material during a class discussion. In a constructivist classroom the students need to be actively involved. The teacher may initiate by asking questions and the students will also ask questions by working with their classmates to explore and discover possible answers. Within this structure of learning, students bring their unique knowledge, understanding, and skills to the learning community. The focus is on the student, with an emphasis placed on active engagement in the learning process to develop and build on student understanding. Through questioning and discovering information, the student learns the material. The

teacher sets up the activity and facilitates the process (Figure 2.1) to ensure students are on task and learning what is intended.

Figure 2.1: Inquiry process

The process begins with questioning and moves through discovery, exploration, and presentation of findings. Throughout this dynamic process, questions are introduced, hypotheses are tested, and new questions are formed and reformed. Central to this inquiry process is reflection and feedback from the teacher and classmates to ensure that understanding and learning are occurring (Coffman, 2009).

2.5.6 Field visit

A field visit enables the learners to experience materials and phenomena in their true and natural relationships. They can observe real conditions and gather actual data. Studies have shown that more education can be acquired in a pleasant outdoor environment than in the classroom. It provides an opportunity for learners to become keen observers, appreciating the beauty and order of the natural environment. It verifies classroom instruction and laboratory exercises. It also enriches the entire programme and develops in the learners a love for nature in all her beauty. This method is rarely used because of the responsibilities and cost involved. But even a walk in a nearby park can be environmentally educative (Jerath & Saxena, 2001).

The present study focuses on constructivistic approach to Environmental Education using all the above mentioned methods. Because there is growing concern about the state of the environment, and at the same time we are very often confused by the complexities of economic, ethical, political, and social issues related to it.

Environmental problems become everyday news in our media. The Union of Concerned Scientists from "World Scientists' Warning to Humanity," have unequivocally stated, that we can no longer look to science and technology alone to solve these problems. We must also turn to ourselves as individuals to make change and develop a new ethic - a responsible attitude toward caring for the earth (Ministry of Education, 1995).Environmental Education intended to provide students' opportunities to learn about the functioning of natural systems, identify their beliefs and opinions, consider a range of views, and ultimately make informed and responsible choices. Constructivism believes that knowing students beliefs, views in classroom process helps to make better understanding and meaningful learning among students. Before going to detail about this let us discuss about Environmental Education.

2.6 Environmental education-meaning and definitions

In general Environmental education is, forming desirable belief, attitude, value, interest and understanding about environment. While understanding the meaning of environmental education three of its connotations i.e. education about, education through and education for the environment are implicit in the meaning.

Education ABOUT environment means making environment a subject of investigation. It is based on a specific topic or a restricted area in which the main concern is to gain information and comprehension. It can be done in the classroom as well as in the field.

Education THROUGH environment usually connotes using environment as a medium for study, the use of real life situations as the basis for learning and enquiry. It is essentially an approach or method of enquiry usually conducted through field work.

Education FOR the environment means education for conserving and improving the environment, a study of environmental problems and working for their prevention and solution. Problem solving, decision making, development of an environmental ethics and critical judgment are called for here. Commonly accepted definition of environmental education is: Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment

and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution (Gigliotti, 1990).

2.7 Goals of environmental education

The overall goal of environmental education is to generate environmental action so as 'to improve all ecological relationships including the relationship of humanity with nature and people with one another' (Belgrade Charter, 1975). The Tbilisi Intergovernmental Conference on Environmental Education (1977) elaborated the goals of environmental education as the following: to foster clear awareness of, and concern about economic, social, political and ecological interdependence in urban and rural areas; to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; and to create new patterns of behaviour of individuals, groups and society as a whole towards the environment.

2.8 Objectives of teaching environmental education

The Belgrade Charter has suggested the following six objectives for teaching environmental education.

Awareness: To help individuals and social groups acquire an awareness and sensitivity to the total environment and its associated problems.

Knowledge: To help individuals and social groups, acquire basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.

Attitude: To help individuals and social groups, acquire social values, strong feelings of concern for the environment and motivation to actively participate in its protection and improvement.

Skills: To help individuals and social groups, acquire the knowledge and skills of solving environmental problems.

Evaluation Ability: To help individuals and social groups, evaluate environmental measures and educational programmes in terms of ecological, political, economical, social, aesthetic and educational factors.

Participation: To help individuals and social groups, develop a sense of responsibility and urgency, regarding environmental problems to ensure appropriate action for solving the problems.

2.9 Guiding principles of environmental education

The Tbilisi Declaration, a document resulted from this conference, outlined the following guiding principles for environmental education.

Consider the environment in its totality – natural and built, technological and social (economic, political, technological, cultural historical, moral, aesthetic); Continuous, lifelong education process beginning at pre – school stage and spanning the entire stages through all formal and non – formal systems of education. Inter – disciplinary in its approach, drawing from various branches and integrating into a holistic and balancing perspective. Environmental issues are examined from local, regional, national and international perspectives and students receive insight into the environmental conditions and problems in global contexts. Promote proper values and attitudes and the need for cooperation of local, national and international bodies in the prevention and solution of environmental problems. Develop environmental sensibility, knowledge and problem solving skills among the students.

Assist learners to discover the symptoms and real causes of environmental problems and arrive at strategies for environmental protection and preservation.

Utilize environmental resources for teaching – learning processes and evolve educational approaches for teaching and learning with due emphasis on practical first hand empirical experiences. Emphasize the complexity of environmental problems and develop critical thinking and creative problem – solving ability in order to deal with complex environmental problems (NCERT, 1985).

2.10 Need of effective teacher training for environmental education

To Indian school system, Environmental Education (EE) is not altogether a new thrust. Educating children about, through and for environment have always stressed by the earlier national commissions and committees. However, it was only during 1986, that a special focus was made in the country's New Policy on Education. The Policy States that "There is a paramount need to create a consciousness of the environment. It must permeate all ages and all sections of the society beginning with the child. Environmental consciousness should inform teaching in schools and colleges. This aspect will be integrated in the entire educational process". The National Curriculum Framework for School Education (NCFSE) 2000 (NCERT,

2000) also highlights the need for including environmental concerns at all the levels of schooling. It asserts the Fundamental Duties (Article 51 A of part IV A of the Indian Constitution): "…protect and improve the national environment including forests, lakes, rivers, wildlife and to have compassion for the living creatures… "(Common Core Components, p.36). As one of the General Objectives of Education, it mentions "understanding of the environment in its totality, both natural and social, and their interactive processes, the environmental problems and the ways and means to preserve the environment" (p.40).

In consonance with these documents, environmental studies was made an independent subject at the primary level and topics related to environment were suitably infused with different science and social science subjects at all school stages. As a sequel to this explicit policy statement, efforts have been made in the country to introduce EE in school education through reorganizing the content and methodologies of teaching. At the lower primary stage, i.e., up to class V, EE is introduced as integrated themes anchoring concepts of both natural and social phenomena. In Classes VI – X, Environmental Education has been integrated suitably in social sciences, languages and science and technology. The objectives at this stage are to help the children appreciate the contributions of scientists and develop sensitivity to the uses and misuses of sciences, as well as concern for a clean environment and preservation of the ecosystem. Environmental Education is infused into the teaching of other schools subjects like mathematics, crafts and work experiences, and languages.

It is a reality that a high percentage of teaching force at the school level suffers from environmental illiteracy – illiteracy in terms of lack of understanding of the gripping environmental issues the country is facing, the methodologies of teaching – learning for infusing EE in to the school curriculum (Ravindranath, 1997). Teachers need to plan for projects and activities for students' participation in environmental problem – solving. This necessitates equipping teachers with necessary knowledge, attitudes and skills for the effective implementation of EE at the school level.

Realising the above need, the country has made several attempts in introducing EE as one of the thrust areas at teacher training level, and environmental education became a prominent component in in - service training programme. But, it

is impossible to achieve all competencies within a single education programme. In this context, pre – service training of teachers is of paramount importance. Recommendation 17 of the Tbilisi Conference emphasizes the pre-service training of teachers. Competent teachers do not emerge out of the blue. They must acquire and practice the attributes of competency and skills during their education. Teachers education colleges should, therefore, review their teacher education programmes in the light of the philosophy of environmental education.

2.11 Importance of constructivistic approach in environmental education at pre service teacher educational level

Environmental Education requires less focus on training and more focus on developing wisdom and flexible applications of diverse problem solving strategies. The teachers in classroom not just supply information, but make the student to understand the role of the individual in environmental problems and what alternatives and / or actions are necessary to solve such problems. It is important that the problem / issues of environment in EE should engage students with real life issues and reinforce the notion that scientific facts must be accumulated and analysed in social and cultural contexts in order to make valid value judgement.

The teaching methods and styles which environmental education requires is constructivist, student directed and experiential in orientation. Successful EE demands an in depth environment related content knowledge and ownership (responsible environmental behaviour) (Hungerford & Volk, 1990). This can be achieved through constructivist based learning. Learning activities in constructivist settings are characterized by active engagement, inquiry, problem solving, and collaboration with others. For making learning is a constructive process, the instruction must be designed to provide opportunities for such construction. For this, the teacher education programme should prepare student teachers to teach constructivist based student-centred methods. It is also useful to remember the educator's maxim, Teachers teach as they are taught, not as they are told to teach. Therefore, teacher educators should bring the constructivist learning practices in teacher education classrooms. Based on the guiding principle of constructivism and common methods and strategies of constructivist approach is used for the present study. The relevant review of related literature is presented in the following chapter.

REVIEW OF LITERATURE

3.0 Introduction

This chapter encompasses the review of research studies pertaining to constructivist(ic) approach in environmental education in four broader areas such as, constructivism, constructivist approaches in education, environmental education, and constructivist approach in environmental education. The review of the literature concludes with a summary of the literature review and the implications for the present study.

3.1 Research studies on constructivism

The review of literature in this section comprises fifty nine (59) studies on application of constructivism in the field of education. Here the review is presented in research focus, nature of researches, samples used and tools and techniques employed in a sequential manner. The studies of Wang (1998), Seguine (2002), related to impact of constructivist instructional context on quality of teaching. The studies of Lees (1998), Bijas (2007), Cook (2007), and Ross (2008) related to effect of constructivist teaching strategy, constructivist teaching on content understanding, learner construction of relevance of constructivist pedagogy to the content and effectiveness of constructivist instructional methods on students' motivation.

The studies of Owen (1994), Piazza (1994), Coppola (2000), Griffard (2000), Herron (2000), Ziegler (2000), Dias (2001), Schiller (2001), Terry (2002), Hunter (2003), Delli (2005), Thompson (2005), Savasci (2007), Soanes (2007), Kingsley (2008), and Brown (2010) are related to teacher ways in which fosters constructivism in classroom, mathematics culture in a primary constructivist classroom, computer / Internet use in constructivist classrooms, constructivist practice in school and college classrooms / labs; teacher beliefs and classroom practices related to constructivist teaching and learning, understanding of the experiences of teachers as they implement constructivist practices, dilemmas of implementing a socio-cultural constructivist theory of learning in fourth grade classroom, phenomenological experience in constructivist classroom, literacy instruction in a constructivist elementary classroom, identification of constructivist learning characteristics; the studies of Jimarez (2006),

related to use of constructivist strategies to promote conceptual understanding and science process skills.

The studies of Kerr (1999), Dethlefs (2003), French (2008), Butts (2009) related to constructivist teaching to improving academic achievement, relationship of constructivist learning environment to student achievement, attitudes and students' perceptions of their experiences, whether the gifted children have preference for working alone. The studies of Bilal (1995), Gatlin (1998), Soeharto (1999), Olson (1999),White (2000), Makanong (2000), Berube (2002), Ibrahim (2002), Wesche (2002), and Pettitt (2008) related to constructivist approach vs traditional approach, in terms of conceptual change, academic achievement. The studies of Majdalani (1994), Michalec (1999), Curley (1999), Howson (1999), Liang (1999), Eick (2000), Smith (2000), Trundle (2000), MeGlynn (2002), Palas (2002), Akar (2003), Ji (2003), Gallagher (2005), Gill (2005), Quaintance (2006), Akcay (2007), and White (2008), related to conceptual understanding of pre-service teachers in a constructivist setup; constructivist oriented teacher education programme; constructivist approach to integrating science, technology, and engineering into pre-service teacher education; impact of STS / Constructivist learning approach on the beliefs and attitudes of pre-service science teachers; Personal narratives and constructivism in teacher education; teacher's pedagogical beliefs and practices in constructivist approach; interactions between constructivist informed elementary mentor teachers and their student teachers; constructivist teaching strategy to improve pre-service teachers' content knowledge, conceptual understanding; impact of constructivist learning process on pre-service teacher education students' performance, retention, and attitudes in Classroom Management Course;

The studies of Hierlmeier (1999), Berger (2000), Liptak (2000), Lew (2001), Star (2006), Brown (2007), Wilding-Martin (2009) and Saunders (2010) related to constructivist professional development model, teachers perspectives about learning, constructivist instructional practices used by teachers, dynamics of the change in principal as well as teachers' perceptions regarding the maintenance of the constructivist approach, science teachers' perceptions of implementing constructivist principles into instruction; beliefs, practices, and professional interaction of teachers who are implementing constructivist-influenced mathematics instruction, implications

of Paul Ernest's social constructivist philosophy of mathematics education, constructivist behavior among four science teachers.

The studies of Owen (1994), Piazza (1994), Michalec (1999), Wang (1999), Hierlmeier (1999), Howson (1999), Kerr (1999),Olson (1999), Berger (2000), Coppola (2000), Eick (2000),Griffard (2000), Herron (2000), Liptak (2000), Trundle (2000),Dias (2001), Palas (2002), Seguine (2002), Terry (2002), Ji (2003), Delli (2005), Gallagher (2005), Thompson (2005), Quaintance (2006), Brown (2007), Cook (2007), Savasci (2007), Kingsley (2008), Butts (2009) and Wilding-Martin (2009) were of Qualitative in nature. Whereas, the studies of Majdalani (1994), Bilal (1995), Gatlin (1999), Lees (1999), Soeharto (1999), White (2000), Makanong (2000), Smith (2000), Ziegler (2000), Berube (2002), Ibrahim (2002), Wesche (2002), Dethlefs (2003), Star (2006), French (2008), Pettitt (2008), Ross (2008), Brown (2010), and Saunders (2010) were of Quantitative in nature.

The studies of Curley (2000), Liang (1999), Lew (2001), Akar (2003), Jimarez (2006), Akcay (2007), and White (2008) were of both Qualitative and Quantitative in nature. The studies of Schiller (2001), Hunter (2003), Bijas (2007), and Soanes (2007) were of Qualitative Action Research. The study of Gill (2005) used qualitative ethnography.

The studies of Gatlin (1999), Lees (1999), White (2000), Makanong (2000), Ibrahim (2002), Wesche (2002), Dethlefs (2003), Delli (2005), Jimarez (2006), Bijas (2007), Cook (2007), French (2008), Pettitt (2008), Ross (2008), Butts (2009) and Brown (2010) have taken students as the sample in their studies. Whereas, the studies of Bilal (1995), Owen (1994), Soeharto (1999), Hierlmeier (1999), Berger (2000), Liptak (2000), Ziegler (2000), Dias (2001), Lew (2001), Schiller (2001), Palas (2002), Seguine (2002), Hunter (2003), Ji (2003), Thompson (2005), Star (2006), Savasci (2007), Saunders (2010) have taken teachers as the sample in their studies.

The studies of Berube (2002) and Terry (2002) used both Students and Teachers as the sample in their studies. Brown (2007) used Principals and Teachers as the sample. The studies of Piazza (1994), Kerr (1999), Coppola (2000), Griffard (2000), Herron (2000), Soanes (2007), and Kingsley (2008) have taken the whole classroom as the samples in their studies.

The studies of Majdalani (1994), Michalec (1999), Wang (1999), Curley (2000), Howson (1999), Liang (1999), Olson (1999), Eick (2000), Smith (2000), Trundle (2000), Akar (2003), Gallagher (2005), Gill (2005), Quaintance (2006), Akcay (2007) and White (2008) have taken student teachers as the samples in their studies. The study of MeGlynn (2002) used teacher educators as the sample.

The studies of Seguine (2002), Terry (2002), Brown (2007) and Cook (2007) used interviews and observations. Owen (1994) used classroom observation and audio recording. Piazza (1994) used participant observation, and ethnographic interviews. Michalec (1999) used participant observation, field notes, and video recordings of interviews. Coppola (2000) used interviews, observations of classrooms, meetings and the general school environment, and documents. Griffard (2000) used clinical interviews, concept maps. Makanong (2000) used participant observations, faculty meetings, field experiences and taped interviews. Trundle (2000) used classroom observations, document analysis, and structured interviews. Dias (2001) used semi-structured interviews and teacher journals. Schiller (2001) used audio and video recordings and interviews.

Palas (2002) used semi structured interviews. Thompson (2005) used interviews, observations and document review. Quaintance (2006) used interviews, questionnaires, observations, course documents and students' coursework. Bijas (2007), Butts (2009) used interviews and student work samples. The studies of Ziegler (2000), Star (2006), French (2008), Brown (2010) and Saunders (2010) used survey. Berger (2000) used surveys, interviews, and classroom observations. Smith (2000) used survey, attitude scale, interview and questionnaire. Herron (2000) used interview transcripts, videotaped laboratory observation, survey questions. Lew (2001) used survey, video recording and open ended interviews. Akar (2003) used multiple choices and essay type test, attitude scale; open ended questionnaire, and semi-structured interviews. Hunter (2003) used formal and informal interviews, classroom and computer lab observations, and ancillary print material. Savasci (2007) used interviews, surveys, classroom observations, and classroom documents.

Lees (1999), Ross (2008), White (2000), Gatlin (1999), Soeharto (1999), Akcay (2007), White (2008) used pre and post achievement tests, Wesche (2002), Pettitt (2008) used achievement test. The studies of Majdalani (1994), Dethlefs (2003)

used achievement and attitude tests. Liang (1999) used achievement, attitude tests and video recordings of interviews. Berube (2002) used standardized science test and higher-order skills test. Ibrahim (2002) used Force concept inventory test (FCI), the mechanics baseline test (MBT) and Maryland physics expectation survey (MPEX).
Bilal (1995) used paper and pencil knowledge test and clinical interview. Curley (2000) used qualitative, participant observation data (documents, transcripts of consultation sessions, field notes of teaching events, an exit interview of the participants, a peer participation process), and quantitative data (a self – efficacy instrument). Howson (1999) used descriptive and recorded data. Olson (1999) used concept maps, drawings, reflective journal entries and quizzes. Liptak (2000) used open ended interviews, video-taped lessons, study group meeting transcripts, surveys, field notes, and action research projects. Ji (2003) used questionnaire, interviews, observations, journal entries, field notes, and artefacts of students' computer projects.
Delli (2005) used students' written description. Gallagher (2005) used classroom observations and interactions, field observations and notes, reflective journals, Web CT postings, project artifacts, and personal interviews. Gill (2005) used personal narratives write up and field notes. Soanes (2007) videotaped instruction, student work, lesson plans, and a detailed journal. Kingsley (2008) used participant observation, photographs, audio and video taped lessons, semi-formal interviews, student works and teacher materials.

3.1.1 Major findings from studies on constructivism

The major findings as per the main focus of the respective studies are as follows:

3.1.1.1 Researches on effectiveness of constructivism

Lees (1999) study found that no significant effect of a constructivist teaching strategy on students understanding. Ross (2008) study revealed that constructivist approaches were found to have a positive effect on both procedural and conceptual knowledge of student learning in middle school mathematics. Bijas (2007) study findings suggest constructivism informed pedagogy provides opportunities for students to construct relevance of the content by relating new learning to students' personal experiences and prior knowledge. Herron (2000) study indicated that despite being given the same instructions, curriculum and materials, each teaching assistant conducted his laboratory section in a unique way and rarely conducted the complete laboratory in

the intended manner. It was evident that constructivist teaching methods were being learned. Ziegler (2000) study findings suggest that different dimensions of constructivist teaching, learning, and supervisory practices have differing effects on student achievement. The results confirm research supporting the positive effect of constructivist learning practices. Specifically, an emphasis on problem solving was positively related to student achievement in mathematics. The results of the study also suggest that school setting, mathematics certification, teaching experiences, gender and minority status are all factors related to the use of constructivist, teaching, learning and supervisory practices.

Delli (2005) study revealed that the participants reported that they valued reflective practices, constructivist based assignments and instruction. They stated that they learn best when they are involved in an inquiry – rich environment in which all classroom members are part of a learning community. Soanes (2007) study evolved in unexpected ways. The students viewed seatwork and whole group instruction as learning and resisted learning activities that were different from their notion of learning. Researcher was unable to substantially advance constructivist approaches to teaching and learning. Researcher analysed possible reasons for student resistance to these new pedagogical practices using the concepts of habitus and power. He also look at how a variety of social issues challenged the creation of a community of learners in the classroom. The findings from this study provide an in-depth analysis of an attempt to change students' ideas about learning and the negotiations between students and teachers that are necessary to do so. Kerr (1999) study found that parents, teachers and students reported positive attitudes toward the change to constructivist mathematics. Data indicated that the shift to constructivist, standards based teaching and learning resulted in improvement in mathematics achievement. Dethlefs (2003) study found that, no specific dimensions of constructivist learning environment were consistently related to student achievement. However, several dimensions of constructivist learning environments emerged as significant predictors of student attitudes, including Personal Relevance, Shared Control, and Student Negotiation. The dimensions of Critical Voice and Uncertainty appeared to be less important in predicting student attitudes.

The results of Bilal (1994) study showed that although the constructivist approach was not statistically significantly different to the traditional approach on the paper and pencil knowledge test, the result of the clinical interview showed that the instructional treatment did have effects in other respects. The students in the constructivist group interviewed had acquired conceptual knowledge that are consistent with both the structure and concepts of physics, and used physics concepts more accurately to explain the new tasks.

White (2000) study indicated that, change in cognitive development, as measured by pre – test and post – test using GALT, was significant in the experimental group, but not in the control group. Neither group showed significant changes in attitudes toward science over the course of the semester. Both groups demonstrated gains in content knowledge, the gain by the experimental group was significantly greater than the gain with the control group. Gatlin (1999) study indicated that, significant difference was found on the science achievement post test where the students receiving the traditional pedagogy scored higher than the students taught by the constructivist pedagogy. However, the scores of students receiving constructivist – informed pedagogy showed slight increase on the delayed posttest, while the traditionally taught students' scores decreased, thus the difference in the achievement of the two groups was diminished over time. Makanong (2000) study indicated no significant differences of mathematics problem solving processes and achievement between students in the two treatment groups. The qualitative data indicated that constructivist teaching was a promising approach capable of getting students more involved in learning mathematics. Students in this study who learned mathematics based on constructivist teaching tried harder, as measured by the interview task problems, than those who learned based on traditional teaching.

Berube (2002) study indicated that students who were taught by teachers with more traditional and mixed teaching styles performed better on the Higher – Order Skills comprehension measurement, while teachers with constructivist teaching styles actually had the lowest scoring students. Also, the interaction of ethnicity and teacher type was significant, indicating that Higher – Order Skills scores were influenced by that interaction, with Caucasians scoring the highest when taught by teachers with mixed teaching styles. Wesche (2002) study indicated that both the groups were

statistically equivalent on both the computational and conceptual subscales on the pretest, but the behaviorist group significantly outperformed the constructivist group on both subscales on both the immediate and delayed posttests. These results strongly favor a behaviorist approach in teaching the area of a triangle to fifth graders. Combined with the research literature, this unexpected outcome indicates that theorists and practitioners may need to adopt and eclectic approach to their teaching methodology, in which some topics may be taught more effectively from a behaviorist viewpoint and others from a constructivist perspective. Pettitt (2008) study indicated that, overall, the mathematics achievement of the treatment group was not significantly higher than that of the comparison group. It was concluded that the adoption of a constructivist methodology does not negatively impact test scores.

Soeharto (1999) study demonstrated that students in the treatment group reported a significantly higher use of constructivist ideas by their teachers than students in the control group. Results of analysis of covariance techniques showed that there were significant differences between the treatment and control groups, specifically among those classes of students which were taught by teachers who had graduated from high school level preparation programs. Significant differences were also found between the treatment and control groups among those students who were taught by high school graduated teachers. Majdalani (1994) study found that positive correlations observed were between their understanding of number sense and their attitudes. Liang (1999) study revealed that constructivist curriculum model using hands-on, inquiry-based, cooperative learning was more effective in promoting conceptual understanding and positive attitudes toward science learning for those with lower past science performance. The PIPS approach left more room for self-reflection on the development of understanding of science concepts in contrast to the lecture-lab type teaching. A similar study conducted by Smith (2000) indicated that the participation in constructivist classroom does positively affect pre – service teachers' attitude toward mathematics teaching and learning as well as beliefs about the classroom environment.

Akar (2003) Findings show that post-test scores were not statistically different between the experimental and the control groups. However, a significant difference was found in the retention scores in favour of the experimental group. The conceptual

change the learners went through was evident in their metaphorical images which tend to change from a more controlling image to images that depict leadership, sensitivity to individual differences, and student learning. Descriptive findings indicate that retention was fostered through constructivist activities that mainly included reflective writing, critical thinking, and problem solving. Factors such as active learning, meaningful and enjoyable learning environment, and the attitudes of instructors had a positive impact on student learning. Nevertheless, the load of reflective diary writing and portfolio preparation tasks, and collaborative work could be overwhelming and discouraging and these impacted negatively on learners' attitudes towards the course.

Akcay (2007) study findings include the following: (a) Pre service science teachers showed significantly growth over the semester in their perceptions concerning STS / Constructivism, beliefs about science teaching and learning, and attitudes toward science and technology, and their implications for society. These significant changes were not affected by gender nor grade (elementary Vs secondary) level. (b) Pre service science teachers showed statistically significant growth toward an STS / Constructivist philosophy of science teaching and learning in terms of student actions in the classroom, as well as their increased understanding of science processes and content. (c) An STS / Constructivist approach provides student – centered learning environments that are relevant, motivational, and meaningful for pre service science teachers. Further, it encourages them to interact and to participate more actively in science classrooms.

White (2008) study results showed a significant increase in content knowledge, for the education students, on the geology content knowledge assessment (GCKA). However, none of the students improved on their development of the graphic timelines over the course of the study. The improvement was demonstrated by students at the two lower levels. At these stages it is perceived that there are correct answers to questions and solutions to problems. These findings indicate the need to assess students as to their intellectual levels in order to develop effective teaching strategies to improve learning at all levels in the educational process. Jimarez (2006) study found that the use of constructivist strategies promotes conceptual understanding of science concepts and development of science process skills and a change of attitude towards science.

3.1.1.2 Studies related to students

Quaintance (2006) study found that students' beliefs about learning and teaching changed in much the same way as in previous studies. The students developed an appreciation for constructivist practice, realized the importance of student – centered environments, came to value collaborative learning and social interaction, and moved away from the view that learning is acquiring facts towards a view that learning is constructing knowledge. Students' attitudes towards the course remained stable over the semester, with some exceptions. The students indicated the course content was interesting and relevant; they felt comfortable sharing their thoughts; they disliked the lack of deadlines for the assignments; they were lukewarm about the discussion boards and online journals, and the class discussions, particularly hearing classmates' perspectives, were important for their learning. Student reactions that emerged as the semester progressed included concerns about inappropriate student behavior and confusion about the expectations for student performance.

Olson (1999) study revealed that the assessment of conceptual change through interviews conducted two months after the unit, and many items on the concept maps had decayed from students' memories. Concept maps were insufficient to indicate the depth of students' understanding. Low and high achievement students focused on the method of instruction rather than specific activities. Brown (2010) study indicated that students' perceptions were that all seven areas of a constructivist learning environment were present in their learning communities but to varying degrees. The students' perceptions were all positive and indicated that they were more aware of collaborative inquiry, the opportunity to construct knowledge, and to reflect on prior experiences in their learning community classes. French (2008) study revealed that those gifted students who feel adequately supported by those in their environment will be less likely to indicate a preference for working alone, compared to those who do not feel supported. Butts (2009) study interviews revealed that the participants were able to relate the educational material which they prepared using technology to the project being developed. No participants saw the instructor as a presenter of facts.

3.1.1.3 Research studies related to teachers

The study conducted by Owen (1994) revealed that when the teacher was observed to pose problems at the beginning of as well as throughout, lessons and provided a safe,

risk – free environment, the students were eager and willing to talk about their thinking or how they came to solve a problem. Results from the study suggest that a teacher must develop a safe secure environment if constructivism is to be fostered. The findings of Coppola (2000) were relevant to educational leaders and policymakers who want to promote quality use of computers in schools and want to create environments in which teachers can develop their teaching. On the structural level, teachers had time in the day to devote to learning and reflection, office space, designated computers, access for students, a stable technological infrastructure, and technical support on demand. On the cultural level, the norms of school and community emphasized learning, autonomy and independence, innovation, and accountability for quality. Overall the culture functioned well because it was coherent, appropriate for the local context, and consistent over time. Within this environment, faculty learned constructivist teaching with computers through a process that included commitment to learning how to do so, formulating pedagogical problems, exposure to new ideas, creating new curriculum, trying ideas in the classroom, reflecting on their work, and refining the practice.

Dias (2001) study revealed that, Commitment to teaching and supportive relationships at the school helped the first year teachers negotiate satisfying role in inquiry teaching. It is also mentioned that, constructivist theory represented a narrowing of the gap between educational theory and practice. Schiller (2001) study found that, the teachers study group created a non-threatening forum for reflection, support, and sharing as each teacher learned that they were not alone in the struggles and challenges they experienced in negotiating constructivism. Hunter (2003) study revealed that the teachers' use of constructivist pedagogy was consistent across all aspects of their practice, they used meta cognitive and purposeful teaching strategies, and they were leaders in their profession. Paradoxically, the teachers understood the importance of teaching with technology, but exhibited limited knowledge of how to incorporate the Internet into their teaching. Teachers also experienced time constraints, a conflict between their constructivist philosophy and expectations placed upon them, and the need for information literacy skills curricula and technical support.

Savasci (2007) study findings revealed that teachers generally reported that they held constructivist teaching and learning beliefs. However, they had difficulty in incorporating their beliefs into classroom practice. Only one teacher could implement his beliefs related to constructivist teaching and learning into classroom practice; as such, his expressed beliefs were consistent with his observed classroom practice. Personal Relevance and Student Negotiation were the most frequently preferred constructivist components and Critical Voice was the most perceived constructivist component in science classrooms. Shared control was one of the least preferred and was the least frequently perceived and implemented constructivist component in science classrooms. Whole- class activities were frequently observed in all science classrooms. However, teachers working in the private middle school tended to spend more class time in group work than those working in the public high school. On the other hand, teachers working in the public high school tended to allocate more class time to individual work than those in the private middle school. The teachers working in the private middle school tended to use more student-centered activities in their classrooms. Teachers working in the public high school tended to use more teacher – centered activities in their classrooms. School type (private versus public) and grade level influential factors that affected teacher practice.

Kingsley (2008) study the researcher discovered four major steps in a dance between teacher and students that developed literacy skills in a caring environment by nurturing self-esteem and self-regulation in learners. The teacher designed a peer tutoring program with first grade students in which literacy skills instruction was embedded within an authentic context that responded to second language learners with learning challenges. The teacher's roles as director, philosopher, enabler and connector were explored and a mirror image of students and teacher were provided through a narrative tracing of three focus students. Besides describing the literacy practices of the teacher, this study uncovered a spiritual dimension of the teacher's role in that she began from the sacred space of teaching from the heart. Using gentle judgment and praise she built self-esteem by reflecting back to her students an image of competent, intelligent, human beings.

The study of Ibrahim (2002), on the impact of the Guided Constructivist teaching method on students' misconceptions about concepts of Newtonian physics reveals that in teaching learning process greater conceptual learning is fostered when

teachers use constructivist based interactivity teaching strategies to train students to link everyday experience in the real physical world to formal school concepts. Ji (2003) study findings indicated that: (a) the teacher's characteristics play a major role in determining the nature of her pedagogical beliefs, practices and her willingness to change toward a more constructivist teacher; (b) the masters program has significantly influenced the change in her pedagogical beliefs and practices into constructivist model of teaching and learning. (c) When Web – based technology is involved in the teacher's curriculum, it is more likely that the teacher engages in the role of active designer of her class and curriculum, and provides the students more meaningful 'real – life' experience of learning environment.

Berger (2000) study determined that participants did incorporate skills and knowledge from Opening the Gate (staff development through constructivist orientation) into their daily practice. Hierlmeier (1999) study indicate that teachers made adjustments to their pedagogical thinking focusing more on several constructivist principles: personal relevance and learning styles, student initiative, daily discrepancy resolution, and appreciation for primary sources. The findings also revealed teachers prevailing effort to replicate their own preferred learning environment as fundamental to pedagogical decisions and planning for their students. Many of the teachers' efforts to change the learning environment on campus were thwarted by lack of school vision for experiential learning lack of staff collegiality, and teachers' limited ability to network community resources. Star (2006) study results showed that the majority of teachers (70%) report that they use constructivist practices in their classrooms. Results also revealed that teachers use constructivist practices mostly during the presentation of new information. Results also reveal that middle school science teachers use constructivist practices more than the secondary school science teachers.

Brown (2007) study found that although the principal, who initiated application of constructivist strategies retired, constructivist strategies remain in use. The changes that occur with change in leadership, as predicted in the Tri – Partite Theory, were managed at South wood by an internal replanning process of establishing PLCs. This study lends credence to the importance of professional learning communities as a constructivist change strategy, which finessed the entropy

organizations face with leadership changes by establishing PLCs as a socialization process. Saunders (2010) study revealed that, no significant differences between teachers who implement constructivist practices and those who do not with regard to their beliefs and perceptions. There was no significant difference found between teachers who implement constructivist practices and those who do not with regard to their scientific knowledge mean rating, or their constructivist practices rating ($p > .05$).

Liptak (2000) found that changes in teacher – principal relationship and leadership role of the principal happened when the teacher and principal believed the constructivism. Lew (2001) study results indicate that the new teachers were largely early constructivist teachers. Constructivist teaching approaches were used during student teaching. Socialization and induction processes had minimal effects. Both observed practices and beliefs about teaching and learning were student – centered; after declines in years one and two, constructivist behaviors improved by the third year of teaching. Students of the new teachers perceived their lessons as being more interesting, more relevant to them, and that they had more autonomy about instruction than reported by students in other programs. Their perceptions better matched those of students taught by more experienced teachers, who were identified as expert constructivists. Another study by Seguine (2002) found that constructivist teachers fostered strong relationships with their students and taught beyond the prescribed curriculum to ensure meaningful student learning. These constructivist teachers enacted their practice with or without administrative support and desired professional development that addressed their needs and promoted an – active learning environment.

3.1.1.4 Studies related to school education

Wang (1999) study revealed that although bringing many constructivist ideas into their internship, three out of four these pre service teachers were unable to retain all these ideas or articulate them into their practice. Instead, they developed some ideas that were contradictory to their program's expectations. The pre service teachers actually moved closer to their collaborating teachers at both conceptual and practical levels. The ideas they shared with their collaborating teachers were able to be retained and practiced in their teaching. The ideas they failed to share with their collaborating

teachers disappeared or were not enacted in their practice. The new ideas they developed in their internship were often those their collaborating teachers held and practiced. The expectations both pre service and collaborating teachers had for their roles in the internship, had a strong impact on what they were able to do in their collaboration. The kind of collaboration they developed, in turn, contributed to the chances for the quality of these pre service teachers' learning. The culture of teaching in each school was different and not always supportive of their constructivist ideas. Wilding-Martin (2009) study brought the idea of Paul Ernest. Ernest sees learning as the social construction of knowledge through conversation. Therefore, he believes that mathematics education should foster knowledge construction through active engagement and student interaction. In addition, he claims that mathematics education should contribute to the development of democratic citizens who are able to critically evaluate political and social claims that are based on mathematical arguments.

3.1.1.5 Studies related to teacher education

MeGlynn (2002) study revealed that firstly, most faculty – educators teach as they were taught, developing constructivist pedagogy requires a process of activity reflection, and dialogue for authentic change to occur. Learning is not the result of the process; learning is the process. Secondly, planned change is successful when outcomes are identified, and conditions and resources are in place, which support the phases of the change. Third, disequilibrium promotes learning. In order to risk change, faculty – educators require an environment that is voluntary, non – evaluative, and collaborative. Forth, a theory – to – practice, learner – centered approach requires new skill sets and they reveal gaps in basic traditional teaching techniques. Next, participating in constructivist pedagogy is uncommon for a majority for a majority of students. The role of the learner in a constructivist classroom requires articulation and forming by the faculty – educator. Finally, change is a non – continuous, complex learning process that requires establishment of a collegial, trusting relationship between participants.

Curley (2000) exploratory case study indicated that constructivist supervision facilitated reflectivity in some student teachers and not in others. Difficulties in implementing constructivist supervision are a promising beginning for the development of a constructivist orientation to the supervision of student teachers.

Trundle (2000) study results indicate that without the instruction most elementary pre-service teachers were very likely to hold alternative conceptions of the cause of moon phases. Also, participants who had the inquiry-based instruction were much more likely to hold a scientific conceptual understanding shortly after instruction, and many continued to hold scientific understanding months later. Michalec (1999) study indicates that with respect to the program studied, the theory / practice divide was non – existent. Pre service teachers in the program learned how to teach in both constructivist and teacher centered style of teaching at both the university and public schools. The site of learning to teach had a lesser impact on which style of teaching pre service teachers learned than did the kind of pedagogical relationship they formed with more experienced practitioners.

Howson (1999) study (case studies) revealed the evidence that, difference in the ways the pre – service teachers communicates their understanding and process make constructivist theory their own. They work to interpret their own realities in the classroom as their prior beliefs and knowledge are challenged. Constructivist concepts are implemented with some successes and some disappointments showing fluctuation in growth during their experiences. Gallagher (2005) findings from this case study included a deeper understanding of science, technology and engineering reported by the majority of the pre service teacher participants. In addition, pre service teachers gained and reported more advanced strategies for problem solving, communicating, and working within a course that used a constructivist framework for learning. Results from this study suggest that engineering can provide a valuable context for pre service teacher preparation that involves learning and teaching of science, technology, and problem solving. Gill (2005) study findings indicates that using the teacher educators' real-world experiences in the elementary school classroom provides pre service teachers with an up-close and personal view of education that validates the authenticity of the teacher educator. Palas (2002) study the mentors were found to embrace a non – linear, multi – directional view of learning in which learners made choices and decisions and in which teachers valued their autonomy to structure classroom time in ways that supported beliefs about active child cantered learning. Finally a theme emerged depicting the struggle participant mentors felt as their student teachers entered the teaching field. Mentors were concerned that these novice teachers might encounter administration or school cultures with expectations for large

amounts of time spent explicitly drilling and remediating for high stakes standardized tests. Mentors expressed concern about whether their student teachers would find opportunities to follow through on teaching practices they had experienced in their student teaching. A key finding was the need for shared language to describe beliefs about the learning process. Eick (2000) study revealed that, three major factors consistently influencing use of constructivist practices: (a) personal history informing beliefs and practices, (b) content and pedagogical understanding, and (c) cooperating teacher interpretation of the curriculum and associated pacing regime.

3.1.1.6 Studies related to suggestive format

Thompson (2005) study reveals the importance of autonomy and interplay between the accountability movement, misunderstandings of child developmental and societal pressure. For the participating teachers in this study, the current educational environment limits teacher autonomy and constructivist practices. In addition, when teacher backgrounds are not specific to early childhood education, their autonomy, and therefore, their use of constructivist practices, is further limited. It is recommended that teacher education programs facilitate teacher autonomy by helping pre – service and in – service teachers to articulate and defend their beliefs. Finally, when teachers are given more autonomy and use more constructivist practices, this could act as a catalyst for change in the wider culture. Terry (2002) study findings first describes the characteristics of constructivism as they exist in the classroom under study. Secondly, elements that contribute to the construction of an atmosphere of trust within the constructivist classroom have been explored. Through analysis, caring, respect, communication and cooperation have been identified as four basic elements in the development of trust. Thirdly, these elements are shown to require conditions of honesty, acceptance, commitment, and responsiveness devoted to the relationship. When these elements and conditions are fully integrated, a significant level of trust should exist that will support the forces of diversity, conflict, risk, and reflection.

Cook (2007) study findings were that teachers should provide students with constructivist lessons such as cooperative groups, problem based learning and inquiry question in which to learn content objectives. As social beings, students are more motivated to participate in activities that allow them to work with peers, contribute their own ideas, and relate topics of interest to their own realities. Keeping these ideas

in mind during lesson preparation will increase students' motivation and achievement. Variation of instruction should include activities that reflect multiple intelligences and real world situations. The findings of Piazza (1994) ethnographic study were the reality of the constructivist classroom studies offers implications for emerging constructivists' teachers in establishing environments which promote the construction of mathematical knowledge. A constructivist culture was found to be constructed as meaningful to the construction of knowledge. The educational goal of autonomy created cultural meaning for schooling experiences. Reform efforts supporting a constructivist approach to education require a re-conceptualization of education. Researching lived histories of emerging constructivist teachers may offer insight into the reform of teacher education, professional development, and teacher induction. Constructivist teachers are potential agents of educational change because they act autonomously. Griffard (2000) qualitative case study revealed numerous gaps in graphic decoding, indicating that both direct experience and explicit instruction are needed if students are to "learn how to learn with graphics," especially those graphics central to understanding a computer simulation's representations of structures, inputs, processes and outputs.

3.2 Researches on constructivist approaches

3.2.1 Researches on cooperative learning

The studies of Basili (1989), Ali (2003), McNair (2006), Gilbert (2008), Hines (2008), Morris (2008), Goyak (2009), Chester (2010), Conring (2010), Dong (2010), Donohuie (2010), Morrison (2010), Niemi (2010), Purghart (2010) and Romero (2010) are related to cooperative groups incorporating conceptual change strategies, similarities and differences of cooperative learning in private versus public schools, effect of cooperative learning vs. traditional learning on students achievement, effect of cooperative learning on students achievement, small groups of fifth graders construct meaning of narrative and informational texts, systematic literature review on science outcomes associated with cooperative learning in secondary and early post-secondary science-classrooms, influence of the Big Five personality factors on behavioral indicators of children's cognitive and social development during small group collaborative discussions, to compare two different cooperative learning models in terms of their effects on student achievement, influence of verbal and nonverbal

behavior on power and status within small groups, teacher use of cooperative learning on student achievement, effects of small-group and traditional didactic instruction on student acquisition of facts and reasoning skills, influence of affect on cooperative productivity.

The studies of McNair (2006), Morris (2008), Donohuie (2010), and Morrison (2010) were of Qualitative in nature. Whereas, the studies of Basili (1989), Ali (2003), Gilbert (2008), Goyak (2009), Chester (2010), Conring (2010), Niemi (2010), Purghart (2010) were of Quantitative in nature. The studies of Hines (2008) and Dong (2010) were of both Quantitative and Qualitative in nature. The study of Romero (2010) was of meta-analysis in nature. The studies of Ali (2003), Gilbert (2008), Morris (2008), Chester (2010), Conring (2010), Dong (2010), Morrison (2010), Niemi (2010), Purghart (2010), and Romero (2010) have taken students as the sample in their studies. The study of Hines (2008) used teachers as the sample. McNair (2006) used students and teachers as the sample. Goyak (2009) used student teachers as the sample. The studies of Basili (1989) and Donohuie (2010) have taken college students as the sample in their studies. Ali (2003), Chester (2010), Purghart (2010), used achievement tests. Gilbert (2008) used pre and post test, attitude scale and interviews. Conring (2010) and Niemi (2010) used pre and post-tests. Basili (1989) used concept map, audio recordings. McNair (2006) used observations, documents and structured interviews. Hines (2008) used survey and interviews. Morris (2008) used verbal responses and observation of nonverbal behaviors. Goyak (2009) used College and University classroom Environment Inventory (CUCEI) and the Watson- Glaser Critical Thinking Appraisal Form – S (WGCTA-FS). Dong (2010) used video recording, questionnaire and survey. Morrison (2010) used student and teacher interviews, audiotapes, and verbatim transcriptions of audio tapes. Romero (2010) used Meta review analysis.

3.2.1.1 Major findings

Basili (1989) study's transcriptions of verbal interaction revealed five of the eight groups audiotape had verbal behavior suggestive of all four conditions of the conceptual change process (e.g. dissatisfaction with preconceptions, and perceptions of intelligibility, plausibility and utility of new concepts). All the individuals, who had evinced all four conditions, achieved correct concepts on the posttest. Dong (2010)

study found that, Extroversion showed a big influence on how many speaking turns the students were able to get discussions. Conscientiousness demonstrated significant prediction on all the measures in the post discussion questionnaire which aims to evaluate how engaged the children were. Emotional Stability showed an interesting interaction effect, with gender on the number of talking turns the students made. Openness revealed a significant positive main effect on the students' self-reports of the level of involvement in the discussions. Agreeableness showed significant negative impact on the students' self-rating of how many negative emotions they experienced. Morris (2008) study results indicated that the identity of the student asking a question or requesting help in some form or another is a better predictor of whether he she will receive help than the type of questions he/she asks. Nonverbal behavior was analyzed for social gestures, body language, and shifts in possession of toots. Each nonverbal act was coded as either "positive" (encouraging participation) or "negative" (discouraging participation); and, the researchers found that in groups in which there was unequal participation and less "help" provided among peers (according to the verbal analysis results) there tended to be more "negative" nonverbal behavior demonstrated than in groups in which "shared talk time" and "helping behavior" were common characteristics of the norm.

The combined results from the analyses of the verbal and nonverbal behavior of students within small groups were then reviewed through the conflict, power, status perspective of small group interactions in order to determine some common characteristics of high functioning (collaborative) and low functioning (non-collaborative) groups. Some common characteristics of the higher functioning groups include: few instances of conflict shared "talk time" and decision making, inclusive leadership, frequent use of encouraging social gestures and body language, and more sharing, of tools than seizing. Some shared traits among the lower functioning groups include: frequent occurrences of interpersonal conflict, a focus on process (rather than content), persuasive or alienating leadership, unequal participation and power, frequent use of discouraging social gestures and body language, and more seizing of tools than sharing.

Donohuie (2010) study findings showed that affect played a decisive role in promoting cooperation and productivity and that its influence accumulated,

accentuating the positive or negative effect. Ali (2003) study results showed that overall the students in the Cooperative Learning with meta cognitive Scaffolding group significantly outperformed the students in the Cooperative Learning group who, in turn, significantly outperformed the students in the Traditional group in all (mathematics performance , mathematical reasoning, and meta cognitive knowledge) measures. Chester (2010) study found that significant relationship between cooperative learning dyads and physics achievement by high school minority students was found. By learning in small groups, students were able to help each other construct meaning and make sense of their learning. Conring (2010) study findings indicated a significant difference in the mathematical achievement of 2nd grade students taught using cooperative learning strategies when compared to the mathematical achievement of 2nd grade students taught using traditional teaching method. The use of cooperative learning strategies could increase math achievement, which may improve the likelihood of children being able to reason mathematically in real world situations.

The results of Romero (2010) meta-review indicate that cooperative learning improves student achievement in science. The overall mean effect size was .308, a medium effect. Moderator analyses on study participant characteristics gender and ability level were inconclusive based on the small number of studies in which data on these characteristics were disaggregated. If the intervention was structured in a particular fashion, the effect on student achievement was greater than that for an unstructured intervention. The intervention showed a greater effect on student achievement in biology classes than in other science disciplines. Studies performed using cluster randomized or quasi-experimental without subject matching methodologies showed a greater effect on student achievement in science than studies that used the quasi-experimental with subject matching methodology. Niemi (2010) study revealed that the learning using a structured dyad model resulted in significantly higher student achievement scores than learning using the Jigsaw II model. Purghart (2010) study revealed that students placed in the small-group instruction classrooms increased their learning in the social studies unit significantly more than those in the traditional classroom for factual recall and reasoning questions. Quantitative results showed no significant difference between the gains of high and low-achieving students. Gilbert (2008) study found that cooperative learning does not have a

significant impact on academic success. However, when considering academic progress among groups, there were differences amongst grade levels. Students in grades 3rd, 4th, and 5th posted considerably higher math scores in cooperative learning groups than 1st and 2nd grade students.

McNair (2006) study revealed that procedures employed by teachers during cooperative learning included the following: directly teaching the subject to students before beginning cooperative group learning, placing students in groups of four, closely monitoring students, assessing students, and rewarding students. Students reported sharing, taking turns, and helping one another as procedures used during cooperative learning. Cooperative learning was viewed as being valuable in the classroom. Competition was not considered a vital part of cooperative learning. A few teachers and administrators considered competition an important factor of cooperative learning during the interview process; however, competition was not observed being facilitated in the classroom during cooperative group learning. Morrison (2010) study revealed that (1) Fifth graders initiated and maintained meaningful talk of written text in peer-led settings with minimum teacher intervention; (2) They used numerous cognitive processes to generate talk as they engaged in discussion of texts; (3) They talked about narrative and informational texts in similar ways; (4) And they engaged in more lengthy discussions of informational text and provided more meaning making utterances for this text type compared to narrative text. Hines (2008) study results indicated that teachers' overall actual use of cooperative learning strategies was quite frequent and these strategies ranged from presenting and explaining, to modeling and intervening, to teaching the skills needed for students to work together. Goyak (2009) study results revealed significantly in the means in the cooperative learning group in four of the eight constructs within the CUCEI. Results within the WGCTA-FS disclosed no significant differences between the means of the two groups.

3.2.2 Researches on problem based learning

The studies of Dempsey (2001), Diercks (2003), Krivel – Zacks (2003), Pilliner (2003), Casey (2008), Dobbs (2008), Mondschein (2008), Nelson (2008), Burris (2009), Sanderson (2009), Seifert (2009), McCaughan (2010), Pease (2010), and Tims (2010) are related to problem based learning and its use in science teaching; PBL on teachers technological perception; problem-based learning (PBL) as an

approach to teaching information literacy skills; effects of participation in a Problem – based learning (PBL) teacher education program; perception of PBL and attitude towards its adoption among teachers; effectiveness of PBL; students perspectives on PBL; student achievement in the problem-based learning classroom; relationship between tutors' pedagogical beliefs and their comfort and challenges with the facilitation of Problem-based Learning (PBL) tutorials; PBL to prepare school principals for teacher supervision in a constructivist classroom; impact of a metacognitive reflection component in a problem based learning unit; Effect of problem-based learning on critical thinking ability, effects of problem based learning (PBL) and traditional lecture instruction (TI) courses on critical thinking, knowledge and application of strength and conditioning.

The studies of Dempsey (2001), Nelson (2008) and Tims (2010) were of Qualitative in nature. The studies of Diercks (2003), Krivel – Zacks (2003), Pilliner (2003), Dobbs (2008), Mondschein (2008), Burris (2009), Sanderson (2009) and Pease (2010) were of Quantitative in nature. The study of Seifert (2009) and McCaughan (2010) were of both qualitative and quantitative in nature. The studies of Dobbs (2008), Mondschein (2008), Burris (2009), Seifert (2009), Pease (2010) and Tims (2010) have taken students as the sample in their studies. The studies of Pilliner (2003), Nelson (2008) and McCaughan (2010) have taken teachers as the sample in their studies. The studies of Diercks (2003) and Krivel-Zacks(2003) have taken student teachers as the sample in their studies. The study of Dempsey (2001) used principals as the sample. The study of Sanderson (2009) used undergraduate college students as the sample. Dempsey (2001) used participant journal entry. Diercks (2003) used science teacher efficacy belief instrument. Krivel – Zacks (2003) used scale (likert scale) on inclusion of students with special needs and feelings of preparedness. Pilliner (2003) used post facto survey. Dobbs (2008) used pre and posttests. Mondschein (2008) used pre and posttests, student journals. Tims (2010) used in-depth phenomenological interview. McCaughan (2010) used online survey and interviews. Seifert (2009) used pre-test and post-test on poetry terms students essay scores, survey, students journal entries and a think-aloud exercise. Burris (2009) used critical thinking ability test. Sanderson (2009) used California Critical Thinking Sails Test (CCTST), pre and post-tests of National Strength and Conditioning

Association Certified Strength and Conditioning Specialist (NSCA-CSCS) in knowledge and practice exams.

3.2.2.1 Major findings

Casey (2008) study found that the Problem Based Inquiry method can be used effectively as an indirect training evaluation method. This study demonstrated that PBI can increase transfer of training and increase training effectiveness, in most cases. Pease (2010) study results indicated students' superior mastery of the concept learned via PBL in terms of understanding, integration and application. It also indicated that collaboration is not an essential component of PBL, as revealed by a lack of a significant difference in students' performance across these two conditions. Performance in both conditions remained superior to that in the Lecture/discussion condition. Tims (2010) study results indicated that PBL may help ESL adult students improve, learn, and/or practice English because it promotes hands-on learning as well as the possibility of integrating the four language skills. However, the students' learning in needs should determine the type, length, and focus of the project activity, as well as the degree of active teacher involvement. Sanderson (2009) study revealed that, student course evaluations revealed student perceptions of PBL in which students found textbook usage, the use of PBL problems, and communication of strength and conditioning concepts with the group as she most beneficial PBL course components to learning strength and conditioning with peers as teachers as the least beneficial. PBL students also noted feelings of frustration, culture shock, and lack of time in learning course material. All PBL students were graduating seniors with no prior PBL experience. The instructor recorded observed critical thinking, application of knowledge, an£ positive and negative comments and class interactions in field notes. Students did not improve critical thinking, knowledge, and application in strength and conditioning better with PBL than TI. It is important to note PBL scores were not statistically less than TI suggesting that PBL was an equally effective pedagogical method.

McCaughan (2010) study results showed a statistically significant relationship between pedagogical beliefs and facilitation comfort with PBL facilitation techniques. Interview data corroborated these findings. Pilliner (2003) study found that majority of teachers were unaware of problem – based learning (PBL). Teachers who embrace a student – centered teaching preference are more likely to be aware of PBL. Little

more than half the teachers have a student – centered teaching philosophy, and less than half appreciate the student – centered teaching components of PBL. Teaching philosophy is related to the teachers' age and inference for PBL teaching components. More female than male teachers embrace the student – centred components of PBL. The greatest perceived barriers to teacher implementation of PBL included, assessing and reporting student learning, a loosely structured, sometimes noisy learning environment, and system unwillingness to provide PBL support sources. Dobbs (2008) indicated that there was not a significant difference in student achievement between the PBL and traditional teaching methods. Diercks (2003) study results indicated in increase in the pre service teachers' self – efficacy in teaching science. Krivel – Zacks (2003) investigation revealed that the majority of the groups involved agreed that PBL curriculum does have an effect on reasoning, interest, enthusiasm, and satisfaction of faculty and teacher education students. Majority of participant groups also were of the opinion that PBL and non – PBL curriculums provided equal knowledge of basic skills and principles, and professional preparation to the students.

Nelson (2008) study indicated several identified positive themes: the need for integration, the PBL process, professional growth, peer interaction, and leadership. Group dynamics and communication technologies were mentioned as negative aspects of the online (PBL) model. Additionally, participants indicated that the following issues represent challenges of learning technology integration through online PBL: group dynamics, scheduling and time issues, use of multiple disciplines, and pushing the boundaries of student learning. Mondschein (2008) research indicates that integrating PBL into curriculum focusing on information literacy facilitates the development of information competencies and promotes academic engagement among students. The findings of this research suggest that a first-year seminar incorporating PBL should consist of a sequenced curriculum including information competencies reflecting the five student learning outcomes. Burris (2009) study found, that students in the supervised study treatment group produced higher scores or critical thinking ability. While this difference was statistically different, there was no practical difference between the two groups. The supervised study treatment group outperformed the PBL group on content knowledge. The difference was both statistically and practically significant.

The overall findings of Seifert (2009) study fail to lend support for the intervention that was examined. The qualitative analysis results were not statistically significant between the two experimental groups and the control group. While the qualitative data sources provided some insights regarding how students learn, the data did not indicate that this type of metacognitive support greatly impacted student learning over the course of his study. Dempsey (2001) study revealed that the PBL project meets the criteria for a successful PBL (e.g. Promotes collaboration, mirrors real world, meets objectives, etc.). Participants' journal entries provided rich insight and texture to the findings.

3.2.3 Researches on inquiry learning

The studies of Blain (2001), Gabel (2001), Callard (2002), Ruyter (2002), Livingston (2005), Furtak (2006), Gejda (2006), Reger (2007), Reid – Hector (2007), Slone (2007), Choi (2008), Hunsburger (2008), Kessner (2008), Slack (2008), Tzou (2008), Horvath (2009), Jensen (2009), Tosa (2009), Varma (2009), Harris (2010), Katz (2010), Regis (2010), Sack (2010) and Weakley (2010) are related to science inquiry, inquiry approach to mathematics instruction, Inquiry – based instruction in secondary science classrooms, Inquiry – based learning practices and team learning, influence of inquiry – based activities on higher order thinking of gifted students, scientific and guided inquiry, teachers' support of inquiry practices as they enact an inquiry-based curriculum, dilemma of guidance in scientific inquiry teaching, teachers plan inquiry-based curricula that scaffold the diverse learning needs of the students, teacher learning in enquiry based classroom, inquiry tasks in classroom, effects of an inquiry-based earth science course on the spatial thinking of pre-service students, pre-service teachers' perspectives on their understanding of inquiry-based pedagogy and their confidence to teach science, inquiry-based instructional strategies in students achievement, teacher and student perceptions of conventional and inquiry-based mathematics instruction, teaching inquiry based curriculum material, cross-cultural comparison of science teachers' understanding of, and attitudes towards inquiry-based teaching, effects of collaboration and inquiry on reasoning and achievement in biology.

The studies of Blain (2001), Callard (2002), Ruyter (2002), Livingston (2005), Furtak (2006), Reger (2007), Reid – Hector (2007), Slone (2007), Hunsburger (2008),

Slack (2008), Tzou (2008), Katz (2010) and Regis (2010) were of Qualitative in nature. Whereas, the studies of Gabel (2001), Gejda (2006), Jensen (2009), Tosa (2009) and Harris (2010) were of quantitative in nature. Choi (2008), Kessner (2008), Sack (2010) and Weakley (2010) were of both Qualitative and Quantitative in nature. The studies of Blain (2001), Gabel (2001), Callard(2002), Reger (2007), Slone (2007), Kessner (2008), Jensen (2009), and Harris (2010) have taken students as the sample in their studies. The studies of Ruyter (2002), Livingston (2005), Gejda (2006), Choi (2008), Hunsburger (2008), Tzou (2008), Tosa (2009), Regis (2010) and Sack (2010) have taken teachers as the sample in their studies. The studies of Slack (2008), Horvath (2009), Varma (2009) and Weakley (2010) have taken student teachers as the sample in their studies. The studies of Furtak (2006) and Katz (2010) have taken teachers and students as the sample in their studies.

Blain (2001) used non-parametric Wilcoxon test of inquiry skill and attitude toward school science course. Ruyter (2002) used interviews, observations, and document analysis. Furtak (2006) used videotapes and interviews. Gejda (2006) used survey. Reger (2007) used video-taps, student logs and rubric. Reid – Hector (2007) used in depth interviews, the Team Learning Survey, researcher observations, field notes. Slone (2007) used pre and post instruction interviews and rubrics. Choi (2008) used pre and posttest survey and intensive case study. Kessner (2008) used achievement test, surveys, checklist, open ended survey, and interviews. Slack (2008) used demographic survey, an open-ended questionnaire with follow-up interviews, the researcher's observations, participants' lab notes, personal interviews, and participants journals. Jensen (2009) used reasoning ability and achievement test. Tosa (2009) used survey and observation. Katz (2010) used perception continuums, teacher and student responses, teacher statements, observations and in-depth interviews. Harris (2010) used pre-post achievement tests. Regis (2010) used interviews, survey and lesson plans. Sack (2010) used surveys, interviews, and classroom observations.

3.2.3.1 Major Findings

Blain (2001) study revealed that, grade three students had significant improvements in inquiry ability and attitude toward school science as a function of their participation in mixed-age dyads completing inquiry-based science experiments with a high school physics partner. The social interaction between the 'more capable other' (Vygotsky,

1978) with the grade three student in the mixed-age problem solving team indicates a contributing factor in this improvement. Gabel (2001) study indicates that a scaffolded approach in all pedagogical aspects contributes in a successful performance from the students in designing their own scientific investigations. The study of Callard (2002) reveals that after engaging in the three instructional units based on an inquiry approach, all students did indeed demonstrate learning of not only the mathematical content expected in traditional eighth grade mathematics, but also demonstrated learning that went beyond these expectations in many instances.

Furtak (2006) study revealed large differences in the guidance teachers provided (in scientific inquiry teaching) to students during the unit. Teachers whose students showed lower gains in learning exhibited patterns of alternating between high and low levels of guidance. The teachers whose students showed higher gains had more mixed patterns of guidance. The results suggested that the teachers whose students had higher gains illustrated more instructionally responsive teaching, and took an active role to move students toward learning goals, whereas the lower-gain classes received little meaningful guidance from teachers. Measures of student learning indicated teacher effects. Reger (2007) study showed marked increase in and deeper levels of higher-order thinking for two of the students. The other boy and girl showed progress using the inquiry activities, but it was not as evident. The social dynamics of the group seemed to hinder one girl's participation during some of the activities. The social interactions played a role in strengthening the exchange of ideas and thinking skills for the others. The teacher had a tremendous influence over the production of higher – level statements by modeling that level of thinking by questioning the students. Through the practice of answering a question with a question, the teacher gradually solicited more analytical thinking from the students. Slone (2007) study found that, prior to inquiry based instruction most of the sixth grade students were very likely to hold non-scientific conceptions of magnets and magnetic phenomena. After instruction fewer students held non – scientific conceptions and most students held at least some scientific understandings. A similar finding has also been noted by Trundle (2000) among pre-service teachers. Another study by Choi (2008) found that participant teachers constructed fairly positive beliefs and practical knowledge that promoted inquiry-instruction throughout the course.

Moreover, they improved their knowledge and skills of conducting inquiry in their own science lessons.

Kessner (2008) study results indicated a general improvement of students meeting mastery of the fifth-grade science state assessment when kits were implemented. Teacher fidelity and high implementation were validated with Student and Teacher Surveys. Jensen (2009) study results showed that within non-inquiry instruction, heterogeneous mean group scores were higher in both reasoning and achievement than homogeneous groups. In contrast, within inquiry instruction, homogeneous mean group scores were higher in both reasoning and achievement. Inquiry instruction, as a whole, significantly outperformed non-inquiry instruction in the development of reasoning ability. Within inquiry instruction, low-ability students had significantly greater reasoning gains when grouped homogeneously. Harris (2010) study found that both the experimental group and the control group significantly increased their mean scores from the pretests to the posttests. The amount of gain from the pretest to the posttest was significantly greater for the experimental group than the control group. The experimental group significantly outperformed the control group with regard to their mean number of items answered correctly on the life sciences test.

Katz (2010) study found that, students in the four classrooms viewed: (1) the conceptions of mathematics and mathematics instruction differently; (2) adaptive reasoning and thinking in the mathematics classrooms differently; and (3) the roles of teachers and students differently. There was greater distinction between the students' views in inquiry classrooms and students' views in the conventional classrooms. Weakley (2010) study found that statistically significant changes were observed in the use of spatial constructs and concepts by students in each of this course treatment that were compared. Students were also observed to apply spatial modes outside the classroom that represented the spatial thinking: within the new context of the University environment as they observed and described the landscape.

Horvath (2009) study showed that, six of the pre-service teachers did not demonstrate shifts in content of planning, teaching and reflecting on inquiry-based science. Three of the pre-service science teachers who shifted perspectives were chosen for further analysis. All 3 pre-service science teachers were found to have

constructed a more robust view of inquiry. Yet each pre-service science teacher also described experiencing and engaging with inquiry in relation to her own unique set of instructional contexts. Varma (2009) study indicate that when multiple inquiry-based experiences and instructional strategies, consistent with the National Science Education Standards, are integrated into a traditional elementary science methods course and reinforced through observations of classroom practice in the field, pre-service teachers develop an understanding of scientific inquiry and inquiry-based science instruction, develop an appreciation for the benefits of teaching and learning science in a constructivist environment, develop confidence to teach science and indicate intent to use inquiry -based science teaching strategies m their own classroom practice.

Slack (2008) study found that pre-service teachers' experiences with Scientific Inquiry were that the experience increased their abilities to conduct inquiry, increased their understanding of how they might use Scientific Inquiry in their classroom, increased their understanding of why variables are used in experiments, and did not increase their physics content knowledge. Ruyter (2002) study indicated two main findings. First, the concept of scaffolding was broadened from an instructional strategy or remedial tool to consider curriculum as scaffolding. The second finding emerged from the data on the teachers' planning process. The data reveal the complexity of the curriculum creation process and the essential role of teacher inquiry into her or his own pedagogical content knowledge in order to create curricula that are engaging and accessible to all learners. Another study conducted by Livingston (2005) found that, with the environment in place, the teacher can provide various problem situations that promote students' active reflection. The dialogic structure of the teacher's facilitation of student's science knowledge is shown to utilize students' presumptive statements to hone their construction of inductive or deductive arguments. Gejda (2006) study indicated that participants reported practicing the 5Es (engage, explore, explain, elaborate, and evaluate) in inquiry – based instruction in their secondary science classrooms. Time, resources, the need to cover material for mandatory assessments, the science topics of concepts being taught, and professional development on inquiry – based instruction were reported to be important considerations in participants' decisions to practice inquiry – based instruction in their science classrooms. A majority of the secondary science teachers participating in this

study indicated they had the time, access to resources and the professional development opportunities they needed to practice inquiry – based instruction in their secondary classrooms. Study participants ranked having the time to teach in an inquiry – based fashion and the need to cover material for mandated testing as the biggest obstacles to their practice of inquiry – based instruction in the secondary classroom.

Reid – Hector (2007) findings indicate that the Inquiry Based Learning Project primarily functioned to generate learning by facilitating the groups' transition from a task-oriented team to a learning system. Collectively the IBLP facilitated team learning by creating a learning environment situated in a climate of trust, facilitated a balance between advocacy and inquiry; and served as a mechanism to bridge diversity relevant to educational background, team roles and gender. The IBLP helped the team to deal with dysfunctional patterns of communication and interpersonal conflict rooted in issues of gender diversity relative to power inequities and access. Hunsburger (2008) study found that to reconstruct one's role as an inquiry teacher requires more than a theoretical understanding of the approach but entails an iterative process of experimentation, reflection and reconstruction that is unique to and deeply personal for each teacher. The researcher also discovered that for the three teachers in my study the role of co-learner is integral to their identities and how they live their lives. He also find that the setting in which the implementation takes place has much to contribute to the process through providing a safe and supportive environment for making mistakes and taking risks.

Tzou (2008) study explored three questions (1) what is the nature of teachers' support of inquiry practices? (2) How do teachers accomplish goals along multiple dimensions of inquiry?, and (3) What aspect of inquiry are in tension and how can we describe teachers' practice in terms of the tradeoff spaces between elements of inquiry in tension?. It was found that the teachers provided support for inquiry along all three dimensions (cognitive, social, and linguistic**)**, sometimes in ways in which the dimensions were in tension. Tosa (2009) study results shown that inspite of the variations in teachers' definitions of inquiry-based teaching, teachers in both countries strongly agree with the idea of inquiry-based teaching. However, little inquiry-based teaching was observed in either of the countries for different reasons. The data

indicate the Japanese teachers did not generally help students construct their own understanding of scientific concepts in spite of well-planned lesson structures and activity set-ups. On the other hand, the observational data indicates the American teachers often lacked meaningful science content in spite of their high level of pedagogical knowledge.

Regis (2010) study results indicate that collaboration influenced the content teachers planned to teach as they discussed Investigations-related issues, determined Grade-Level Expectations (GLEs) to be taught, and/or exchanged activities for teaching. Whether they collaborated through district-sponsored meetings, school-level planning, or by personal choice, teachers ultimately created lesson plans individually. Teachers who considered Investigations to be an effective curriculum that addressed the GLEs supplemented sparingly, while those who perceived "holes" in the curriculum supplemented extensively. Most teachers recorded minimal information in their lesson plan due to time constraints and a limited understanding of curriculum features. Sack (2010) study revealed that many of 4th grade teachers like teaching science, actively pursue ways of improving their science teaching skills, but do feel as if science is an area of deficiency for them. They reported that their teacher preparation programs did not have science content courses, as an area of concentration, and they feel as if additional content knowledge would be beneficial to enhancing their instructional methods. Many teachers reported attending different kinds of district and state level workshops to help them advance their pedagogical content knowledge around the state science standards, but few teachers reported participating in professional development workshops that would improve their science content, knowledge. Case study teachers support this claim as well; however these teachers did say that they were exposed to additional science content classes during their pre-service training. Student findings collected through a series of think-aloud interviews and classroom observations suggested that scaffolding and repetition are imperative to student learning and their development of scientific thinking skills. By giving students repeated exposure to the desired science content, they were able to show proficiency with the embedded inquiry task.

3.2.4 Researches on concept mapping

The studies of Abayomi (1988), Carter (1999), Salata (1999), Snead (2000), Jackson (2006), Conklin (2007), Ku(2008), Pickens (2008), Campbell (2010) and Somers (2010) are related to effectiveness of the concept – mapping strategy, the effect of concept mapping on pre-service elementary teachers' knowledge of science inquiry teaching, relationship between concept mapping and the content and organization of technical writing, meta-analytical review of Novak's concept mapping, concept maps to explore pre-service teachers' perceptions of science content knowledge, teaching practices, and reflective processes; learner achievement. The studies of Carter (1999), Ku (2008) and Somers (2010) were of qualitative in nature. The studies of Abayomi (1988), Salata (1999), Snead (2000), Jackson (2006) and Conklin (2007) were of quantitative in nature. The study of Pickens (2008) was of both qualitative and quantitative in nature. The study of Campbell (2010) was of meta-review in nature. The studies of Carter (1999), Salata (1999), Snead (2000), Conklin (2007), Ku (2008) and Pickens (2008) have taken students as the sample in their studies. The studies of Jackson (2006) and Somers (2010) have taken student teachers as the sample in their studies. The study of Abayomi (1988) used teachers and students as the sample.

Abayomi (1988) used pre and post achievement tests and Group Embedded Figures Test. Carter (1999) used solicited personal documents including written proposition lists, concept maps, and examinations, were examined along with tape recorder conversations. Salata (1999) used survey and pre and post achievement tests. Snead (2000) used a conventional weather test and six performance assessment items test. Jackson (2006) used Equivalent forms of the Teaching Science Inventory (TSI) and Equivalent forms of the Science Lesson Planning (SLP) test. Conklin (2007) used concept map as pre writing and post writing assessment. Ku(2008) used student's pre and post concept maps, the instructor's concept maps, participant observations, semi-structured interviews with the students and the instructor, semi-structured interviews with the students via instant messaging, documentation of the student's write ups, instructor's handouts and lesson plans. Pickens (2008) used pre-post achievement tests. Campbell (2010) used mata analysis review. Somers (2010) used interviews, observations, and pre and post concept mapping.

3.2.4.1 Major findings

Abayomi (1988) study revealed that although there was no statistical significant difference between the two groups, the means of the posttest scores for the students in the concept – mapping group were higher than the means for the students in the outlining study guide group. There was no significant difference between achievement scores of field – dependent and field – independent students. Based on the one – on – one interviews, students responded favorable to the concept – mapping strategy. Salata (1999) found that achievement improved to a statistically significant an meaningful level when students were presented lectures using a concept map organizer. Achievement was higher when students were shown lecture using the concept map organizer as compared to the outline organizer. Conklin (2007) study revealed that concept mapping significantly improved the depth of content; however, no statistical significance was detected for organization. Students had a significantly positive change in attitude toward using concept mapping to plan a writing assessment, organize information, and think creatively. The findings indicated concept mapping had a positive effect on the students' abilities to select concepts appropriate to respond to writing prompt, integrate facts into complete thoughts and ideas, and apply it in novel situations. Concept maps appeared to facilitate learning how to process information and transform it into expository writing. Sustained practice in designing concept maps may influence organization as well as content.

Campbell (2010) meta-analytical review results indicate that Novak's concept maps are effective learning tools for enhancing and promoting achievement among students. Within the learning domains of Science, English/English as a Second Language, Education, and Electives, concept mapping improves achievement. However, within the learning domain of Math, concept mapping groups did not demonstrate improvement of achievement. Both computer-generated and non-computer-generated maps were slightly more effective. Snead (2000) study found that concept maps not made significant overall effects on student's science achievement. Jackson (2006) study results indicate that, there were basically no relationships between the treatment and outcome measures. There were no significant differences between the three groups in their knowledge about how to teach science. The learners did learn how to teach science using inquiry. There is little evidence to support that concept mapping was more successful than the listing strategy in improving

preservice elementary teachers' knowledge of teaching science using inquiry science instruction methods.

Carter (1999) study on collaborative concept mapping strategy revealed that most students paid only moderate attention to each other's comments. Most commonly observed cooperative behaviors were seeking meaning, providing explanations, and completion of partner's statements. The degree of pair symmetry did not consistently influence student interactions or cooperative behaviors. Students used easily memorized, but not necessarily accurate, answers. They had difficulty in focusing on abstract concept and in forming explicit relationships. They also had difficulty with the hierarchical nature of concept maps. Ku (2008) study findings suggested that the student generated pre-concept maps prior to the design and problem-solving activities revealed students' utilization of their pre-existing knowledge, either from previous courses or from other design and problem solving activities to generate their pre – concept maps. The pre-concept maps also revealed preconceptions or misconceptions the student held in regard to the knowledge domain. The post – concept maps, observations, interviews, and write-ups/evaluations suggested that the students learned and developed technology concepts as a result of the design and problem solving activities through meaningful learning and through the problem solving process in a constructivist learning theory.

The study of Pickens (2008) revealed that when the participants developed their concept maps it became their model for thinking. As the participants created their model they developed a sense of ownership and empowerment of the knowledge. The participants further described that concept mapping required a higher level of thinking. Participants described that concept mapping helped them to critically think as it required them to research and investigate relationships. Somers (2010) study findings showed that concept map usage clarified students' understanding of the organization and relationships within content area and that the process of creating the concept maps increased participants' understanding of the selected content. The participants felt that the visual element of concept mapping was an important factor in improving content understanding. These participants saw benefit in using concept maps as planning tools and as instructional tools. They did not recognize the use of concept maps as assessment tools. When the participants

were able to find personal relevance in and through their concept maps they were better able to be reflective about the process. The experienced teachers discussed student understanding and skill development as the primary purpose of concept map usage, while they were able to use concept maps to accomplish multiple purposes in practice.

3.2.5 Researches on collaborative learning

The studies of Armstrong (2000), Oakley (2001), Zinicola (2003), Caputo (2008), Cuneo (2008), Perry (2008), Wissel (2008),Griffith (2010), Jadallah (2010) and Joscelyn (2010) are related to students collaborative group investigation; effects of collaborative learning on performance in undergraduate mathematics; Teachers working collaboratively for continuous improvement; teacher conceptualization of collaboration; teacher influence on children's collaborative argument construction; relationship between students' attitudes towards collaboration in groups and students' learning; learner experiences in collaborative projects; effects of collaborative inquiry groups (CIGs) on teacher efficacy beliefs, teacher isolation, and student achievement on writing. The studies of Armstrong (1999), Oakley (2001), Wissel (2008), Griffith (2010), Jadallah (2010) and Joscelyn (2010) were of qualitative in nature. The studies of Caputo (2008) and Cuneo (2008) were of quantitative in nature. The studies of Zinicola (2003) and Perry (2008) were of both qualitative and quantitative in nature. The studies of Armstrong (1999), Zinicola (2003), Cuneo (2008), Wissel (2008) and Jadallah (2010) have taken students as the sample in their studies. The studies of Oakley (2001), Perry (2008), Griffith (2010) and Joscelyn (2010) have taken teachers as the sample in their studies. The study of Caputo (2008) used college students as the sample. Armstrong (1999) used field notes and ethnographic interview. Oakley (2001) used interviews, individual and interactive journals, field notes for his study. Zinicola (2003) used field notes, cognitive and reflective journals, audiotapes and videotapes of student talk, and audiotapes of group interviews. Caputo (2008) used questionnaire. Cuneo (2008) used pre and posttests. Perry (2008) used questionnaire, standardized test, online and face-to-face collaborative inquiry group, field notes and interviews. Wissel (2008) used interviews. Griffith (2010) used interviews, participant observation and artifacts. Joscelyn (2010) used survey, interview and observation.

3.2.5.1 Major findings

Cuneo (2008) study found that while collaboration resulted in a slight performance increase, the differences between the two groups were not significant. However, the survey indicated that students in the collaborative group felt mere confident in their problem-solving ability, enjoyed the activity more, and had a more positive experience in completing the activity than the students who completed the activity individually. It was also found that students in the collaborative group felt slightly more pressured for time than the group working individually. Griffith (2010) study showed that, the Professional Learning Community was making significant progress towards its goals of increased collaboration and pedagogical knowledge, but there was insufficient evidence to determine if participants' science content knowledge improved. Caputo (2008) study found that among the three factors—students' attitudes towards collaboration in groups, faculty/student interaction, and faculty feedback—students' attitudes towards collaboration in groups had no significant relationship with students' learning while faculty/student interaction and faculty feedback had the most significant relationship with students' learning.

Perry (2008) study results showed that teachers who attended face-to-face CIGs and online CIGs felt less isolated within their building as measured by a repeated t test and the individual interviews. Also, the results showed that participants who experimented with improving writing strategies increased- their self-efficacy-beliefs as measured by the repeated *t* test. Another study conducted by Armstrong (1999) reveals that, participants were able to observe their own learning experiences in terms of relationships formed in their respective groups. Their ability to see themselves learning from within these relationships contributed to their overall learning experience and learning outcomes.

Zinicola (2003) study finding was that all students learned as a result of 12 talk sessions as evidenced by pre- and post-conceptual change scores. Interactions that promoted learning involved students connecting their thoughts, rephrasing, and challenging ideas. The role structure was only used by students about 15% of the time, but it started the talk with a science focus, created awareness of scientific methods, and created an awareness of equitable member participation. Students offered more spontaneous, explanatory talk when the role structure was relaxed, but

did not engage in as much scientific writing. They said the role structure was important for helping them know what to do in the talk but they no longer needed it after a time. Gender bias, status, and early adolescent developmental factors influenced many of the group's interactions.

Joscelyn (2010) study revealed that collaboration mitigated isolation and led to improved lessons and instruction; however, data collection superseded lesson development and the utilization of team time to solve problems of instructional practice. The data indicated that teacher roles and goals were unclear, for teams had multiple tasks to complete from standardized test preparation and delivering the curriculum to meeting yearly school and district goals. Jadallah (2010) study found that teacher and child moves that were not direct requests, but triggered children to react, were considered to have indirect effects and continued to have a delayed impact in subsequent turns. Teachers' strongest direct effect of immediate influence was in requests; for explanations, followed by requests for reasons and clarification, and finally by requests for evidence. Children's strongest indirect effect of immediate influence on each other was in responding to requests for reasons followed by responses to requests for clarification and explanation, and finally in responding to requests for evidence. Four properties of the systems of classroom talk were examined: dependence. (b) stationarity. (c) Homogeneity, and (d) reciprocity. Stationarity and homogeneity assumptions were not met indicating change over time and across groups. Certain discussion moves exhibited not only unidirectional patterns of interaction, but also bidirectional, in which not only teachers affected children but children affected teachers' as well.

Oakley (2001) found that, those teachers believed constructivist approach, began to de – emphasize test results and focus on student learning and understanding. Wissel (2008) study results indicate that positive and negative perceptions of the functionality of groups are not dependent on practicing the five key elements of collaboration as defined by Johnson and Johnson (1994), nor are they dependent on the absence of social compensation. When the key elements were practiced and there was little to no social compensation, the group members perceived their experiences to be positive and their-groups to be functional. However, when the key elements were not practiced, and social compensation did occur, the majority of group

members still perceived their experiences to be positive and their groups to be functional.

3.2.6 Researches on field trips

The study of Sugg (2008), Marshall (2010), Patterson (2010), Rebar (2010), related to environmental field experiences at a formal environmental education site; impact of an out-of-school science program on the science learning; to compare students' perceptions of the learning environment in a traditional science classroom and a field study classroom; evidence for teachers' field trip strategies. The studies of Marshall (2010) and Rebar (2010) were of qualitative in nature. The studies of Sugg (2008) and Patterson (2010) were of both qualitative and quantitative in nature. The studies of Marshall (2010) and Patterson (2010) have taken students as the sample in their studies. The study of Rebar (2010) used teachers as the sample. The study of Sugg (2008) used school principal and teachers as the sample. Sugg (2008) used survey and interviews. Marshall (2010) used semi-structured interviews. Patterson (2010) used surveys (modified version of the "What is happening in this Classroom Survey" (WIHIC) and the "Test of Science Related Attitudes" (TOSRA). Rebar (2010) used artifacts, surveys and interviews.

3.2.6.1 Major findings

Sugg (2008) study found that while science teachers generally have positive opinions of field studies, awareness of the requirement to provide them is low and obstacles remain which prevent teachers from employing the method. Many science teachers are not providing opportunities for their students to experience science and environmental education instruction in natural settings. Half of the teachers and more than a third of the principals surveyed were not aware of the requirement to provide students with field investigations. The study generated quantitative and qualitative evidence demonstrating that teacher use of the field investigation method is strongly linked to the following factors: (a) teacher and principal awareness of the requirement; (b) administrator support; (c) funding for transportation to appropriate natural settings; (d) intra or interdepartmental competition for limited field trip opportunities: and (e) teacher training. The presence or absence of these factors has significant implications for policy and practice in science and environmental education. Marshall (2010) study findings indicate that qualitative differences in the

in-school science experiences of upper elementary children exposed to OST (out-of-school) settings and those not so exposed with respect to their conceptual understanding, epistemology of science, and formation of identity as science learners.. OST participants were more able to rapidly recall their in-school science experiences than not-OST participants. OST participants were also able to transfer their OST science knowledge to their in-school science experiences.

Patterson (2010) study results from Phase one showed that students prefer the classroom for investigation and prefer the field environment for enjoyment of science. Students that are low socio-economic class rank cooperation in the field higher than the Classroom and students that do not qualify for free or reduced lunch prefer the field environment for enjoyment of science. The qualitative data showed that students are physically engaged, develop a sense of place and learn skills in the field that reinforce concepts learned in the classroom. Rebar (2010) study findings reveal that teachers attempt to link the curriculum to the activities, resources, and content encountered on the trip using a variety of connections. However, these curriculum connections are characterized as products of opportunistic situations and reveal limited depth. Evidence further indicates that teachers treat the field visit as a background experience for their students rather than as an opportunity to introduce new concepts or do an activity that is integrated into the curriculum. Nevertheless, teachers included in this study were leading field trips that created countless learning opportunity for their students. Because training specific to field trips is rarely included in preservice programs, teachers were asked about influences on their field trip practice with specific focus on observed strategies.

Based upon the results of their studies researchers' suggested varies aspects for further studies. Snead (2000) study suggests that the effect of concept mapping on students science achievement is not clear and therefore, researchers should continue to seek more data to either or reject the effectiveness of concept mapping. Dempsey (2001) study suggests that further research is needed regarding the placements of a PBL project in a course (initial or culminating activity) and the impact of various grouping arrangements on the problem solution. Hierlmeier (1999) study suggests that need for more pre – service and professional development opportunities that address the teacher – as – learner and teacher – as – reflective – researcher in praxis, within

the context of classroom, campus, and community. Choi (2008) study suggests that a follow-up study is needed to assess the participants' implementation of inquiry-instruction in their classroom, and to examine whether the use of inquiry-instruction with their students makes a significant difference in students' science learning. Rebar (2010) study suggests that field trip pedagogy be integrated into science methods courses required for preservice teachers. Niemi (2010) study suggests that promoting the use of cooperative learning in classrooms converting schools into learning communities.

3.3 Implication for the present study

From the review of the above studies following implications were drawn. The studies on constructivism were generally qualitative in nature, but not many studies conducted for student teachers at teacher education level, because, the sample of studies were of teachers, students and student teachers. Constructivist approaches like, Teacher guided discovery/inquiry, Problem Based Learning, concept mapping were generally used. It is found that constructivistic approach Provides risk free environment to the learner and teacher role as a facilitator helps learners own thinking which further lead to the sense of ownership among learner. This extends students interest, enthusiasm, and satisfaction towards learning. Through constructivist approach conceptual change occurs among the learner from non-scientific to scientific. Those teachers who believe in constructivism have positive influence on their teaching. The participation in constructivist classroom influences student teachers attitude towards classroom teaching, and learning. Use of constructivist approach positively influence change in principal role and relationship with teachers.

3.4 Researches on Environmental Education

The review of literature on environmental education comprises 30 studies on different aspects of environmental education. The studies of Schultz (1955), Leftridgf (1977), Irwin (1993), Robertson (1995), Tomar (1998), Loman (1999), Bradford (1999), Chang (1999), Hammond (1999), Chacko (2002), Lewandowski (2002), Daniel(2006), Scott (2008) and Mathison (2009) primarily focuses on enhancing students' levels of environmental sensitivity and literacy, relationship between locus of control, attitude toward, and perception of environmental education, environmental perception, conceptualizing environment, perspectives on the environment and

environmental education, impact of an experiential science program on students' understanding of ecological science, differing concepts of human-environment interactions and the environmental problematique, misconception on environmental issues, improving environmental education instruction for better understanding, and ecological mindedness in the Ec(h)o of consumerism.

The studies of Lin (2000), Suneetha (2000), Dey (2008), Poddar (2009), Gul (2011), Kose (2011), Tuncay (2011) and Mosothwane (2000) related to undergraduate students' attitudes towards environment; relationship between environmental moral reasoning patterns and environmental attitudes; primary and secondary school students' misconceptions related to greenhouse effect; pre-service teachers' conceptions of environmental education; the status of environmental education at the teacher preparation level; Supplementary Curricular Programme on Environmental Education; status, issues and prospectus of environmental education; Environmental Education in primary schools. The studies of Brown (1989), Gilbertson (1991), Rickinson (2001), Sharma (2004), Lane (2007), Manes (2007), Shin (2009), Meuth (2010), and Foster (2010) are related to status, foundation and development of environmental education; environmental literacy; implementation of environmental education; trash arts environmental education program; strategy for environment in Multi-Grade teaching, examine the nature and quality of current research evidence on students and their learning in environmental education.

The studies of Ko (2003), Charmatz (2008), Tenam-Zemach (2008), Kola-Olusanya (2009) and Horne (2010) are related to teachers' Perceptions of Teaching Environmental Issues; student and teacher empowerment through a socially critical environmental education perspective; analysis of the themes of environmental sustainability in the United States curriculum science content standards and students' views of environmental scientists, environmental caretakers and environmentally responsible behaviors, Understanding young adults' learning, thinking, and actions on environmental sustainability. The studies of Robertson (1995), Bradford (1999), Daniel (2006), Manes (2007), Scott (2008), Kola-Olusanya (2009), Mathison (2009) and Foster (2010) were of qualitative in nature, whereas, the studies of Schultz (1955), Leftridgf (1977), Brown (1989), Gilbertson (1991), Irwin (1993), Tomar (1998), Loman (1999), Chang (1999), Lin (2000), Suneetha (2000), Chacko (2002),

Tenam-Zemach (2008), Dey (2008), Poddar (2009), Kose (2011), Tuncay (2011) and Gul (2011) were of quantitative in nature. Lewandowski (2002) study used action research based case study. Meuth (2010) study used survey. Shin (2009) study used critical Action research. The studies of Ko (2003), Sharma (2004) Charmatz (2008) and Mosothwane (2000) were of both quantitative and qualitative nature.

The study of Chacko (2002), Ko (2003), Lane (2007), Manes (2007), Mathison (2009), Shin (2009) had taken teachers as the samples in their study. The study of Robertson (1995), Chang (1999), Lin (2000), Tuncay (2011), Mosothwane ( ) had taken student teachers as the samples in their study. The studies of Schultz (1955), Leftridgf (1977), Gilbertson (1991), Tomar (1998), Loman (1999), Suneetha (2000), Lewandowski (2002), Daniel(2006), Scott (2008), Horne (2010), Meuth (2010), Foster (2010), Kose (2011), Gul (2011) had taken students as the samples in their studies. The study of Irwin (1993) had taken teacher education as sample of the study. The study of Bradford (1999) had taken common people as sample of the study. The study of Brown (1989) taken both teachers and principals as the sample of the study. Sharma (2004), Charmatz (2008), Dey (2008), Poddar (2009), had taken both students and teachers as the sample of the study. The study of Kola-Olusanya (2009) taken university going young adults as the sample of the study.

Schultz (1955) used pamphlet and tests. Leftridgf (1977) used questionnaire, multiple choice test and photographic slides. Loman (1999) and Chacko (2002)used questionnaires. Chang (1999) used questionnaire survey, locus of control (LOC) scale, attitude scale and perception scale. Lin (2000) used modified version of Towler's questionnaire. Sharma (2004) used Questionnaire, Semi-structured interview, Class room observation, Reaction scale and Achievement test. Mosothwane ( ) used open ended statements and questions. Suneetha (2000) used Basic Understanding Test in Environmental Education, and Scale on Attitude towards Environment. Dey (2008) used Enviromental Attitude Scale, Environmental Awareness Scale, Environmental Opinionnaire for teachers, and Opinionnaire for teacher educators. Poddar (2009) used Environmental Awareness Ability Measure, Environmental Attitude Measure, and Environmental Achievement Measure. Kose (2011) used attitude scale. Gul (2011) used Likert kind scale. Tuncay (2011) used case studies and attitude scale.

Robertson (1995), Kola-Olusanya (2009) used interviews. Tomar (1998) used achievement tests and semi-structured interview. Bradford (1999) used individual interviews and focus group discussions. Lewandowski (2002) used digital aerial photographs, journals, cognitive maps, sketches, interviews, and audio recordings of classroom and field- based activities. Daniel (2006) used interviews, observations, stories, and productions of student drawing. Lane (2007) used in-depth interview and classroom observation. Foster (2010) used classroom visits, field notes and interviews. Horne (2010) used semi-structured interviews. Meuth (2010) used survey. Ko (2003) used surveys and interviews. Manes (2007) used observations, interviews, surveys, and documents. Charmatz (2008) used written surveys, scores on Middle School Environmental Literacy Survey Instrument (MSELI), observations, interviews, and student work.

3.4.1 Major findings

The major findings as per the main focus of the respective studies are as follows:
Chacko (2002) study revealed that, there was significant difference between environmental literacy of teachers who received training in environmental education and teachers who did not receive any training in environmental education. Leftridgf (1977) study revealed that, rural students were more perceptive of environmental issues than urban students. In her study Tomar (1998) found that the achievement of students on environmental aspect was found to improve, if there is a better school ecology, infrastructural facilities and they were utilized properly. Loman (1999) study revealed that, students' understanding of key concepts related to ecology and students' feelings about science in identified areas were of statistical significance. However, a review of the mean gains or losses showed relatively small change. Therefore, the results of this study were inconclusive.

Daniel (2006) found that, students' conceptions of the environment did shift from a non-specific scene of the outdoors to one that was identifiably connected to their own lives and their own pueblo. There was no convincing evidence that the students' ideas about science shifted, nor was it evident whether students made connections between western science and their traditional knowledge. It was evident that forming relationships with members of the community based on shared

understandings of the program's purpose was a difficult process and that it takes time. Scott (2008) study revealed that, children chose the ways they interpreted and expressed their environmental knowledge, ethic of care, advocacy, and commitment to action. This development of each child's self-expression resulted in motivational and powerful learning experiences that inspired and nurtured their connections to the earth. Gilbertson (1991) study indicated that, students were found to be more literature toward environmental issues than ecological principals. Student attending a residential type experience were more environmentally literature. There were no significant differences between the control groups and those who attended a field trip type experiences.

Meuth (2010) study results indicate that students have high levels of ecological knowledge but, convey only moderate feelings towards the environment. The students report that they are willing to engage in more pro-environmental behaviors than they actually report doing. They also display modest abilities to identify and analyze environmental issues as well as select appropriate action plans. Regarding the domains critical to environmental literacy, the mean scores for this sample fell within the high range for ecological knowledge; scores for affect, cognitive skills, and behavior all fell within the moderate range. For each grade level, the overall environmental literacy composite scores also fell within the moderate range. Horne (2010) study found that some of the stereotypes, particularly related to gender, revealed in prior research (Barman, 1999, Chambers, 1983) are evident among many elementary students. Male environmental scientists were drawn twice as often as female environmental scientists. Females were represented in more pictures of environmental caretakers than environmental scientists. Students overwhelmingly drew environmental scientists (98.1%) and environmental caretakers (76.5%) working alone. Wildlife was noticeably absent from most drawings (85%). Where wildlife was included, it was most often birds (6.9%) and fish (3.1%). More than one species was evident in only 2.5% of the pictures. Fifty percent of environmental caretakers were shown picking up trash from land. Actions such as reducing resource use occurred in only 13 out of 319 pictures (4.1%). Pictures of environmental caretakers sharing knowledge were even less common (2.5%). Almost 22% of females drew multiple individuals compared to 18.5% drawn by males. Females were more likely to show

individuals collaborating while males were more likely to show individuals working in opposition.

Kose (2011) study found that undergraduate students had positive attitudes toward the environment as regard to their gender and faculty types. It was emphasized that female students were more sensitive toward environment than male students. Gul (2011) study indicated that the students had fewer misconceptions than those specified in the literature related to "events depending on increasing of greenhouse effect", events getting bigger greenhouse effect" and "events to reduce greenhouse effect". Suneetha (2000) study found that experimental treatments using specially designed supplementary curricular programme have been found significantly more effective in developing basic understandings in environmental education and also developing a favourable attitude towards the environment in all the four selected schools. The study has demonstrated its effectiveness in terms of multi-disciplinary approach, substantiating the Infusion Technique for teaching of environmental education. Dey (2008) study indicated that boys and girls of government secondary schools have been found to have better environmental awareness, attitude in comparison to their counter parts. It was found that a significant and positive relationship between environmental awareness and environmental attitude among students. The perceptions of the teachers reveal that the status of environmental education is not much encouraging. A lot has to be done with respect to curricula, development of teaching-learning material, modes of transaction, co-curricular activities, and providing reinforcement for attainment of the objectives of environmental education.

Poddar (2009) study revealed that no significant difference was found in the Environmental Awareness of Male Teachers and Female Teachers. The Environmental Awareness of Urban School Teachers was found significantly higher than that of Rural School Teachers. The Environmental Attitude of Male Teachers was found significantly higher than that of Female Teachers. The Environmental Attitude of Urban Teachers and students was found significantly higher than that of Rural Teachers. The Environmental Achievement of Male Students was found significantly higher than that of Female Students. There was found to be a significantly positive correlation between Environmental Awareness and

Environmental Attitude of Teachers. The Environmental Awareness and attitude of Teachers has been found to have significant effect on the Environmental Achievement of the Students.

Foster (2010) study analysis reveals that learning is divided into a section concerning teacher-controlled environmental ethics and a section concerning student controlled physical environmental learning. The separation of the program into distinct parts creates two contrasting experiences within the program. As a result, creative attempts by students to connect the two sections through constructive learning techniques are thwarted by the program's disjointed format. Despite the failure of the program to empower and legitimize student learning, this study describes the complexity and ingenuity of student-controlled learning and shows how it adds valuable dimensions to children's environmental educational experiences. Mathison (2009) study try to explain that, pursuing the understanding of ecological mindedness involves a recovery and uncovering of and for the 'other,' not solely on an intellectual level, but emotional and 'spiritual' as well. This pulls forward the power of an echo to resonate and reverberate with related 'others' themes such as peace education, participatory democracy, global education, tolerance, difference, and indusivity—in other words, transformative education.

Charmatz (2008) study revealed that environmental action projects provide a context for students and teachers to learn interdisciplinary content knowledge, develop personal beliefs, and learn ways to take action in their communities. This pedagogy has the potential to increase cooperation, communication, and tensions within school communities. Students' participation in the development of environmental action projects may lead to feelings of empowerment or being able to make a difference in their community, as an individual or member of a group. Schultz (1955) study indicated that teachers will make more effective use of materials if they understand some basic concepts of ecology and have had field experiences. Manes (2007) study collected the data in two phases and included observations, interviews, surveys, and documents. The results showed that the participant teachers gained insights into ecological issues and confidence in their ability to teach these topics, but for the most part they were not successful with implementation.Shin (2009) study revealed that, teachers came to understand the importance, objectives, potential

topics, and teaching methods of early childhood environmental education. While implementing environmental education in their classrooms, teachers recognized possibilities for environmental education through connections with children's daily lives and previous activities conducted in their class-rooms. Teachers also identified that critical action research through group communication provided practical and useful knowledge of their educational practices. Teachers' improved pedagogical knowledge and awareness about EE increased their confidence to teach environmental education.

Brown (1989) study results indicated that 78.6% of the respondents felt that they were not adequately prepared to teach EE and in-service was not available in 70.9% of the schools. Lack of time to develop an EE program was the item most respondents indicated as inhibitive to EE curriculum development. Teacher interest was the element most influential in implanting EE into the elementary curriculum in the study sample but state mandate was the most influential element in the exemplary school. Schlottmann (2009) study argues that emphasis on "methods," such as critical thinking, reflection, and case-sensitivity, could greatly increase the ability of students to under-stand and respond to complex, changing and unprecedented environmental problems; an emphasis on cultivating student agency and competence in ethical thinking (the "methods" emphasis) is a more effective and justifiable aim than teaching that specific' implicit ideas. Ko (2003) study found that Integrated Science teachers' attitudes toward environmental education, skills of teaching environmental education, beliefs in the relevance of Integrated Science to environmental education, and intentions of teaching environmental education in Integrated Science classes were associated with their actual ways of teaching of environmental education. Teachers tended to teach more environmental education if they held more favorable attitudes toward environmental education, had more skills of teaching environmental education, believed more in the relevance of Integrated Science to environmental education, and would actually want to teach more environmental education in Integrated Science classes if there were fewer constraints. Sharma (2004) study revealed that 80% (20) teachers were not teaching environment every day, whereas the remaining 20% (5) teachers were teaching environment every day. But all the teachers strongly agreed that they were informed about how to teach about environment in multi-grade teaching.

Rickinson (2001) reviews on environmental education reveals that most of the studies are predominantly of quantitative, rather than qualitative, evidence, but this is changing as new foci (e.g. students' perceptions of nature) emerge, bringing different methodological approaches and conceptual frames. It provides more information about students' environmental knowledge and attitudes than about their educational experiences and preferences, and more about learning outcomes than learning processes. Robertson (1995) study indicated that student teachers conceptualizations of human – nature relationships traverse a range of eco – philosophical perspectives. Chang (1999) study indicated that pre service teachers moderately agreed that their actions to offer EE could bring desirable outcome in EE; they possess positive attitudes and perceptions regarding EE.

Empirical data collected in Irwin (1993) study revealed that, the colleges of education with respect to the understanding of concepts, aspects of environmental knowledge and opinions on selected environmental issues indicated that amongst both students and lectures, while there were important positive aspects, often culturally related, there were also significant problem areas. Similarly an evaluation of development and operation of the present college environmental education program, including an evaluation by student participants, indicated important strengths and weaknesses. Tuncay (2011) study revealed a significant positive correlation between eco-centric moral reasoning and environmental attitudes of pre-service science teachers', whereas there was not a statistically significant relationship between neither of anthropocentric nor non-environmental moral reasoning and environmental attitudes.

Mosothwane (2000) study indicates that teacher trainees hold clear conceptions about environmental education. Furthermore, teachers' conceptions about a subject influence their instructional planning and their delivery of subject matter. The pre-service teachers reported that colleges of education did not teach content and methods of teaching environmental education. Lin (2000) study findings revealed that, for nearly two decades, the number of Canadian teaching institutions offering environmental education courses to pre-service teachers has remained generally low and the level of priority granted nominal. The few institutions that do offer such courses tend to emphasize the traditional forms of environmental education – ecology,

conservation education, outdoor education, and biology. In addition, pre-service teachers continue to receive much of their environmental education training from faculty members who (1) possess degrees in education and biology and (b) have low levels of participation in environmental education projects and research. The low-standing status of environmental education at the pre-service teacher level will likely persist unless major barriers at different levels are addressed. These include hindrances found in institutional practices and organizations in faculties of education and at the instructional level. The two case study findings revealed that the personal beliefs, ideologies, and perspectives of environmental instructors have a powerful influence on how they structure and teach environmental education to pre-service teachers. As a result, pre-service training courses vary substantially among institutions within the country. Of the two courses examined, one predominantly prepared pre-service teachers to design teaching strategies that primarily cultivated an appreciation and sensitivity toward the environment facilitated student – centred activities that enhanced an environmental ethic, but lacked learning experiences focusing on "real" environmental problems related to social action strategies. Most significant was that critical perspective that addresses social, economic, moral and political issues appears to be generally missing in most environmental education courses for prospective teachers.

The findings of Bradford (1999) investigation indicated that rural Hondurans conceptualize their environment through the worldview lenses of survival and poverty, leading to sense of fatalism when confronting the complex and multifaceted problems associated with quality of life and environmental quality. Lewandowski (2002) study reveal that, even short experiences in a familiar setting may have a significant impact on individuals' appreciation of and concern for the local environment. Hammond (1999) study indicates that, the continuing debate about the nature and conceptualization of environmental education as needless repetition of issues which have been satisfactorily resolved, important questions remain to be addressed by curriculum theory in this field. Lane (2007) study revealed that there are subtle differences in using the term integration and infusion, and some EE professionals would say there are subtle and insignificant differences. Because of this ambiguity, it is recommended that the term infusion be avoided and EE professionals focus on understanding and applying the integration approach to implementing EE.

The study also revealed that teachers insert environmental concepts and that this approach needs further investigation.

Tenam-Zemach (2008) study found that at the national and state levels, there was a lack of articulation of the goals of environmental sustainability or an ecological paradigm. With respect to the science textbook, a greater number of keywords were present; however, the context of many of these keywords did not align with the discourse of an ecological paradigm. Further, the environmental sustainability themes present in the textbook were limited to the last four chapters of the text. Kola-Olusanya (2009) study data reveal that despite the unavailability or near-absence of environmental studies and education within the formal school curriculum (particularly at the elementary and high school levels), the young adults rely on other locations for learning, such as the internet, environmental non-governmental organizations (ENGOs), television, and family. Based upon the results of their studies researchers' suggested varies aspects for further studies. Leftridge (1977) study suggests that, concerted effort needs to be made in schools to implement environmental awareness activities into all disciplines and curriculum designers should seek innovative ways of incorporating environmental education from a multidisciplinary approach.

3.5 Implication for the present study

The training of environmental education and field experience helps teachers to have better environmental literacy and better conceptual understanding. Along with the environmentally literate teacher, if the schools have better infrastructural facilities it facilitate students' achievements in environmental education. The conceptual understanding about environment among students is better when the subject is made connected to their own lives.

3.6 Researches on constructivism and environmental education

The review of literature on constructivism and environmental education comprises 11 studies. The studies of Robertson (1995), Lord (1999), Muller Dahlberg (1999), Barnes (2002), Christenson (2002), Ramkumar (2003) and Thompson (2005) primarily focuses on impact of constructivist methods in environmental education. The study of Wright (2006) related to effects of constructive versus traditional teaching methods on the environmental literacy, The study of Skidmore (2008) is related to effectiveness of concept mapping and collaborative groups in promoting

understanding of ecology. The philosophical study of Kannel – Ray (2005) is related to resolve the tensions between the two pedagogical frameworks: constructivism and environmental sustainability. The study of Wee (2008) is related to children's conceptions of land use' in the context of an environmental science class. The study of Crede (2009) is related to traditional western versus nature immersion model of sustainability education.

The studies of Robertson (1995), Christenson (2002), Ramkumar (2003), and Wee (2008) were of qualitative in nature. The studies of Lord (1999), Thompson (2003), and Wright (2006) were of quantitative in nature. The study of Skidmore (2008), Crede (2009) was of both qualitative and quantitative in nature. The study of Christenson (2002), Crede (2009) used teachers as the sample. Whereas, the studies of Muller Dahlberg (1999), Lord (1999), Barnes(2002), Ramkumar (2003), Wright (2006), Skidmore (2008), Wee (2008) had taken students as the samples in their studies. The studies of Robertson (1995), Thompson (2003) had taken student teachers as the samples in their studies. Robertson (1995) used interviews. Muller Dahlberg (1999) used Classroom observation, students' written work, and interview. Lord (1999) used student questionnaires, achievement tests and concept maps. Christenson (2002) used audio tapes, reflective journals and field notes. Thompson (2003) used pretest and posttest. Ramkumar (2003) used participant observation, documentary analysis and in-depth interviews. Wright (2006) used Environmental Literacy Instrument. Skidmore (2008) used pre-post tests and concept map. Wee (2008) used interviews, drawings and photograph journals. Crede (2009) used seminar and survey.

3.6.1 Major findings

The major findings as per the main focus of the respective studies are as follows: The study of Ramkumar (2003) revealed that, students expressed autonomy in learning through interactions with teachers and fellow peers, proposed hypothesis based on certain concepts to explain the occurrence of events during the context of scientific investigation, and showed willingness to change ideas in the light of evidence. Another study of Muller Dahlberg (1999) revealed that, the factors identified by students for their conceptual learning were teacher guidance, social interaction both in small group and in whole class discussion; authentic learning task, and strategic questioning the teacher used to activate their prior knowledge. In Christenson (2004)

found that, children were getting more opportunities to use critical thinking skills as various classroom activities were carried out to include multiple perspectives on environmental issues when the teachers collaboratively plan for controversial environmental issues. Another study conducted by Barnes (2002) revealed that, the way students think about, learn from, and solve real environmental problems were all constrained by the perspective tenets (including cultural tenets of role, status, and power) and envisioning processes. It was concluded that students need help from the community to go further in solving these real environmental problems.

Lord (1999) study revealed that, students in constructivist classes performed significantly better on exams, rated the course higher, and participated more in campus and regional environmental support efforts than students in traditional classes. Skidmore (2008) study results showed no statistically significant difference (using a test) between (a) posttest scores of students individually constructing maps compared to students who constructed in groups and (b) map quality from beginning to the end of the semester between the individual and group constructors. During the data analysis, all students collectively showed a significant improvement from pre- to posttest scores. Improved quality of maps constructed from the beginning to the end of the semester of all students was not supported quantitatively, but the qualitative analysis showed some overall improvement. Social change will come from providing accurate knowledge for students to use for decisions related to environmental problems and by creating more critical thinkers because of a variety of learning strategies in schools, as well as teachers' increased use of concept mapping for improved student learning.

Wee (2008) study on social constructivist framework was utilized to steer data collection and to guide interpretation. Qualitative methods such as interviews, drawings and photograph journals were used to elicit children's ideas and field notes provided a rich description of the learning environment. It was found that, children in this study did not view humans as part of the environment. Land use was conceptualized as a human activity for human benefit, that is, children's conceptions of land use were framed by an anthropocentric worldview. Furthermore, children's conceptions of land use-related outcomes were negative and limited to large-scale, visible forms of environmental impacts. Environmental science instruction did not

change these ideas; in fact, they were reinforced by the school curriculum. In his research study Robertson (1995) argue for the place of eco – philosophical literature within environmental teacher education and for a constructivist based pedagogical approach which encourages students to explicate and critique their personal beliefs. The study of Thompson (2003) revealed that, intervention of lab based and utilized in – context, constructivist approaches positively influence participants' abilities to retain science content knowledge and to affect their belief in themselves as teachers.

Wright (2006) study results showed that the constructivist – based curriculum was not a significant factor of influence, suggesting that regardless of which learning environment they were expose to, subjects experienced similar improvements to their environmental literacy across a sixteen – week semester. Given that the findings were contrary to expectations and counter – indicated by several other learning environment studies as well, a broader investigation as to why the two learning environments produced similar results is warranted. Crede (2009) study findings indicate that a nature immersion model of sustainability education is much more effective than a traditional pedagogical model. Nature immersion was cited by all seminar participants as the single most important factor in the overall success of the seminar and, therefore, student learning. The seminar experience was an important catalyst for the long-term benefit of changing attitudes, behaviors, and lifestyles toward more sustainable living. It motivated participants to take on leadership roles in sustainability and encouraged them to become better stewards of the planet. The experience also enhanced their social relationship and depend their sense of responsibility toward others.

Van Kannel – Ray (2005) philosophical study indicated that the tensions between constructivism and environmental sustainability are resolved in two ways. First, there are forms of constructivism that align in viable ways with the criteria critics argue are necessary for a sustainable environment and which derive from the seminal work of Vygotsky and the sociocultural constructivists. Social constructivism additionally aligns with environmental sustainability since it focuses on the shared experience of a culture and the dialogic nature of inquiry. Second, emerging from the literature of environmental sustainability are the guiding principles for a new pedagogy of communal constructivism. What separates the emerging process of

communal constructivism from sociocultural constructivism and what it gains from environmental sustainability is a moral compass. These guiding principles inform the idea of responsible embeddedness within a system of communities.

3.7 Implication for the present study

The constructivist based learning environment allows students autonomy in learning, proposing hypothesis for scientific investigation. Teacher guidance, social interaction, authentic learning task, and strategic questioning were important factors for conceptual learning. Through constructivist based pedagogical approach student express their personal beliefs and multiple perspectives on environmental issues, also perform well in their exams. Constructivist approaches positively influence participants' abilities to retain science content knowledge and to affect their belief in themselves as teachers.

3.8 Overall implication

Constructivist approaches provides risk free environment for the learner in the classroom and teachers' role as a facilitator further helps learners own thinking which lead to the sense of ownership. This helps students interest, enthusiasm, and satisfaction towards learning. The training of environmental education and field experience helps teachers to have better environmental literacy and better conceptual understanding. Along with the environmentally literate teacher, if the schools have better infrastructural facilities further facilitate students' achievements in environmental education. Through constructivist based pedagogical approach student express their personal beliefs and multiple perspectives on environmental issues and perform well in their exams. From the review of related literature it is observed that there are very few studies conducted on constructivism and environmental education in teacher education. Further, pedagogical demands of environmental education go well with the constructivist methods. So it is necessary to conduct research on constructivist approach to environmental education at teacher education level in Indian context.

METHODS OF STUDY

4.0 Introduction

The purpose of this chapter is to set out, as clearly as possible, the process through which the data was gathered, so that the work can be contextualized within the framework of Primary Teacher Education and Schooling. It begins with rationale and questions that guided the research study. Then I presented the objectives and explanation of the terms. This was followed by the Research methods, location and context of the study, selection of student teachers, selection of the schools, selection of themes, data collection methods, process of data collection and data analysis. In the final two sections, I outlined how I gathered and analysed the data used in this thesis.

4.1 Rationale

In recent years, environmental education has become a prominent curricular concern for education at all levels and constructivism has become an 'attracting' pedagogy for educational policies and innovation. The National Curriculum Framework (NCF) 2005 stressed the need of environmental education in school curriculum. It states that

> "It has become imperative now more than ever before to nurture and preserve the environment. Education can provide the necessary perspective on how human life can be reconciled with the crisis of the environment so that survival, growth and development remain possible."

The NCF 2005 further highlights the need for our education system to move from rote learning to meaningful learning. For this, it suggests a fundamental change in our view about how we think of learners and process of learning. It strongly advocates implementing constructivist approach to school education. From the review of related literature, it is apparent that, teachers have the opportunity to know learners pre-conception/alternative conception/misconception. By using problem based learning, inquiry learning, and concept maps the learner can be encouraged to actively participate in classroom teaching-learning process. In this process learners and their teachers have an opportunity to reflect, negotiate and contradict each other's ideas. By doing so, they retain the ideas which they find it correct and modify those ideas which they find flaws in it.

Lord (1999) found that students following an environmental programmed based on the principles of constructivism had a better understanding of the concepts

covered by the topics of the programme than did students in the "traditional", "teacher-centred" group. Furthermore, majority of them ("constructivistc" group) stated that they found the programmed interesting and enjoyable. There are parallels between environmental education and constructivist approach. Both their philosophies require students to take an active role in learning and building on factual knowledge to improve investigative and critical thinking skills. Constructivism focuses on active learning and real life problems; environmental education focuses is on real life environmental problems. Constructivism emphasizes the classroom activities to be learners centered and any program that meets the goals of environmental education is participant centered. Constructivism emphasizes authentic assessment of student progress in the curriculum activities. Environmental Education also emphasizes the same by open ended questions, position papers on environmental problems, checklists of group interaction skills and anecdotes (Klein, E,S and Merritt, E, 1994).

There is no system of education that can rise above the quality of its teachers, so if we want to improve the quality of teachers and their teaching, it has to begin with teacher education classrooms. But, despite national policy on education, (NPE 1986) National curriculum framework for school education (NCFSE 2000) and National curriculum framework (NCF 2005) emphasizing the importance of pre-service teacher preparation in environmental education, there are still inadequate levels of environmental education provision at the teacher education level and that pre-service teachers' preparedness for teaching environmental education is overwhelmingly low. The preparation of pre – service teachers is especially critical in achieving environmental and ethical awareness, as well as in developing the values, attitudes, skills and behaviors conducive to a sustainable future. If teachers help the learner to get deep knowledge about environmental issues and problems, they will have positive attitude towards environment and develop proper environment action skills. Because, understanding of issues appear crucial to ownership. When individuals have an in-depth understanding of issues, they appear more inclined to take on citizenship responsibility toward those issues. (Hungerford & Volk, 1990).

Having the experience of teacher in a school and of teacher educator for three year and in a teacher education institution, the researcher strongly believe that making learners and student teachers responsible in their learning is possible, only when they

are made active in teaching learning process. So the researcher took interest in undertaking this research study on environmental education at primary teacher education level through constructivistic approach.

4.2 Research questions

1. What is the level of understanding about constructivistic approach among pre-service primary student teachers?
2. What is the level of understanding about Environmental Education among pre-service primary student teachers?
3. How well the primary pre – service student teachers and their learners change their perspectives on Environmental Concepts using Constructivistic approach based classroom process?
4. Do the student teachers and school learners appreciate developing environmental knowledge through constructivistic approach?

4.3 Statement of the study

A study on Constructivistic Approach to Environmental Education among Primary Pre – Service student teachers

4.4 Objectives

1. To study student teachers changing perspectives (conception) about environmental concepts in the constructivistic classroom.
2. To study the application of constructivist teaching methods and strategies by student teachers while teaching environmental concepts in their classroom during internship programme.
3. To study students changing perspectives (conception) about environmental concepts in the constructivistic classroom.
4. To study the student teachers perception about constructivistc approach to Environmental Education.
5. To study the school learners perception about constructivistc approach to Environmental Education.

4.5 Explanation of the terms

4.5.1 Constructivistic approach

In the literature on constructivism two terms viz., constructivistic and constructivist are frequently used interchangeably because of their unified meaning held by scholars (Sigrén, 2003; Simons, 2000; Terwindt, S.2000; Jonassen, D. H. 1992). In the present study also both the terms have been used at different places interchangeably. Constructivistic approach is a broader term which indicates that knowledge is constructed by the learner/individual by employing the means such as Problem Based Learning, Inquiry learning, concept mapping, cooperative and collaborative learning.

4.5.2 Environmental Education

Environmental Education is the education provided to the learners through different curricular content / concepts to equip them with better knowledge, understanding and developing action skills which will help to sustain better physical environment.

4.5.3 Changing perspective

Changing Perspective means the change that occurs in the student teachers and learners' or students' conceptual idea, viewpoint, and the way of thinking about any concept which he/she exhibits through their verbal or nonverbal expression.

Conceptual Change: Learners frequently enter learning situations with knowledge inconsistent with scientific views. This is termed as misconception/novice conception/tenacious ideas in different situation. The instruction is to enable students to construct scientifically accepted ideas while rejecting inaccurate constructs or larger cognitive structure. This process is called conceptual change.

Constructivism: A learning theory contending that learners construct their own knowledge based upon previous learning and social interaction

4.5.4 Pre –service primary student teachers

The student teacher of first and second year primary teacher training institution, who are eligible to teach primary schools after completing the course. The students from school were referred as learners.

4.6 Research methods

In the present study the students/children were referred as learners. This research study is framed as a qualitative case study for several reasons. First, case study

allowed me to examine closely student teachers' development of ideas of constructivism and changing perspectives about environmental concepts within a specific context, namely problem based learning (PBL), Inquiry learning methods in a collaborative learning setup. In the same way, second, it allowed me to examine closely the extent the student teachers use/adopt constructivist teaching in their classroom as a teacher and changing their own learners' perspectives about environmental concepts. Thirdly, it allowed me to use my own notes, plans, and reflections about the process as a participant observer at teacher education classroom and as an external observer at school classroom.

4.6.1 Location and context of the study

The present study was conducted at Tirupattur Teacher Training Institute, Tirupattur, Vellore District in Tamil Nadu. The name Tirupattur itself means an union of ten villages. Even though nearby towns like Vaniambadi, Ambur have many Tanneries and shoe making industries, Tirupattur don't have any big industrial climate except one sugar-cane factory and sandal wood oil factory (presently closed) in nearby villages. The economic activities of the town are mainly agricultural.

The main crops around the villages are sugar cane, banana, cotton, cereals, pulses, rice, coconut trees, mango farms, sapota (Tropical fruit with a rough brownish skin and very sweet brownish pulp, generally called cheeku in Northern India). In recent years, villagers mainly cultivate cotton and those who have water facility go for sugar cane, banana and rice. The cultivation of pulses and cereals has gradually decreased. Due to agricultural crisis villagers are gradually loosing interest in their farming activities and going in for some manual jobs outside the village. In recent years Beedi (a country made cigarette by tobacco leaves) and 'agarbati' (incense sticks) making has become common jobs in some villages.

In Tirupattur town, there are people belong to different religions viz., Hindu, Muslim, Christian and Jains. But the majority of the people belong to Hindu community. With regard to the composition of people in the surrounding villages of Tirupattur town, a peculiarity can be observed. While in some villages people belonging to a particular caste living completely segregating themselves from other caste groups, where as a mixed composition of people living together in some other villages. With regard to educational facilities Tirupattur has one Engineering college,

two Arts and Science Colleges, four B.Ed colleges and 10 Primary Teacher Training Institutions. Moreover, it is also an education-district (not a revenue district). The Tirupattur Teacher Training Institution (Indicated in Figure 4.1 & 4.2) is the first co-education teacher training institute in the town. It is located in Pachal village which is at the extreme end of North West part of the town (In the Figure 4.3).

Figure 4.1: Photographs shows a Tirupattur Teacher Training Institution

Figure 4.2: Photographs shows a Tirupattur Teacher Training Institution and the researcher along with his team

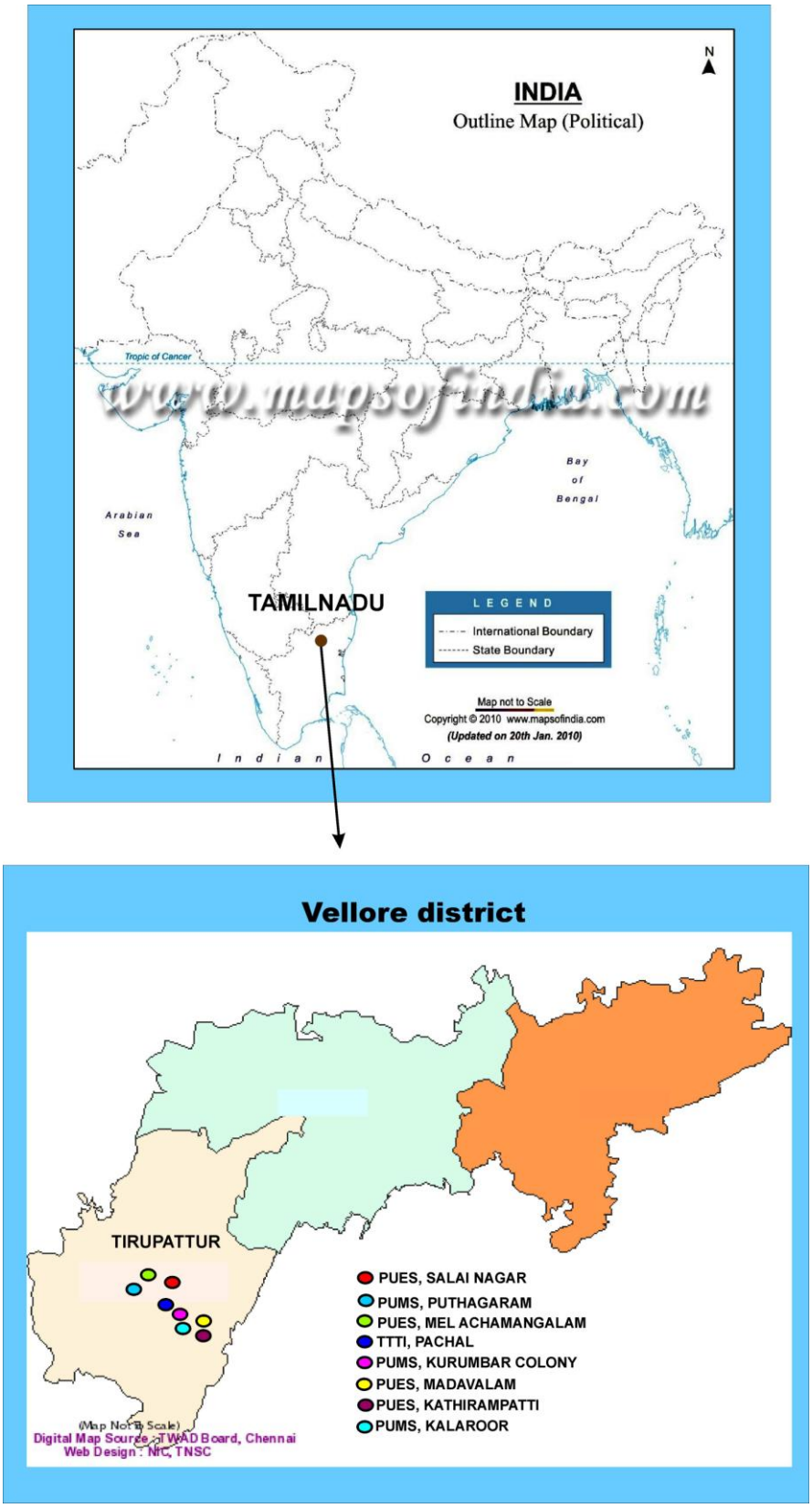


Figure: 4.3: Map showing the Tirupattur taluk, teacher training institute and the study schools (in coloured circles)

4.6.2 Selection of schools

Out of 21 schools allotted by District Education Office for internship programme (practice teaching) of Tirupattur Teacher Training Institute (TTTI), 4 elementary (Grade I to Grade V) and 3 middle schools (Grade I to Grade VIII) in the surroundings of Tirupattur (Show in the Figure 4.3) have participated. This was done based on the willingness of school head masters. The schools were:

1. Panchayat Union Elementary School, Kathirampatti
2. Panchayat Union Elementary School, Madavalam
3. Panchayat Union Elementary School, Mel Achamangalam
4. Panchayat Union Elementary School, Salai Nagar
5. Panchayat Union Middle School, Kalaroor
6. Panchayat Union Middle School, Puthagaram
7. Panchayat Union Middle School, Kurumbar Colony

4.6.3 Selection of student teachers

For the objective one, all the 49 (19 male and 30 female) student teachers of first year and 50 (20 male and 30 female) student teachers of second year were purposively selected. For objective two, 11 student teachers of first year and 6 student teachers of second year were selected based on their willingness from the selected schools.

4.6.4 Selection of themes

The selection of the themes for the research was done based on three aspects (content analysis of text books, concept maps and focus group discussion) in the following manner.

1. The researcher identified a list of 19 environmental themes through content analysis of Grade I to Grade VIII text books prescribed by Government of Tamil Nadu. This comprises of EVS text books of Grade I to Grade III, Environmental Science and Social Science text books of Grade IV and V, Environmental components from Science and Social Science text books of VI to VIII. The themes are given below in Table 4.1.

Table 4.1: Environmental Themes identified through content analysis

Themes	Student teacher
• House • Health and Hygiene • Land – soil • Environment • Water • Population • Plants • Animals • Air	First Year
• Energy Resources • Earth • Living things • Environment • Health and Hygiene • Water • Air • Population • Disaster and Disaster Management • Soil	Second Year

2. The student teachers made the concept map of identified themes. This was done just after the researcher oriented the student teachers on process of making Concept maps. Since, concept maps are an explicit, overt representation of the concepts and propositions a person holds, they help to recognize missing linkages between concepts. Also it is an effective tool for showing misconceptions a person holds. Misconceptions are usually signaled either by a linkage between two concepts that leads to a clearly false proposition or by a linkage that misses the key idea relating two or more concepts (Novak, J.D., Gowin, D.B., 1986).
3. The researcher conducted focus group discussion (FGD) to know student teachers' view on what they think as most important environmental issue / problem in their context. As one of the important uses of FGD is obtaining general information about a topic of interest (Stewart, 1990). The general questions asked during FGD were:

- What are the topics do you think related to environmental studies / education?
- What is the sequence in which environmental themes can be dealt in classroom?
- Do you think, teaching environment problems are important as a prospective teacher?
- Do you think, your teaching have an impact on learners' environmental behaviour? If so, what extent?
- What are the important environmental problems have you observed / do you observe in your locality?
- In Tirupathur is concerned, what are the important environmental problems / you have observed or do you observe?

A list of themes related to Environmental Studies was generated through FGD. They were: Environmental Problems / Pollution (air, water, soil, and noise), population explosion, traffic congestion, delayed monsoon (climate change), natural disasters, health and nutrition, Land, water, air, living things, planets, food cycle and wastes.

Examining all the three aspects (content analysis, concept maps and FGD) the researcher decided to engage the following themes with the student teachers in Table 4.2. Due to paucity of time the researcher could engage only the themes (Indicated in bold in table 4.2) with the student teachers.

Table 4.2 Themes identified for research

First Year	**Second Year**
House	**Energy Resources**
Health and Hygiene	**Environmental pollution**
Land / Soil	Traffic congestion
Water	Earth
Air	Water
Living and Non-living things	Air

4.6.5 Data collection methods

The main data collecting strategies employed in this study were Focus Group Discussion, Participant observation, Semi and Unstructured interviews and Document analysis. This has been summarized in the following Table 4.3.

Table 4.3 Data collection methods

S.No	Area of Focus	Data Collection Methods	Sources of Data
1	Objective 1	Participant Observation Semi and Unstructured Interviews Document Analysis	- Teacher Educator (Researcher) -Student teachers -Teacher Education Classroom -Student Teacher group work journal - Audio tapes - Field Notes - Still photographs - concept maps -Rubrics for self and peer assessment -Learning log
2	Objective 2	Participant Observation Semi and Unstructured Interviews Document Analysis	- Practice teaching Supervisor (Researcher) -Student teachers (Teachers) - School Classrooms - Learners (school children) - Learner group work Journal - Audio tapes - Field Notes - Still photographs
3	Objective 3	Participant Observation Semi and Unstructured Interviews Documentary Analysis	- Practice teaching Supervisor (Researcher) -Student teachers (Teachers) - School Classrooms - Learners (school children) - Learner group work Journal - Audio tapes - Field Notes - Still photographs

4	Objective 4	Semi and Unstructured Interviews	- Teacher Educator (Researcher) -Student teachers - School and Teacher Education Classrooms - Audio tapes
5	Objective 5	Semi and Unstructured Interviews	- Practice teaching Supervisor (Researcher) - Student teachers - Learners - School Classrooms - Audio tapes - Field Notes - Still photographs

4.6.6 Concept Maps

For the present study the student teachers made concept maps on the identified themes 2 times.

First, Student teachers initial (pre) concept maps were used as one of the means to identify the research themes.

Second, at the end of the research the student teachers were asked to make concept maps on the same themes. The post concept maps were used for analyzing changes in the student teachers understanding of the themes which were dealt during the research work.

4.6.7 Participant observation

The data for the present study was collected through participant observation. The participant observation focuses on "…human interaction and meaning viewed from the insiders view point in everyday life situations and settings" (Jorgensen, 1989 cited in Ramkumar, 2003). In this study the participant observation was done in two phases. In the first phase the participant observation was centered on teacher education classrooms. The focus was on observing how student teachers engage themselves in constructivist based classroom activities. In order to conduct the participant observation I took the role of a teacher educator. This allowed me to access and reach student teachers in terms of "access to the world of everyday life from the stand point of a member or insider" (Jorgensen, 1989 cited in Ramkumar, 2003).

In the second phase the participant observation was centered on various school classrooms which were chosen for the present study. The researcher took the role of a practice teaching supervisor in the schools. This allowed me to access the learner and student point of view as an observer. I observed the way student teacher engaged learners in a constructivist based classroom activities. In these phases I observed two aspects (i) the perspective change (conceptual change) among the student teachers and the learners on environmental concepts. (ii) how well the student teacher adopted the constructivist principles in their classroom engagement in schools as a teacher.

4.6.8 Recording observations

In order to record observation Tape recorder, still photography and field notes were used. Tape recorder and still photography were used to record the action / event, when it really occurred. Tape recorder was used occasionally to report on the action of an event as it was happening in front of the observer so that narrative of an event is stored as it happens. Field notes were used to report on the day-to-day observation after the event occurred. Although this approach is well suited for the study it had its own problems. At early stages of my fieldwork, I faced some difficulty in writing down all my observation notes. This was because a number of activities took place simultaneously and in a short period of time. In the later stage at occasions I started recording my field experiences in audio tape to avoid time constraint in preparing for the next days work.

4.6.9 Interviews

The interviews with student teachers in teacher education classroom were more of conversation between teacher educator and the student teachers (group), student teacher – student teacher, student teacher group – student teacher group. However, the questions were not focused on individual student teacher but more on the group. Similar pattern of conversation happened between student teachers and their learners in schools. The casual conversations done after the class with student teachers provided lot of insight into various things such as their aspirations, opinion on the education system, teacher preparation programme, their social background etc.

4.6.10 Recording interviews:

Tape recorder was used to record the interview. In the event of non availability of audio cassette the interview were recorded with a note book or note pad.

4.6.11 Document Analysis

In this study document analysis consisted of the analysis of elementary level Environmental Studies (EVS) textbooks prescribed by Government of Tamil Nadu. This comprised of EVS text books of Grade I to Grade III, Environmental Science and Social Science text books of Grade IV and V, Environmental components from Science and Social Science text books of Grade VI to VIII. The content analysis was done to identify the general environmental themes which are dealt during the research work. Student teachers group work as well as learners' group works written either in note books and sheets were analyzed to identify their understanding on environmental concept / themes. In order to analyze the contents of student teachers, learners note books or sheets translation procedure was adopted **(see appendix).** This gave me an insight into the way school learners view an activity or set of activities or theme.

4.7 Process of data collection

The entire study was carried out in 2 phases.

4.7.1 Phase –I (with student teachers)

In the beginning certain general environmental concepts were identified from the textbooks of environmental science (Grade I – IV), Science and Social Science (Grade V – VIII). The identified concepts were divided into two groups. Those concepts derived from Grade I to V were placed in group I, and those derived from Grade VI to VIII were placed in group II. This was done primarily keeping in mind the nature of examination to be taken up by the student teachers. After initial rapport building with student teachers, I started orienting about making concept map in both the first year and second year classes. I explained about how to make concept maps, different kinds of concept maps, and things to be taken care while making concept maps. During this time, I made a concept map on the black board about crops, based on student teachers ideas. After this I gave a concept in each period (allotted for my research) in the classroom and student teachers' made the concept maps. This had taken one week time to complete. The first year student teachers made concept maps

of health and hygiene, water and land. The second year student teachers made concept maps on energy resources, environment and earth.

During this time I observed that, in afternoon of the day the second year students-teachers were going for physical education class, after the first period, regularly. The first year student teacher used to go after the second period. Here I found that there were good numbers of students chatting instead of playing games. So, with the permission of the Principal, I conducted focus group discussion in the afternoons. Through focus group discussion with student teachers I tried to know what do they think about the concept 'environment', and what are the issues they considered as related to environmental problem. There were quite a few issues the student teachers felt as very important environmental problem. One of them was traffic congestion in the town. But due to other reasons such as lack of time availability, subtle resistance from local faculty members, and student teachers' tight schedule with other academic works, this issue could not be take up during the current research work.

Based on the Focus Group Discussion and concept maps, the environmental problems were framed by me considering institutional factors. Then, I gave orientation about cooperative/collaborative learning by explaining about group formation, kind of leadership, material resources, role of the teacher and the assessment procedure. I also explained about Problem Based Learning, Inquiry learning and steps to be followed to solve a given problem. I have administered Multiple Intelligence **(**MI) test through the scores of MI each student teachers' strength in various intelligence areas was identified (In the Figure 4.4).

Figure 4.4: Researcher engagement with the student teachers (second year) during the Multiple Intelligence Test

I have tried to group those teachers who scored high in one particular intelligence test in one group. However other factors such as previous academic achievement, gender and their location were taken into consideration the group in a heterogeneous composition. I have tried to put the student teachers who have scored more in particular intelligence grouped together. Each class was divided into nine groups. Each group comprised of 5 student teachers; some group had six student teachers. Initially few student teachers wanted some changes in the formation of a group, because they wanted their close friends in their group. But I explained the reasons and convinced them. Here I faced some resistance from four teacher educators while making groups comprising both men and women. I was suggested to go for separate men and women groups. But the Principal stood by me and said that, ***"it is your research work, so you carry on the way you want".*** Initially these teacher-educators were really angry, but gradually they cooperated with me.

After making the groups, I introduced the theme in the classroom by providing a paper to each group where the theme was written on it and asking a student teacher from any group to read it out loudly. If the student teachers wanted to listen to it once again, I asked another student teacher to read it again. Then the student teachers identified and listed down whatever the content they know related to the theme and what are the contents they should know to solve the problem and corresponding learning issues (concepts) in their individual groups. During this time, I moved around each group and observed their work and interacted whenever need arised**.** Once they listed down what they wanted to know (mostly in the form of questions) and learning issues (mentioning concepts), they started looking for the sources of information. Usually school textbooks, library books (public library), newspapers, the researcher and occasionally internet were their sources of information. Through discussions based on the collected information the group members made a report which communicated solution for the theme based problem. During these discussions if they proposed hypothesis or they found some more questions to be answered they were free to carry out some activities or test the hypothesis through collaborative problem solving by making them think critically or again look for solution through different sources of information, and this is where inquiry learning become handy. Also at times the group members sourced the information from the researcher. Through such activities they experienced the PBL and Inquiry method.

For each problem the groups took 1 to 3 week time to complete. During these group works I always moved around each group and audio recorded the interaction. As nine goups were working simultaneously, I decided to audio-record the interaction between me and the members of the particular group. Initially it was difficult for the researcher on how to go about it. Gradually I tried to see their group work by their writings or asking them on what they discussed so far. Whenever I have seen any alternative conception in their explanation, I probed them to know their perspective, and demanded further information to support their ideas. At times the group members themselves had contradictory views leading to searching for further information. Sometime they would find difficulty in locating information for which I suggested some sources or provided the information. Once all the groups completed their task, they presented it to the whole class. At this point, most of the alternative conception/misconception they expressed earlier during their own group work was in progress was absent here. This was because the student teachers not only interacted in their own groups but they interacted with other group members after college hours. Occasionally some alternative conceptions expressed during the presentation were discussed in the whole class. The student teacher presentation of the first problem took 4 periods, which brought the resistance from the teacher educators. Also there was repetition of similar ideas expressed by different groups which brought less participation of students in post presentation discussions. To avoid this, the researcher used whole class discussion at the end of group work of each theme on alternative / novice / tenacious / misconceptions of the student teachers which they expressed during the group work.

The student teachers were asked to assess themselves as well as their peers about their participation and performance at the end of each theme. For this assessment Ann Lambros (2004) Individual student assessment group rubrics was used. The rubric is of two parts. The first part focus on participation in group work, one's contribution, listening to others, asks and answering questions, stays on tasks, finding information, cooperating with other members, offering positive suggestions, exhibiting leadership and encouraging others. The second part focuses on generating effective learning issues, demonstrating hypothesis and testing, grasping of new concepts, applying new information for the group work, shows skill at teaching peers, demonstrating cooperation and consensus building, effective participation,

identification and sharing appropriate resources, demonstrating growth of knowledge, exhibits functional decisive and focused qualities, exhibits leadership, encouraging others, assessing own strength and weakness appropriately. The rubric used four point scale where 4 indicate excellent, 3 indicates good, 2 indicates fair and 1 indicates poor. Student teacher group also submitted the learning logs (See in DVD) for each theme.

The student teachers' work (student teacher group journal) I got from them for analysis. I wrote my experience regularly on a separate note book (field notes). When I do not get time to write field note I audio recorded the particular day experiences which was later used along with field notes.

4.7.2 Phase – 2

After almost three month exposure (From 20th November to 15th February) of constructivistic approach based methodologies in learning of content (along with learning about behavioristic methods) the student teachers went for a two month internship programme. In the first two week of internship, they were asked to observe the regular teachers' classes. During this time, I visited all the selected schools and interacted with the Head Masters, teachers and student teachers. During those interactions I looked for the willingness of the student teachers in implementing constructivist based lessons in the school class lesson transaction, willingness of the school head masters in giving permission to student teachers to teach through constructivist approach, interest of the regular teachers of the school, and the availability of the classrooms and space (Because in some of the schools two grade a schools were sharing a classroom and due to summer season viz., February to April, the learners could not be taken outside the classroom). Based on these factors, I identified 7 schools for the study. Because of these factors some of the active participative student teachers of phase I who were very much interested in using constructivist approach in their classroom could not participate in phase II, and were not included.

A total of 28 student teachers were allotted to teach in these 7 schools during their practice teaching session. Among these 18 student teachers were from first year and 10 student teachers were from second year of their programme. Out of this, 11 student teachers from first year and 6 student teachers from second year showed

interest and agreed to teach lessons through constructivist methods, over and above their with regular lessons. The remaining student teachers did not agree. This was because; whatever the lessons they taught through constructivist method were not to be counted as their 'practice teaching' lessons. These student teachers felt it was burdensome to teach through constructivist method as they were supposed to prepare two lesson plans along with teaching learning material (TLM) every day for the regular lessons.

During the internship of student teachers, I used to go to one or two schools in a day and observed their lesson transaction. I was contacting the student teachers through telephonic talk and (or) evening meetings and (or) going early to the schools. The student teachers used Problem Based Learning and Inquiry Approach in their learners. The learners from the school divided into cooperative groups for this research. The criteria followed for making student teachers groups is used for making student groups. For framing the context based problem the student teachers went around the village and the school surroundings, and came out with certain environmental issues to be dealt in class. At times, student teachers discussed with the researcher for framing the problem. They adopted the problem based learning procedure which they experienced in their own teacher-education class. I observed their lesson transaction and audio recorded their interaction with their learners. During those times, I could see learners' alternative conceptions and conceptual change through interaction with student teachers and their peers. The school learners used their textbook as a major source of information. Occasionally they referred to other sources. I got some books from Centre for Environmental Education, Bangalore for their reference. I collected learner work sheets for the analysis purpose. After six weeks of constructivist based teaching learning process, I interacted with school learners to know how they perceived the constructivist classroom. I audio recorded their views. I wrote my experience in field note. The student teachers found very difficult to write their experiences, because they were hard pressed with time, they had to prepare two lesson plans every day and Teaching Learning Materials for teaching. So virtually they had very little time to write their experiences. Instead, they shared their views with me during lunch time and during evening hours and these interactions have been recorded in my field notes.

Once they returned from internship, I again started interacting with student teachers on how they perceived teaching the environmental concepts through constructivist approach (with semi structured interview). I interacted with those who used constructivist approach in their lesson –transactions and those who did not. I also asked the student teachers to make concept maps on those concepts which were discussed in teacher education classroom. Once this process was over I thanked the student teachers for their cooperation.

4.8 Data analysis

The data analysis was done during fieldwork and post field work. The data interpretation involved constructing the meaning on the student teachers, learners changing perspectives on environmental concepts through analysis of classroom interaction. The data analysis describes the units of analysis, procedure adopted for data analysis and the techniques adopted for establishing validity of qualitative data.

4.8.1 Units of Data Analysis

The data was collected from various sources **(table 4.3)** on student teachers / learners working in groups or whole classroom situation. In order to assess the learning from these sources, it became apparent that individual is not the most useful unit of analysis. Thus, for the present study, the analysis of events and products that involved the negotiation between two or more participants in a group with different understanding of the situation became the necessary part of analysis (Vygotsky, Newman, Grifin & Cole cited in Ramkumar, 2003). The evidence presented is much more typical of all the participants than individuals. However, products of individual student teacher or learner were used in special circumstances to strengthen the evidence.

4.8.2 Procedure of Data Analysis

The data analysis was done in the following manner

1. Student teachers and learners participation in Constructivist classroom on environmental themes / concepts
2. Student teachers and learners perceptions about Constructivist Approach to Environmental Education

4.8.3 Student teachers and learners participation in Constructivist classroom on environmental themes / concepts

The data analysis consists of transcribing the recorded interviews. This was one of the most time consuming and frustrating activities during the post-field work. Each interview was clearly dated and labelled. Then I read the un-edited versions carefully, correcting the minor grammatical errors. During my second reading of un-edited versions of transcription I listened once again the tapes to identify the missing linkages. Then, I carefully selected the relevant information leaving the redundant information. The selected information from transcribed tapes, field notes along with the student teachers or learners group works (notebooks or sheets) were triangulated to view the occurrence of change in perspectives on environmental themes, recurring patterns of using the constructivist principles and methods by student teachers in their classroom engagement. These were analysed with respect to objectives one, two and three (See in details in **4.5**) as follows.

Student teachers and learners changing perspectives (misconception / alternative conception / novice / tenacious / ideas) about environmental concepts

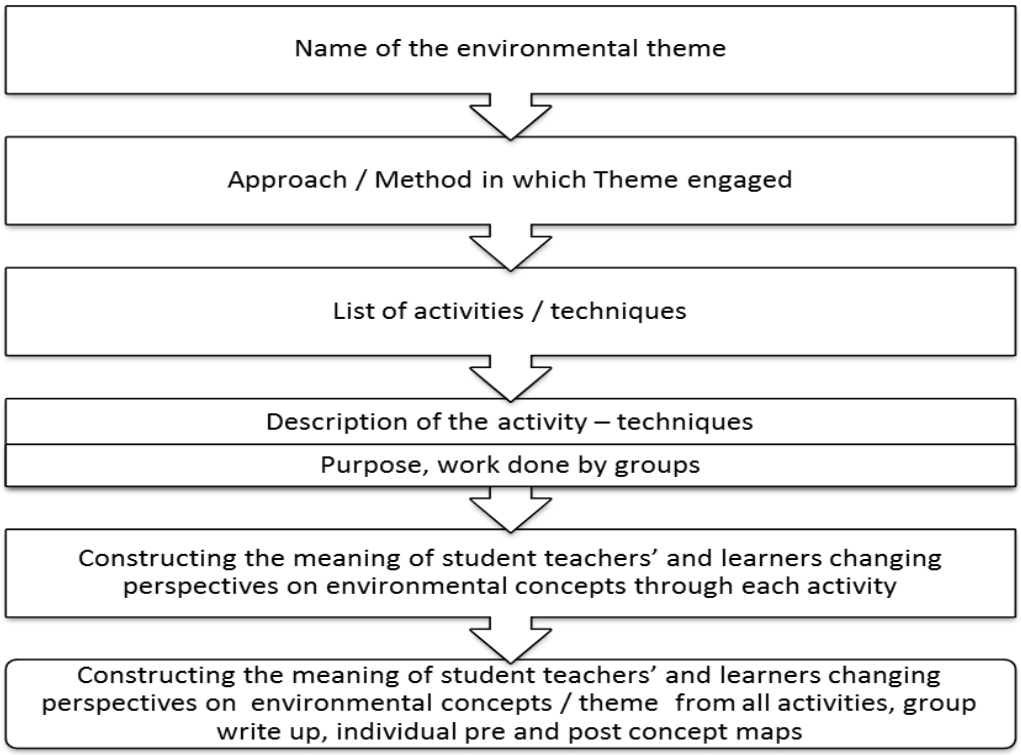


Figure 4.5: The procedure of data analysis and interpretation for objective one, two and three

Coding Categories

In teacher education classroom the environmental themes were engaged in whole class discussion as well as group activity / work. For this purpose first year student teachers were divided into nine different groups and second year student teacher were divided into nine different groups.

During the analysis, each group was represented with a particular code. This is presented in the Table 4.4 below.

Table 4.4 shows the Group Code

S.No.	Groups	Codes
1	Group One	GA
2	Group Two	GB
3	Group Three	GC
4	Group Four	GD
5	Group Five	GE
6	Group Six	GF
7	Group Seven	GG
8	Group Eight	GH
9	Group Nine	GI

However, both first and second year student teacher groups have same group code. To avoid any confusion, along with each theme year of student teacher is mentioned throughout the analysis. In the similar manner each learner group was represented with a particular code. The number of learner groups varied with respect to Grades in a school as well as number of groups of same Grade varied in different schools. To avoid any confusion, along with each theme the student teacher name and year, school name, Grade and sections, if any, is mentioned. Apart from the codes for each group the interaction / whole class discussion between teacher-educator (Researcher) and student teacher (in teacher education classroom) within a group have been represented as follows:

R is used to denote teacher educator

S.T is used to denote student teacher

Further S.T1, S.T2, S.T3 were used to differentiate student teachers belonging to the same group / same class and involved in the conversation with the teacher educator. However, in whole class discussion S.T1, S.T2, S.T3 is used to differentiate student teachers from different groups from the same class.

Similarly for school classrooms,

S.T is used to denote teacher (student teacher)

L is used to denote learner

Further L1, L2, L3 were used to differentiate learners belonging to the same group / same class and involved in the conversation with the teacher. However, in whole class discussion L1, L2, L3 is used to differentiate learners from different groups form the same grade.

4.8.4 Student teachers and learners perceptions about Constructivist Approach to Environmental Education

Qualitative content analysis of audio transcription of semi – structured interviews of Student teachers and learners was done to find out the perception about constructivistic approach in environmental education as part of achieving onjective 5 of the study.

4.8.5 Establishing validity of Qualitative Data

In the present study Triangulation was used as a validity procedure, where researchers search for convergence among multiple and different sources of information to form themes or categories in a study (Creswell & Miller, 2000). In the triangulation procedure, researcher provides corroborating evidence collected through multiple methods such as observation, interviews and documents to locate major or minor themes (Ramkumar, 2003).

DATA ANALYSIS AND INTERPRETATION

5.0 Introduction

The present chapter aims at the analysis and interpretation of the data collected to find out how far the stated objectives of the study have been realized. The information collected from various sources (presented in chapter IV) in two phases of the study has been analyzed in this chapter under two sections as given below:

5.1 Student teachers and learners participation in constructivist classroom on environmental themes

5.2 Student teachers and learners' perceptions about Constructivist Approach to Environmental Education

In section 5.1, data regarding student teachers and learners' participation in the constructivist classroom on environmental themes has been presented in three subsections, 5.1.1, 5.1.2 and 5.1.3. In the subsection, 5.1.1 data regarding student teachers changing perspectives about environmental concepts has been analyzed and presented. In the subsection, 5.1.2 data regarding learners changing perspectives about environmental concepts has been analyzed and presented.

In order to present the real picture of the interaction, among student teachers and researcher in the teacher training class and among learners and student teachers in the school class room, for identify the misconception of the student teachers and learners exact verbatim have been used in Tamil and transcribed into English in this thesis without any editing and hence some sentences may appear grammatically incorrect.

In the subsection, 5.1.3 data regarding student teachers use of a constructivist approach to teach environmental concepts during practice teaching has been analyzed.

In section 5.2, data regarding student teachers and learners' perceptions about the use of constructivist approaches in learning environmental concepts has been analyzed.

5.1 Student teachers and learners' participation in Constructivist classroom on Environmental themes

The data regarding student teachers and learners' participation in the constructivist classroom on environmental themes has been presented in three subsections, 5.1.1, 5.1.2 and 5.1.3.

5.1.1 To study student teachers changing perspectives (conception) about

environmental concepts in the constructivist classroom.

5.1.2 To study learner changing perspectives (conception) about environmental concepts in the constructivist classroom.

5.1.3 To study the application of constructivist teaching methods and strategies by student teachers while teaching environmental concepts in their classroom during internship programme.

5.1.1 To study student teachers changing perspectives (conception) about environmental concepts in the constructivist classroom.

In the subsection, 5.1.1 (a) data regarding student teachers changing perspective about environmental concepts has been analyzed and presented. The data were collected by employing various methods and sources such as collaborative learning, enquiry learning and problem based learning **(Appendix: A).** The theme-wise analysis of the student teachers' data is presented below.

5.1.1.1 Theme: House

Participants: First Year student teachers

***Approach / Method*:** PBL

PBL problem:

In your village due to natural calamity 5 houses were completely destroyed. Consider that you are an expert in the field of construction work. The district administration requested you to give suggestions to make temporary shelter and later making permanent arrangement for affected people. Your suggestion is expected to include the following areas.

(a) Type of house
(b) What kind of basic facilities the house includes in it.
(c) What measures are to be done in constructing safe buildings
(d) Cost involved

Description of Classroom process:

The PBL problem is introduced in the classroom by providing photocopies of problem for all the groups. From few groups student teachers were asked to read the problem aloud and the researcher asked if any group has difficulty in comprehending the problem

it can be addressed. After this the student teacher groups started discussing the problem in their respective group.

During the group work the researcher visited each group and interacted with student teacher about the progress of group work. Each group worked with their own pace. Therefore, the content of researcher's interaction with each group varied depending on the group's progress. However, the researcher interacted with the individual groups during the progress of group work and whole class interaction at the end. Henceforth, researcher interaction with student teachers is presented after the group work.

Group Work

Different student teacher groups' varied in their view on a solution for the problem. The amount for constructing a permanent house group varied from Rs. 10,000 to two lakh rupees. Similar type of house which need to be constructed for affected people varied from slanting roof houses with cement / iron sheet roof to concrete houses. Groups also suggested the need for natural calamity warning system and informing public about protecting themselves during calamities. However most of the group had a similar view to having basic facilities such as water, electricity, toilet facilities in the houses which is planned to be constructed. The synoptic view of group work (translated) is presented in the **appendix A1.**

Researcher Interaction with student teacher groups

The researcher interaction with the student teachers during group work centered on the similarity to the group work, except one group discussed about why houses in the hilly areas are not constructed very tall? The student teachers viewed that it is because, "hilly areas cold is a little bit more, if cold is heavy and house is little bit higher (taller) then it is difficult to stay there" and "During rainy seasons soil erosion (Land slide) happens". During the discussion the student teacher's initial expression shown equating the term soil erosion with landslide, but during further discussion another student teacher used the term landslide.

Concept Maps:

While comparing pre and post concepts of student teachers, it is observed that there was a considerable change in their understanding of the concept House.

In pre-concept maps

Individual student teachers generally depicted one or many of the following concepts: types of houses, various ways in which different types of houses get affected / destroyed, things required to make various types of houses, general use of a house. There were other concepts such as electricity and water connection, use of bricks for brushing teeth, painting etc., were connected with house concept. However, some student teachers concept maps (Figure 5.1) lacked linkages between concepts.

In post-concept maps

Student teachers generally depicted few of the following concepts: types of houses, specific advantage and disadvantage of each type of houses, various natural calamities and types of houses which can sustain impact of specific calamites, things required for construction of different types of houses, different houses with economic value, life of different types of houses, types of houses in different geographical locations such as coastal area, plains and hilly areas, process of construction of different types of houses and measures to be take care for protecting different houses. In the post concept maps (Figure 5.1) the linkages between concepts were clear in many student teachers.

Self and Peer Assessment:

Only one group submitted the rubric of self and peer assessment. Out of five members in the group three were submitted their assessment rubric. All the three members rated low the fourth member's performance against the specified statement. The group generally rated everyone engagement as good against each criteria. However one member engagement was indicated as fair and few aspects such as encouraging others, cooperation, making suggestion to group work rated as poor. One of the members was not participated in the group work, therefore not assessed. None of the members made use of rubric for self- assessment even though the researcher asked to do so.

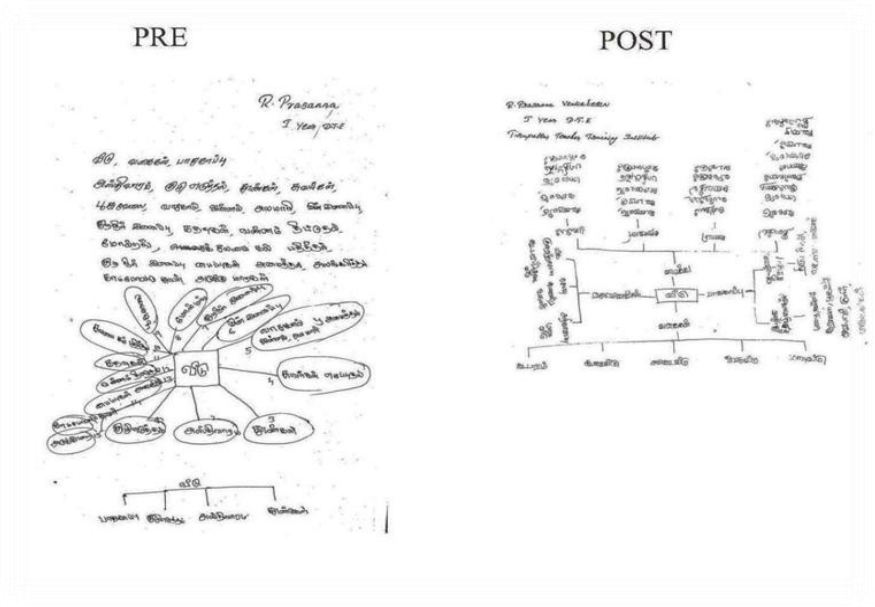


Figure 5.1: Pre and post concept maps on the theme of house

Analysis

In this theme, even though replacing of new concept with the old concept (misconception) did not occur explicitly during researcher interaction with a student teacher, but the cognitive structure of the concept is widened. This can be observed from the student teachers' pre and post concept maps. The student teacher interaction in groups helped them to widen the conceptual understanding. The improvement in linkages among the concepts in post concept maps also shows the rejection of some of the ideas attached to the concepts. One of the concept maps of a student teacher is presented above **(See all the concept maps on various themes in the soft form (DVD) attached).**

The pre-concept map depicts house as a major concept, the process of making a house and basic facilities are connected directly with the major concept. The post-concept map shows types of houses, various natural calamities and types of houses which can get affected by them. In the post-concept map the linkages between concepts are clearer than the pre-concept map. The synoptic view of group work (translated) is presented in the **appendix A1.**

5.1.1.2 Theme: Health and Hygiene

Participants: First Year student teachers

***Approach / Method*:** PBL

PBL problem:

You have two articles with you regarding Anganwadis and Nutrition deficiency among Indian children.

Assuming you are a team of nutrition related experts, planning to give suggestions to the government. Your report is expected to address

(a) Nutrition requirement with respect to different age groups
(b) Which are the different nutrition available in different food items
(c) Amount of food requirement for children of different age groups

Your team is expected to keep in mind that different raw food material available in different seasons and economic aspects while preparing the report.

Description of Classroom process:

The PBL problem is introduced in the classroom by providing photocopies of problem for all the groups. From few groups student teachers were asked to read the problem aloud and the researcher asked if any group have any difficulty in comprehending the problem it can be addressed. After this the student teacher groups (Figure 5.2) started discussing the problem in their respective group. During the group work the researcher visited each group and interacted with student teacher about the progress of group work. Each group worked with their own pace. Hence, the content of researcher's interaction with each group varied depending on the group's progress. During the PBL problem on house, student teachers' group discussions (Figure 5.3) mainly relied on their own experiences, textbooks and what they read in newspapers etc. However, in this theme student teachers used their own experiences, textbooks, newspapers, IGNOU material on health and hygiene, hospital brochures on immunization schedule, growth record, development card of children etc.

Figure 5.2: Photographshs shows the Student teachers, first year, of group E are in discussion on health and hygieneie

Figure 5.3: Student teacher (first year) groups are in discussion on the issue of health and hygiene

The student teacher took more time to complete this PBL problem. The student teachers discussed various aspects in their group and made their report.

Group Work

The structure of group work of some student teacher groups varied from PBL structure suggested as they accommodated more information. So the synoptic view of group work **(appendix A2)** also changed accordingly. Each group written work varied from 5 to 28 pages, the synoptic work only indicates the concept / title.

Most of the groups work indicated the daily nutritional requirement of different age group with the relevant food items, nutrition requirement (protein, vitamin, carbohydrate, fats and minerals) their functions and possible diseases on their deficiency and nutritional requirement of infants, children and pregnant women. Group works also includes growth and malnutrition, food habits, protection from mosquitoes, the importance of breast feeding, low-cost nutrition rich food items, seasonal foods and fruits, food chart with calorie value, preventive measures to deficiency diseases and plan of a balanced diet. However, some groups work indicated specific information on blood group, genes, functions of chromosomes, Ribonucleic acid (RNA), Body Mass Index (BMI) etc. The synoptic view of group work (translated) is presented in the **appendix A2**.

Researcher Interaction with student teacher groups

The researcher's interaction with the student teachers during group work was centered on the similarity to the group work. However, at the end of group work, the researcher asked each group to make their presentation of their group work to the whole class. After each presentation student teachers from other groups, researcher raised questions / sought clarification from the presentation group. During this some of the perspective changes were observed. They were:

"For removing black colour of skin donkey milk is fed"

"Black dog blood also people feed it to babies …. for immunity power"

"If we take blood from monkey and inject into our body, we also become monkeys"

"acid rain … is artificially made"

Classroom Interaction on For removing black colour of skin donkey milk is fed and Black dog blood also people feed it to babies …. for immunity power

The first two student teachers conceptions were based on the cultural practice and belief system. Even though the student teachers belief from cultural practice agrees feeding donkey milk to infants changes the skin colour, they accepted that it don't have any scientific proof. This created disequilibrium in their conceptual understanding.

The researcher's interactions with student teachers are given below.

R: What is the benefit of giving donkey's milk to children?

S.T1: It has more immunity power sir.

(**S.T**2 wanted to say something, but **S.T**3 interrupted with loud voice)

S.T3: When we take the olden days there is a disease called karruputhavappu usually affected children. To cure it, donkey's milk was given to children.

R: What disease?

S.T3: Kaurpputhavappu

R: Is it a disease?

S.T3: *When child developing in the womb it is there. When a child is born when we see the child is looking little black. It is like; when poison is mixed with blood how body colour will go black, like that. For removing that black body colour donkey milk is fed. When we feed it the colour change little bit , little bit starts crying and or baby activities/behavioural change observed (during this time **S.T**4 beating **S.T**3, both were very close friends and they always make joke and laugh in the class silently) after birth and later child grown there is a good change.*

S.T5: Black dog blood also people feed it to babies. They asked me to give it. They said it is useful for immunity power. Along with donkey milk, this also they asked to feed to babies. Cutting black dog's ear and take the blood and give.

(Some of them showing annoyance by listening this)

(There was noice)

Chorus: *There won't be any scientific relevance.*

S.T6: If the native doctor (Nattuvaithiyar) is there in our village we can consult him.

R: What do you think?

S.T3: We don't think it has some scientific proof, but that is what people believe.

S.T5: People do that, now it is coming down, but it is a practice

R: No. Do you think, feeding of donkey's milk will change the skin colour?

S.T3: *I don't know. But people believe it.*

S.T5: Sir, Children skin colour slightly changes frequently when they are infants. I am not sure, whether it changes skin colour. But it is in practice.

Classroom Interaction on acid rain … is artificially made

The second student teachers conceptions were based on the lack of conceptual understanding. The peer interaction in the whole class situation clarified the misconceptions.

S.T1: Rain also is sometime poured as acid rain, because chemical factories release H_2SO_4 (sulfuric acid) gas it mix with rain and becomes acid rain. When it fall on earth plants gets affected and if it rain at sea, living creatures in the sea also affected by this.

S.T2: She said about acid rain. It is artificially made. Naturally rain….

S.T1: (interrupts)

R: Wait, wait, wait… what do you think about acid rain?

S.T2: *We are creating that. We can create rain. For that some chemical is there (he wanted to say chemical name but while uttering it sounds as reason) if we put that then we get rain. If we see in cinema there are rain situations; we can produce artificial rain. Natural rain does not contain any pollutants. We can keep it clean and drink that water. We cannot get any effect from that. But the artificial rains there are so many effects.*

S.T3: Artificial rain is different and acid rain is different.

S.T2: Then, what is the difference?

(**S.T**2 and **S.T**1 both wanted to say)

R: Wait a minute mam. (some student teachers laughing in the class)

S.T4: Say **S.T**3

S.T3: Artificial rain means on dry snow (ularpani when we spray) potassium iodide, we get it. Acid rain means…….

R: Wait a minute he wanted to say something.

S.T5: Sir, rain naturally pours. But when the poisonous gas in the air mixes with rain, the natural rain becomes acid rain.

R: Where from the poisonous gas comes?

S.T5: By burning gas

R: You wanted to say something. Say..

S.T1: *That type of poisonous gas is present. From chemical factories more chemicals; more CFC from* ***refrigerator*** *comes, because of those ozone layer become a hole. These are all because of chemical reactions. The same way the factories which produces H_2SO_4 (sulfuric acid), the gas coming from the factory mixed with air and becomes SO_2 (sulfurdioxide) that becoming acid rain and pour into the earth and sea; plants and*

aquatic plants and animals gets affected by this. When we see, due to ozone hole the sunrays fall into a human, because of that many skin diseases it makes.

R: What do you think?

ST2: *Initially I thought both are same (acid rain and artificial rain)*

Concept Maps:

While comparing pre and post concepts of student teachers it is observed that there was a considerable change in their understanding of the concept Health and Hygiene. However, the very minimum number of student teachers submitted both the concept maps, it is difficult to make conclusive inference for the whole class.

In pre-concept maps individual student teachers generally depicted one or many of the following concepts: various types of foodstuffs, nutrients and its importance, deficiency diseases, the impact of environmental pollution on health, different parts of the human body etc. However, some student teachers concept maps lacked linkages between concepts.

In post-concept maps student teachers generally depicted few of the following concepts: various types of foodstuffs, nutrients and its importance, impact on health by use of insecticides on food crops, balanced diet, health and exercises, nutrient rich food stuffs and organs of the human body. In the post concept maps the linkages between concepts are clearer than the pre-concept maps.

Self and Peer Assessment:

Out of nine groups six groups were submitted the rubric of self and peer assessment. Most of the student teachers from various groups rated their peers as good or excellent against different aspects indicated in the rubrics. Few teachers rated their peers as fair, good and excellent. However, within the group there is no internal consistency on low rating of any particular member. None of the members made use of rubric for self-assessment.

Analysis:

In this theme, replacing of new concept with the old concept (misconception) did occur explicitly during the whole class discussion between researcher and student teacher groups (refer researcher interaction with student teacher groups in the previous pages). The student teachers' interactions show (i) the role of cultural practice and belief system in forming an individual conceptual understanding. The student teachers positioned

themselves the tension between the cultural practice / belief vs scientific truth, and conceptually inclined towards the scientific truth. (ii) The impact of lack of conceptual understanding of meaning making of other related concepts.The synoptic view of group work (translated) is presented in the **appendix A2.**

5.1.1.3 Theme: Soil

Participants: I Year Student Teachers

Approach / Method: Brain Storm, collaborative problem solving, Inquiry Learning

Context:

During the discussion on a previous theme on Nutrition requirement it was expressed that use of fertilizer in agriculture led soil to become infertile. As most of the student teachers are from village and agricultural background, the researcher felt that it is appropriate to discuss 'soil' as a theme. The researcher initiated the discussion by posing a question on what do they know / understand about soil.

Description of Classroom process:

The researchers' question driven the class in a brainstorming mode and student teachers expressed their ideas on soil. Gradually the discussion moved on to student teachers critically looking into each other's ideas and conceptualizing their understanding of soil. The discussion has also led to an inquiry activity on water holding capacity of various soils and their nature. The concepts discussed during the discussion were soil & earth; soil fertility; water holding capacity of various soils.

Student teachers' interaction - Whole class Discussion:

During the whole class interaction student teachers expressed some of their misconceptions and it was addressed by the peers in a collaborative discussion. The misconceptions were:

"Soil is earth"

"Naturally it (soil) was made by god….. With full protection, God made this"

In both the cases other student teachers' contradicted these ideas. Through discussion these misconceptions were addressed.

During the whole class discussion a student teacher raised a question that,

"If we take a rock and grind it into small-small minute pieces and make it as a soil, in that soil if we sow a plant, will it grow or not?"

"Why did rock soil have less water holding capacity?"

The classroom interaction for the first misconception is given below.

Classroom discussion on – Do plant grow in rock soil:

This led to further discussion and brought the understanding on nutrient present in the rocks.

S.T1: *Sir, They are saying that soil came from rock. If we take a rock and grind it into small small minute pieces and make it as a soil in that soil if we sow a plant, will it grow or not?*

(Few others talking with low voice)

R: Oh! Good question? Listen...

S.T2: Which question sir?

R: If we break rock into soil,will a plant grow or seed germinate in that soil?

S.T3: No it won't grow.

S.T2: It will grow.

(Some discussion)

S.T1: They are saying that from rock, soil comes, and plants don't grow in that, then, how plants grow in that soil?

R: That is a question!

S.T2: It will grow... From rock also sometimes plant grows.

S.T1: *(interrupts) we had an experience. When we put a bore, the soil (rock powder) came out. You know this soil came from a rock. We planted a plant in that soil, but the plant didn't grow.*

S.T3: It won't grow sir.

S.T4: It will grow sir.

S.T1: It didn't grow.

S.T4: It will grow.

S.T1: No.

S.T4: Because it is artificial.

S.T3: Whether soil comes from artificial or nature but it had come from the rock only.

(**S.T5** wanted to say something)

R: Just a minute, I think he asked a nice question. Very good. Say mam,

S.T5 &S. T6: *The soil come from rock had to decompose (magganum).*

(A big laugh in the class)

R: How it decomposes?

S.T7: With bacteria like living creature.

S.T2: The things from water.

S.T6: Plant, tree or creepers after drying, it gets decomposed.

R: Do you say plant came before soil?

S.T6: No sir.

(RS – Recording stopped)

R: The plant did not grow in the soil (rock powder) that came while drilling borewell?

S.T7: Soil has to break. (Here he intended to say decompose, but he used the word break)

R: For decomposition what we need do?

S.T7: We don't need to do anything. It naturally happens through decomposition by a living creature.

S.T1: From (He begins, meanwhile Shali interrupts)

S.T6: *The soil comes from Rock, has that remained in the same place? No. it has not. During rain it floats from one place to another. When it mixes with the soil in that new place it receives nutrients. That is how plants grow.*

R: Yes mam. So you are saying that the soil is already present?

S.T6: No sir, Plants might have been destroyed. Those nutrients mixed with the soil. So that is how plants grow.

R: For soil formation, do you want to say; already at that place plant might be present in dry and decomposed form?

S.T6: No sir, (laughing)

S.T2: She says how plants decompose that she explained.

S.T8: Sister, how plant decomposes?

S.T1: (says something in a low voice)

R: (with a smile and little laugh), another person want to say, let us listen,

S.T9: Sir, it was said that soil had come from Rock. The soil which came from Rock, if we plant a seed immediately will it grow? or has it grown? Does anybody know that?

R: Look, here he had an experience of his own. It didn't grow.

S.T10: *After soil formation, several thousand years later only living creature come into existence. If we see that way, the soil which just formed from rock, if you take that soil and we plant the plant, in that case no plant grow.*

S.T1: We planted only after 10 months.

(There are a noise and discussion in the class)

S.T8: It requires several thousand years.

S.T2: (laughing loudly) ha ha, ha…

S.T1: If rock breaks, whether plant grow or not?

(Again noise, everybody answering)

S.T2: Sir, you take land soil (Kollamannu) and rock soil (Paaraimannu). See which one has more salt (she intended to say nutrients).

R: Raise your hand, if you want to say something (towards student teachers)

S.T1: Do the soil that we get from rock have high / low water holding capacity? When you see it

(A word from class comes low – before he completes)

S.T5: Low

S.T2: Low.

S.T1: Why? You are saying that soil has more water holding capacity. Why did which came from rock soil have less water holding capacity?

S.T8: The decomposed soil has more water holding capacity (Padhapaduthapattamannuikkueerappathamaathigam)

S.T1: Why? What do you mean by decomposed soil?

S.T2: Yes. How many times it rains in the soil and how many living a creature (jeevarasigal) dies that become fertilizer.

(Continues)

S.T2: Due to that minerals are obtained in the soil and by that plant grows.

S.T1: (interrupts)

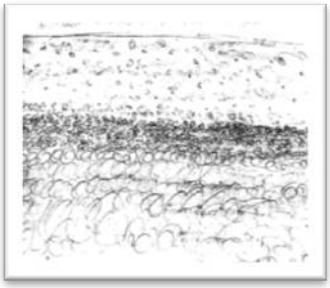
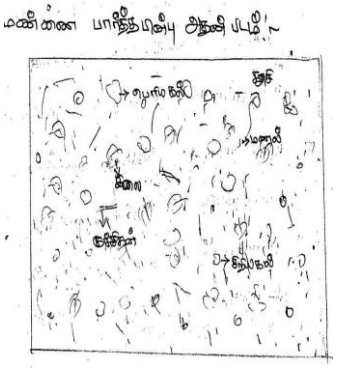
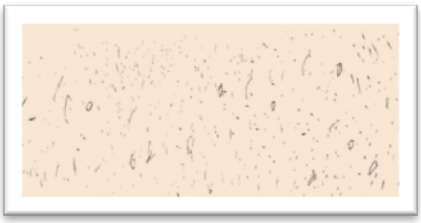
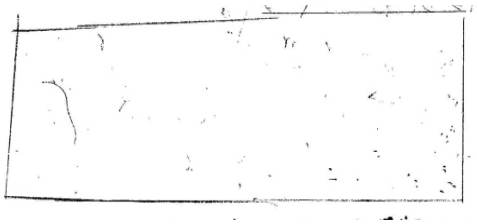
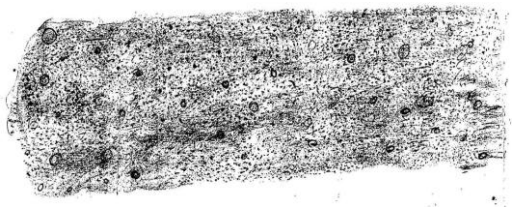
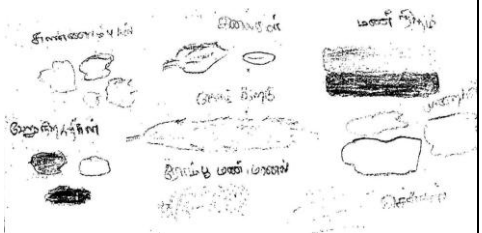
R: It is a very good discussion. Good.

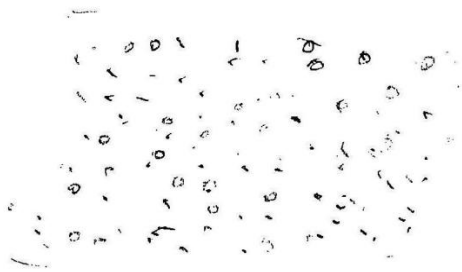
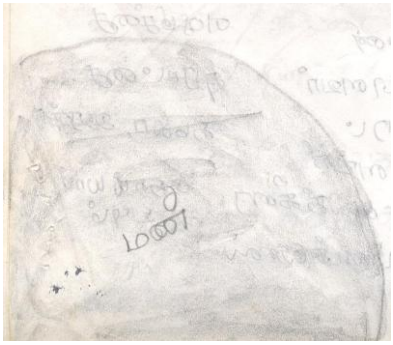
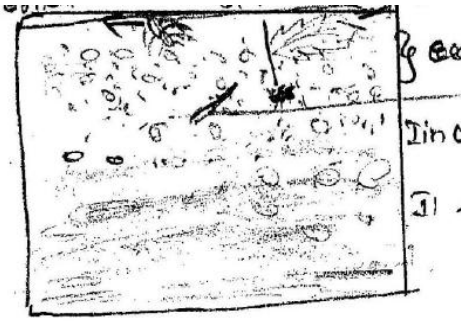
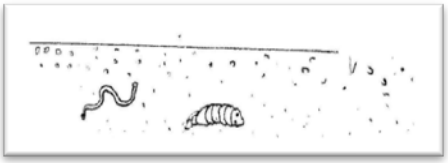
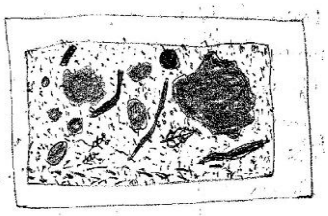
During the whole class discussion the researcher also discussed about finding acidic and basic nature of the soil. But the elaborative discussion on this did not happen. Similarly making a group drawing on student understanding of the concept "soil" was done before and after the observation. Devising the plan of activity for water holding capacity was not discussed on the same day. The activity was carried out in a demonstration mode by student teacher in the class. (Due to some problem in cassette recorder the classroom interaction was not recorded) However, through the researcher's field notes it was observed that the student teacher did not have any difficulty in devising the activity plan during the classroom discussion. The researcher's interaction with student teachers in whole class discussion along with a synoptic view of group work is given in **appendix A3.**

Student teacher groups conception of top soil:

The student teacher groups were asked to make a drawing of top soil based on their previous understanding. Later student teacher groups were asked to make the drawing by observing the top soil outside the classroom. Out of nine groups six groups made both the drawings is given in the table **5.1.**

Table 5.1: Drawings of top soil by different groups

Group	Before observation	After observation
B		
D	 Stem, leaves, unripe& ripen fruits, small stones, insects and worms were there.	 Small pieces of grass, ants, and small stones were seen. The colour of the soil was brown and less amount of moisture observed.
E		 Lime stones, leaves, feathers of hen, stone powder (norambu), small stones of different colour, small sticks etc.

Group	Before observation	After observation
F		 In top soil ants, leaves, ant's food, smaller sticks, plants, grass, stones were present.
G		 Dried grass, small stones, insects, dried leaves, sticks, ant, cow dung and glass pieces. The soil was of brown in colour.
H	 Small stones, earth worms, worms which are present in manure, ants etc.	 Dried grass, small stones, weeds, insects, ants, pieces of paper and dried leaves. The soil was of brown in colour.
I	 Microbes, worms, plants, grass, earth worms, snake, frog, centipedes, small stones, wastes, small bricks and leaves.	 Ants, small plastic and iron pieces, broken bangles, coconut shells, seeds, leaves, small sticks, cow dung, small bricks, stones and paper pieces.

Student Teacher groups' observation on soil nature, water holding capacity of coconut farm and dam area soils:

The student teacher groups' experience of soil nature and water holding capacity of coconut farm (sandy soil) and dam area (alluvial soil) is drawn from their group work.

Things used: Two transparent glasses, two similar coconut shells with equal size holes at the bottom, two pieces of the same cloth, dam and coconut farm soils and water.

Arrangement: Equal amount dam and coconut farm soil taken in the coconut shell covered with cloth. One glass of water poured into each of the soil. The student teacher groups observed in soil nature (texture, size) by touching it, and water holding capacity of the soils.

Soil Nature:

All the groups observed that coconut farm soil is of pieces of bricks, small stones and texture of the soil is hard and most of the group observed that the soil is of brown colour. On dam soil most of the group observed that soil is soft / smooth texture but having some small stones and more of finer particle. Most of the groups observed that soil is about coffee color and few groups observed that it is the red color.

Water holding capacity:

All the groups observed that coconut farm soil absorb the water quickly and at the same time drain it out quickly than dam soil. The water holding capacity of coconut farm soil is less than dam soil. The groups also observed that the drained water of coconut soil is more or less clear whereas, dam soil is of muddy water.

Concept Maps:

The researcher asked the student teacher to make the concept map on land in the beginning. For the present theme the pre and post concept map of the same is used. At instances, in post map few student teachers used soil / earth as a major concept. While comparing pre and post concepts of student teachers it is observed that there was a considerable change in their understanding of the concept soil - land.

In pre-concept maps individual student teachers generally depicted one or many of the following concepts: land, minerals, various geographical landscapes, water sources, soil, soil types, soil erosion, water, crops, air, industries, various pollution, earth, earth layers, planets and living things. However, student teachers concept maps lacked linkages

between concepts. They try to bring as many concepts but fail to connect related concepts in a logical manner.

In post-concept maps student teachers generally depicted few of the following concepts: Earth, various geographical landscapes, earth and moon rotation, earth resources (land, water, living), minerals, layers of earth, various types of soil, soil formation, soil erosion, various industries, mineral resources, fossil fuels, environment, bio-sphere, crops, life forms and various types of pollutions. In the post concept maps the linkages between concepts are clearer than the pre-concept maps. However, all the concepts were not logically connected.

Self and Peer Assessment

Out of nine groups six groups were submitted the rubric of self and peer assessment. Most of the student teachers from various groups rated their peers as good or excellent against different aspects indicated in the rubrics. Few student teachers rated their peers as poor, fair, good and excellent. However, within the group there is no internal consistency on low rating of any particular member. None of the members made use of rubric for self-assessment.

Analysis:

In this theme, the replacing of new concept with the old concept (misconception) did occur explicitly during researcher interaction with student teachers. The student teachers' interactions showed the impact of lack of conceptual understanding of a particular concept on meaning making of other related concepts. It was also observed that student teacher's posed question to others to get clarity on concepts. Further it is also observed that the student teachers' cognitive structure of concept soil and land widened. This can be observed from researcher interaction with the student teachers and the student teachers' pre and post concept maps. The student teacher interaction in groups helped them to widen the conceptual understanding.

5.1.1.4 Theme: Water

Participants: I[st] Year Student Teachers

Approach / Method: PBL

PBL problem:

Recently Tamil Nadu Government decided to start a project through which it can bring water from Hogenakkal to Dharmapuri and Krishnagiri districts. The same way in our nearby places such as Vaniambadi and Ambur the water scarcity is a common phenomenon. What are the reasons for two situations? How to approach these situations and address the problem? Your team is expected to discuss these issues in detail and submit a report.

Description of Classroom process:

The PBL problem is introduced in the classroom by providing photocopies of problem for all the groups. From few groups student teachers were asked to read the problem aloud and the researcher asked if any group have any difficulty in comprehending the problem it can be addressed. After this the student teacher groups started discussing the problem in their respective group. During the group work the researcher visited each group and interacted with student teacher about the progress of group work. Each group worked with their own pace. Hence, the content of researcher's interaction with each group varied depending on the group's progress. During this PBL problem student teachers group discussions mainly relied on their own experiences. The student teachers discussed reasons for water scarcity and made their report.

Group Work

Most of the student groups could identify industrial effluents the major reason for the scarcity of water in one of the context i.e., water scarcity at Vaniambadi and Ambur. However, most of the groups failed to identify the major reason for the new water project for neighboring districts. There was a wide coverage of information in the past in newspapers about the fluoride presence in the ground water and increasing number of people get affected by thyroid related problem. The student teacher groups indicated other common reasons such as cutting of large number trees on road side during expansion of highways in the recent years, experiencing less rain fall over a period time, conversion of water bodies and rivers into cultivation area, excessive plastic use preventing rain water percolation into earth, rising average temperature, casual approach

of public on use of water, geographical location of Vaniambadi and Ambur falls leeward side of the mountain etc. A group made an observation that due to mixing of industrial effluent into river lead to reducing the fertility of nearby land thereby reducing yield. Hence, this acts as a push factor for people who were involved in agricultural activities switching to industrial (tannery) jobs for their livelihood without any choice, even by knowing they will get diseases by doing that.

Most of the group work indicates the solution for this problem could be rain water conservation and rain water harvesting by constructing new dams, lakes, ponds and rain water tanks. Groups also indicated that, preventing or treating industrial effluents before releasing it. Some of the groups indicated need to control sand mining from rivers, planting more number of trees, developing habit of judicious use of water, use of waste water for agricultural purposes, ground water irrigation, etc. It was also observed that one of the group linking of rivers as solutions. Some groups indicated the desalination and even family planning could be a solution. It was observed that most of the groups did not include their understanding of the problem in the post whole class discussion. The synoptic view of group work (translated) is presented in the **appendix A4.**

Researcher Interaction with student teacher groups

The researcher's interaction with the student teachers during group work was centred on similar to the group work except few situations. One of the group expressed that constructing public places like bus stand on water bodies' in towns lead to water scarcity. In another occasion a student teacher had an understanding that geographically proximal places have similar nature of water. The interaction is presented below.

Classroom Interaction on - geographically proximal places have similar nature of water

R: Yes **S.T**1, you want to say something.

S.T1: *Is Hokenekkal water is salty?*

S.T2:*No. No. There the water is in good condition.*

S.T1: *If water is good and drinkable in Hokenkkal means it is also to be good in Dharmapuri.*

R: Why?

S.T1: Because it is near to Dharmapuri.

S.T2: *The water not yet brought to Dharmapuri. The people use the water which was already there. Hokenekkal water is good sir. Because it is river water and it comes from different places and it is 'Mooligai' (a water contains mooligai –* ***Ayurvedic content)*** *water, so it is good. If it is filtered and used, it will be good.*

R: Hmm, I see. Do you think (**S.T**1), the ground water in Dharmapuri and river water are of similar nature?

S.T1: *No sir. I got it.*

R: mm.

After the group work the researcher engaged whole class discussion to develop a common understanding on the issue. During this the fluoride presence in ground water of Dharmapuri district is made explicitly known to all groups along with other aspects.

Concept Maps:

While comparing pre and post concepts of student teachers it is observed that there was a considerable change in their understanding of the concept Water.

However, the very minimum number of student teachers submitted both the concept maps, it is difficult to make conclusive inference for the whole class.

In pre-concept maps individual student teachers generally depicted one or many of the following concepts: various water bodies, the various purposes for which water is used, the importance of water for various life forms, pollution of water bodies, water borne diseases etc. However, student teachers concept maps lacked linkages between concepts.

In post-concept maps student teachers generally depicted few of the following concepts: Various water bodies, the various purposes for which water is used, water cycle, the importance of water for various life forms, pollution of water bodies, water borne diseases etc.. In the post concept maps the linkages between concepts are clearer than the pre-concept maps.

Analysis:

In this theme, even though replacing of new concept with the old concept (misconception) did not occur explicitly during researcher interaction with a student teacher, but the cognitive structure of the concept is widened. This can be observed from researcher interaction with the student teachers and the student teachers' pre and post concept maps. The student teacher interaction in groups helped them to widen the

conceptual understanding. However, the group work indicates that the most of the groups worked on the problem at surface level than the deeper understanding. This was happening because the student teachers were getting ready for the practice teaching with preparation of lesson plans and getting it approved by subject teachers etc.

5.1.1.5 Theme: Energy Resources

Participants: II Year Student Teachers

Approach / Method: PBL

PBL problem:

Today, India as a developing economy needs more energy for sustaining the environment for economic development. At the same time some of the energy resources are depleting very fast in the world. We are living in a complex situation where on one side energy requirement is increasing and on the other side depleting energy resources.

Your group is expected to prepare a report on

a. What are our energy resources?
b. How do we get energy from our energy resources?
c. Which energy sources are at a risk of getting exhausted?
d. What are the other alternative energy resources?
e. Benefits and adverse effects of various types of energy resources

Description of Classroom process:

The PBL problem is introduced in the classroom by providing photocopies of problem for all the groups. From few groups student teachers were asked to read the problem aloud and the researcher asked if any group have difficulty in comprehending the problem it can be addressed. After this the student teacher groups started discussing the problem in their respective group.

During the group work the researcher visited each group and interacted with student teacher about the progress of group work. Each group worked with their own pace. Hence, the content of researcher's interaction with each group varied depending on the group's progress.

During this PBL problem student teachers group discussions mainly relied on textbooks, newspaper information and their own experiences.

Group Work

Most of the group works indicated that energy sources such as coal, petrol, and diesel are in a depleting condition. The groups work indicated solar energy could be a solution for the problem. Groups also suggested wind energy, mooligai petrol and bio-petrol from sugarcane were of alternative sources. The group works also indicated that locations in which hydroelectric, thermal and atomic power stations situated and how we make use of those energies, its advantage and adverse effects and how to avoid wasting of energies.

Even though groups appear to have understood the problem (from first table 'what you know 'column of PBL format (Table 2.1)), two groups group work indicates on different types of energies instead energy sources. The student teachers of few groups had a misconception that, (i) in dam water flow from the above fall on the wires and due to the rotation of wires electricity generated (ii) depletion of energy sources due to irregular rains which affects growth of trees and affects the coal production. The synoptic view of group work (translated) along with GroupWise analysis is presented in the **appendix A5.**

Researcher Interaction with student teacher groups

The researcher's interaction with the student teachers during group work some of the misconceptions were observed among few groups. They were:

"Space related experiments happening in Thermal & Atomic power stations"

"In dam, due to (turbine) rotation water becomes water vapour"

"The water comes from a height with speed and force, from that through rotation…….. Water comes fast and when water comes with force the rotation speed of string will increase"

"Thermal power station means; if we heat gases in higher temperature, when we make that passes through machines and machine works"

"Hydroelectric power stations…….. Where water falls down from the higher places it produces the high pressure. When it touches the machine, due to water and machine friction electricity is produced"

"Dirty water can be used to produce electricity. Through pure water we cannot get electricity"

"The gases come out from the coal burning through that electricity is produced"

To remove all these misconceptions researchers had a whole class discussion in post group work. The researcher's interaction with the student teachers in the post group work is given below.

Whole Class Discussion

R: How electricity is generated from hydroelectric stations?

S.T1: Through turbine electricity is generated

R: How?

S.T2: *When water falls from the tall place the spring kept at the bottom starts rotating due to water force.*

R: Is it spring or turbine?

S.T3: Turbine sir

R: Someone said that using dirty water we can generate electricity?

S.T4: *Yes sir. Due to salty water we can generate electricity.*

R: Can't we generate electricity through good water?

S.T4: Yes sir. We can't

S.T5: *No sir, Mettur hydroelectric power station is there. It is not salty water.*

S.T4: It is not good water sir

Chorus: It is good water

R: Ok. Ok. Why do you say that from good water we can't produce electricity?

S.T4: I read somewhere sir

S.T3: *No sir. Pure water won't conduct electricity. But we can produce electricity.*

S.T4: Is it?

S.T3: Yes sir

R: Let us come back to the main question, how is electricity generated using water?

S.T5: *The water from higher place fall on the turbine with force. Due to this force turbine starts to rotate; the turbine is connected with big motor through which electricity is generated.*

R: How?

S.T5: *We can run the motor through electricity or we can get electricity through by running the motor*

R: Is it motor or generator?

S.T5: mm…

S.T3: *sir probably it is generator*

R: How do you say that?

S.T3: *In cinema theatre when power cut happens they use a generator. That's why only I said so.*

R: Yes it is generator. Ok. What is the difference between motor and generator?

(Silence)

R: Motor converts electrical energy into mechanical energy and generator converts mechanical energy into electrical energy. So what happens in the case of hydroelectric generation?

S.T5: The turbine is connected to a generator and the generator converts that mechanical energy into electrical energy.

R: What happens in thermal power stations?

S.T6: *The gases coming out from coal burning is used to generate electricity*

R: Is it?

S.T6: Yes sir

S.T5: *Like rail engine, the water is boiled with burning coal and, from the water vapour electricity generated*

R: Is it? How?

S.T7: *The gases coming out of coal burning are passed to the machine, so machines works*

R: Is it?

S.T7: Yes

R: Anyone else?

(Silence)

R: *What he (**S.T5**) said is right. While burning coal the heat energy converts the water (in the water pipe) into vapour. When the water vapour with high pressure comes to contact with the turbine, makes the turbine to rotate. Then through the generator electricity is generated. Ok?!*

S.T3: Sir is atomic energy also is generated same way?

R: Yes. Instead of coal, in atomic reactors Uranium is used. Through nuclear fission heat energy generated, this is again converted into mechanical energy through the turbine and electricity generated. What do you think about wind energy?

S.T3: It is simple sir. Through wind the blades rotate, so the mechanical energy converted into electrical energy using a generator.

R: Yes.

Concept Maps:

While comparing pre and post concepts of student teachers it is observed that there was a considerable change in their understanding of the concept Water.

In pre-concept maps individual student teachers generally depicted one or many of the following concepts: various energy sources (solar, water, wind, fossil), use of various energy sources, various forms of energy etc. However, student teachers concept maps lacked linkages between concepts. They try to bring as many concepts but fail to connect related concepts in a logical manner.

In post-concept maps student teachers generally depicted few of the following concepts: Various sources of energy, sources through which electricity generated, various forms of energy, uses of electricity, various uses of fossil fuels, electricity generation from sources and change in the forms of energy, process of electricity generation from various types of power stations, solar appliances, various types of power stations through which electricity generated from different sources of energy, excessive use of energy its impact on environment, renewable and non-renewable energy sources etc. In the post concept maps the linkages between concepts were clear than the pre-concept maps. However, all the concepts were not logically connected.

Self and Peer Assessment

Out of nine groups seven groups were submitted the rubric of self and peer assessment. Most of the student teachers from various groups rated their peers as good or excellent or fair against different aspects indicated in the rubrics. Few student teachers rated their peers as poor, fair, good and excellent. However, within the group there is no internal consistency on low rating of any particular member. In one of the group all the members rated 0 (1 – poor) for one of the member. During interaction with the student teachers it was found that the student teacher who was rated as 0 by peers was never been participating or engaging any of the activity in the group. The student teacher made use of rubric for self-assessment. Generally student teacher rated themselves as equal to others. However, in one case the student teacher rated very low (poor).

Analysis:

In this theme, replacing of new concept with the old concept (misconception) did occur explicitly during the whole class discussion between researcher and student teacher groups (refer researcher interaction with student teacher groups in the previous pages).

The researcher's interactions with the student teachers' show the impact of lack of conceptual understanding of meaning making of other related concepts. The change of conceptual understanding of energy generation lead to widening of cognitive structure is observed through post-concept maps where student teachers are able to connect the various concepts in a logical manner. During the pre-concept map some of the student teachers draw concept maps of individual energy sources and its uses separately. In the post-concept map, they could connect all these, and some of them could able to depict process of electricity generation, kinds of energy transformation occur during electricity generation from different energy sources etc.

5.1.1.6 Theme: Environmental Problem
Participants: II Year Student Teachers
Approach / Method: PBL

PBL problem:
In today's urban life environmental pollution becoming an important problem. You are an expert team in the area of environmental issues. Your group is expected to analyze the reasons for environmental pollution in the town and provide suggestion for the Municipality- measures to be taken to face the problem. You are also expected to prepare reports for the public on their role in reducing the environmental pollution.
The learners worked in groups and interacted / discussed and prepared the report. During their group the researcher interacted with them and some of the excerpts of these are given below.

Description of Classroom process:
The PBL problem is introduced in the classroom by providing photocopies of problem for all the groups. From few groups student teachers were asked to read the problem aloud and the researcher asked if any group have difficulty in comprehending the problem it can be addressed. After this the student teacher groups started discussing the problem in their respective group.
During the group work the researcher visited each group and interacted with student teacher about the progress of group work. Each group worked with their own pace. Hence, the content of researcher's interaction with each group varied depending on the group's progress.

During this PBL problem student teachers group discussions mainly relied on textbooks, newspaper information and their own experiences.

Group Work

Most of the group work of student teachers indicated that land pollution, water pollution, air pollution and noise pollutions were the major problem for people living in urban area. However, very few group contextualized the problem. The other specific problems observed by some of the groups were traffic congestion, adulteration of fuels, deforestation, water stagnation and contagious diseases. The group works also gives a detailed sketch of various pollutants, peoples practices and factors (like population growth) which lead to land, water, air and noise pollution, the impact of pollution on human health, agricultural productivity etc.

Groups made various suggestions to government bodies in terms of sewage line, industrial pollution control measures, waste management, reaching people through the mass media on various environment friendly practices and local bodies monitoring of people's basic necessities. Groups also made various suggestions to common public on how to keep the environment clean by their practices. However, very few groups had made these suggestions to the target groups (government bodies and public) specifically. Most of the groups' suggestions were general in nature. The synoptic view of group work (translated) along with group wise analysis is presented in the **appendix A6.**

Researcher Interaction with student teacher groups

The researcher's interaction with the student teachers during group work some of the misconceptions were observed among few groups. They were:

"It (natural fertilizer) will give more yielding. Like the olden days (AdiKaalam), by using natural fertilizer we can cultivate"

"By keeping Pugaipokey (chimney) in higher height. There won't be any air pollution"

When student teacher groups' made a brief presentation on their group work the following misconception was observed.

"If the blood of AIDS, if it fell on us, due to that AIDS will come….. blood mixed with onion and those who ate ***panipoori*** *all were got AIDS"*

The first two misconceptions the researcher addressed it in the group itself. The last misconceptions researcher had a whole class discussion after the student presentations.

The researcher interaction with individual groups and whole class is presented below.

Classroom Interaction on - natural fertilizer will give more yielding

R: You have written that by using natural fertilizers, we can stop the land pollution. Is there any specific advantage of that?

S.T1: *Yes. It will give more yielding.* Like the olden days (AdiKaalam), by using natural fertilizer we can cultivate.

R: *If it gives more yielding, then why do we use artificial fertilizers?*

S.T1: Modern times, due to increase in Industries, everything…..

S.T2: People needs.

S.T3: Population explosion is continuously increasing so all people don't get food. For that we have to produce more food items according to their needs.

S.T2: *For quick growth of the crop and for good yielding.*

R: But, you have written that natural fertilizers give more yielding.

S.T2: It is not like that sir. Olden days less number of people and large land area and people use to cultivate longer period crops. For example, in rice there are varieties which take 6 months time and there are varieties that take 3 and half month. These days we do not cultivate 6 month varieties much.

S.T3: Due to chemical fertilizers, soil quality reduces. Because of that food quality reduces. It is not like olden days food, the nutrition is reduced. Due to that human life span reduced.

R: What do you think **S.T**1?

S.T1: Yes sir, natural fertilizer provides quality food products.

Classroom Interaction on - By keeping Pugai pokey (chimney) in higher height. There won't be any air pollution

R: Ok. You have written that by keeping the tall chimney (Pugai pokey), we can control air pollution. How?

S.T1: Effects

S.T2 :(interrupts) Sir, if the place where no chimney (Pugai Pokey)

S.T3 (interrupts): Sir, Air density is more in lower area. When we go higher and higher the air density is very low. Because of that if we keep fire chimney (Pugai Pokey) very height, we are breathing air in lower height only. We are not breathing air from higher height. We breathe only lower O_2 only. *Due to that they keep Pugai pokey (chimney) in higher height. There won't be any air pollution.*

R: Is it so?

S.T3: Yes sir.

R: Do you mean there won't be any air pollution?

S.T3: Yes

R: Have you seen burning the wastes in the land after cutting the sugarcane?

Chorus: Yes

R: While burning if you are near to that place, how do you feel?

S.T2: Lot of smoke and hot. We feel suffocated

R: Fine. If you are a little distance away, how did you feel?

S.T2: Little better

R: Why?

S.T2: Because the smoke is not there

R: Why?

S.T3: *No sir. Smoke is there, but when we go distant the smoke level reduces.*

R: Why?

S.T3: *Because it spreads and it becomes less concentrated*

R: Yes. When the smoke spreads the concentration becomes less. When industries use taller chimneys the impact of air pollution get reduced. It is not completely gone.

Whole Class Interaction on – AIDS

The researcher was not sure on "Spreading of AIS through accidently having panipoori where the presence of blood drops of AIDS patient". Therefore during this interaction the researcher did not make any clarification on the issue.

R: Someone said an interesting incident on AIDS. So I just wanted to know, what are reasons for getting HIV?

S.T1: Through Injection (with low voice) i.e. if the syringe is not in hygienic there is a possibility of getting.

S.T2: If the mother is affected by AIDS; then it will affect the child also.

R: mm.

S. T3&S.T4: improper sexual intercourse.

(There is a noise)

S.T5: By mosquito biting.

S.T6: *It won't spread by mosquito biting (laughing)*

S.T4: *It won't come by mosquito da*.

R: Listen

S.T4: *Why sir? Will it spread through mosquito?*

R: See here.

S.T7: Sir, if the blood of AIDS, if it fell on us, due to that AIDS will come.

R: mm.

S.T7: *You know people sell* ***panipoori****. If they had AIDS (full laughing in the class) while they cutting onion it was in the newspaper. While cutting onion, their finger unknowingly cut by knife (here it means not completely cutting somewhere the knife scratched the finger) that blood mixed with onion and those who ate* ***panipoori*** *all were getting AIDS. When doing research on this, they finally reached the* ***panipoori*** *person and identified he had AIDS.*

R: mm. So even HIV blood if it fell into food and if it enters to body we will get AIDS. She had said that even if HIV person blood unknowingly mixes with our food and we consume it we will get AIDS.

S.T6: AIDS is not a thothu disease

S.T8: It is a disease to spread through the blood.

R: mm…

S.T9: *There is no chance at all to happen like that.*

R: Do you want to say; is there no chance to happen like that at all?

S.T7: *Like that already happened,*

S.T3: It is already happened sir.

S.T7: Those two people.

S.T3: No four people.

S.T6: *Sir, the blood which comes from hand due to cutting is mixed with onion; we know* O_2 *and gas present in blood, so it may be live 2 days.*

S.T7: Those two brothers and sister had AIDS. But their parents don't have AIDS. When doing research on how both these brother and sister got AIDS, two of them daily go to the beach for walking, during that time they buy and eat panipuri everyday. Because of the owner of that panipuri stall had AIDS, they got AIDS like that research report said.

(A lot of noise due to everyone discuss with others)

S.T10: It is said that, the virus come out from the blood that moment it will die, then how they might have been getting AIDS?

R: mm

S.T3: *The virus dies when it comes out from blood.*

R: The virus comes out from blood or body, the virus will die, like that he says… take this as a hypothesis and find the answer for it by reading books and other resources

S.T3: *Why AIDS is not spreading through mosquito means, during mosquito bites when blood enters to mosquito stomach the virus dies so through mosquito it didn't spread.*

S.T7: *When we see panipoori, they did not use onion for fry. They directly use it. So the viruses in the blood are alive. Up till blood gets dried the virus always alive.*

R: mm

Researcher tried to get the answer to this question by consulting local primary health centre physician, internet sources, and informed the student teachers that the chances of getting affected by AIDS of this nature is practically rare. In a later stage, the researcher could get the news item (referred by the student teacher) from the internet about the issue. It is given in the box **5.1**.

Concept Maps:

The researcher asked the student teacher to make the concept map on the environment in the beginning. For the present PBL problem the pre and post concept map of the same is used. While comparing pre and post concepts of student teachers it is observed that there was a considerable change in their understanding of the concept Environment.

In pre-concept maps individual student teachers generally depicted one or many of the following concepts: Living and non-living, classification of living things, environmental pollution (land, water, air and noise), pollution control, environmental protection, human activities which leads environmental pollution (industries, transportation, individual practices), importance of non-living things for living things and impact of environmental pollution on living things (human, animals and plants).

In post-concept maps student teachers generally depicted few of the following concepts: Biotic and abiotic factors, environmental pollution (land, water, air and noise), various ways environment getting polluted, its impact and the solution to the environmental problems, classification of animals based on what they eat, environmental protection, human activities which leads environmental pollution (industries, transportation, individual practices), importance of non-living things for living things and impact of environmental pollution on living things (human, animals and plants).

Box: 5.1

Can one get AIDS by consuming food contaminated with blood?

Tuesday, 04 July 2006

Answered by: Dr. L.M. Nath

Consultant, Community Medicine,

New Delhi

Q. I recently read a news citing a case in Mumbai. The news said that a 10-year old boy ate panipuri about 10 days ago and fell sick. Later when he got a health check up done, the doctors diagnosed that he had AIDS. His parents couldn't believe it. The entire family underwent a check up, but none of them were suffering from the same. The doctor then asked the boy, whether he had eaten out and the boy mentioned that he had panipuri one evening. The hospital team went there to check and found that the panipuri seller had received a cut on his finger while cutting onions and his blood had spread in the food. When the doctors checked his blood, they found that he too was suffering from AIDS but was not aware. Is it possible to have AIDS by eating food contaminated by blood of an AIDS patient? This news had spread panic among the people and created more stigma among the masses regarding AIDS. Please highlight the various modes of spreading of the virus.

A. It is extremely unlikely that HIV would be spread in the way you have described. Firstly the volume of blood ingested (even if it did occur) is likely to have been very small. Secondly while consuming HIV positive blood can theoretically give rise to HIV infection, it is not very likely. Thirdly, and most importantly, given if the child did get infected, in 10 days he would still be in the window period and the usual tests would not have picked up the infection. Please also note that single tests are quite likely to give wrong results due to false positive reports. Single tests do not have any diagnostic value and must always be confirmed by a second test.

Read more at: http://doctor.ndtv.com/faq/ndtv/fid/9204/Can_one_get_AIDS_by_consuming_food_contaminated_with_blood.html?cp

In the post concept maps the linkages between concepts are clearer than the pre-concept maps. However, all the concepts were not logically connected.

Self and Peer Assessment

All the nine groups were submitted the rubric of self and peer assessment. Most of the student teachers from various groups rated their peers as good or excellent or fair against different aspects indicated in the rubrics. Few student teachers rated their peers as poor, fair, good and excellent. However, within the group there is no internal consistency on low rating of any particular member. In one of the group all the members rated 0 (1 – poor) for one of the member. This was observed in earlier problem too. The student teacher made use of rubric for self-assessment. Generally student teacher rated themselves as equal to others. However, in one case the student teacher rated very low (poor).

Analysis:

In this theme, the replacing of new concept with the old concept (misconception) did occur explicitly during researcher interaction with student teachers. The student teachers' interactions show the impact of lack of conceptual understanding of a particular concept on meaning making of other related concepts. It is also observed that the student teachers' cognitive structure of concept environment is widened. This can be observed from researcher interaction with the student teachers and the student teachers' pre and post concept maps. The student teachers interaction in groups helped them to widen the conceptual understanding.

5.1.1.7 Theme: Imaginary Lines

Participants: II Year Student Teachers

Approach / Method: Brain Storm, collaborative problem solving

Context:

During the discussion on AIDS related topic, a student teacher raised a question that, "What is polar region? Is there any life exist?" The Researcher redirected the question to the whole class. The subsequent brainstorming session led the researcher to engage the student teachers to explore their understanding of the following questions:

- How latitude and longitude divide the earth? (Explain with diagram)
- Explain the impacts of earth's movement (rotation and revolution)

- We can see only one side of the moon. Why?
- How does earth's revolution around sun with $23^{1/2}$ degree inclined axis have an impact on seasons in the earth?
- Does sun rotates on its axis?
- How do eclipses occur?
- What are waxing and waning?
- Explain on heat and time zones
- Explain the temperature conditions at polar region and equatorial line area.
- Locating India in heat and time zones

Description of Classroom process:

The student teachers were engaged in group task to develop a write up to answer the above question. The following misconceptions were observed among the student teachers during researcher's interaction with them.

"Moon's one side only we can able to see….Because moon is not rotating. It is static""Sun won't rotate by itself"

"When the earth rotates by itself…… season occur"

"From our earth to some length (distance- in atmosphere) temperature getting reduces (nammaboomilairundukonja length varikkumveppamkuraindhuthanirukkum) Why because due to gravitational force"

After the group work the researcher had the whole class discussion session to clarify these concepts. During whole class discussion these ideas were not explicitly expressed. This may be due to peer interaction among the student teachers from other groups as well as in the initial period researcher made some efforts to clarify these concepts by explaining them about longitude and latitude concept through blackboard as well as globe. Most of the student teacher groups had a view that due to moon non-rotation one could able to see only one side of the moon. This is observed by the researcher during the interaction with the groups as well as group works. The whole class discussion is presented below.

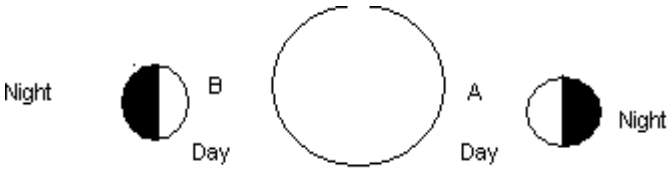
Whole class discussion

R: While interacting with you all, I could see varying responses on how seasons occur, why we could see only one side of the moon, does atmospheric temperature is depend on earth gravitation, eclipses and seasons. Let us sum up our ideas. I have just begun with a question, how day and night happens?

S.T1, **S.T2 and S.T3:** Earth rotation by itself makes day and night.

S.T2, S.T4: Sir, Sunlight fall only one side of the earth; that side day the other side is night.

S.T5: Earth rotates around the sun. But the sun is in the same place. (He explains with a ball) earth is rotating this side (A) it is day; when it moves to this side then it is night.



R: I have drawn what I understood from what you have said, According to you, when the earth is east side of the sun it is day and when it is moved to west it is night. Is it right?

S.T5: Correct sir.

R: What do you think? (Addressing class)

(Silence)

S.T6: Day and night happen due to its rotating by itself. Not sun. When it revolves around the sun it will take 365 days. Leap year means 366 days.

S.T2, S.T3: It will take a year to revolve the sun.

R: S.T5, What do you think?

S.T5: Yes.

R: Good. How does season occur?

S.T2: Due to earth revolution around the sun season occurs.

Chorus: Yes sir

R: Is it only due to revolution around the sun is reason for seasons?

Chorus: Yes sir

S.T7: No sir. Earth's 23 ½ degree tilted axis is the reason.

R: Ok. Can you explain?

S.T7: Sir earth rotates in 23 ½ degree tilted axis and at the same time revolves around the sun. So one part of the earth gets more light than another part.

R: Which part?

S.T7: Sir, if it's upper side (northern hemisphere) gets more light it will be summer season there. But the lower side that time winter season will prevail.

R: Is it?

S.T7: Yes sir

R: Others, What do you think?

S.T2: Yes sir

S.T8: In the book also it is written the same.

R: Yes. Due to earth rotation with 23 ½ degree tilted axis, when it revolves around the sun its position changes at different point of time with respect sun rays. So some time sun rays fall straight to earth surfaces varies with 23 ½ degree Northern to 23 ½ degree Southern latitude. When sun rays fall straight in 23 ½ degree North, the day time in northern hemisphere more than the normal and experience summer. During that time the southern hemisphere experience winter. Ok.

S.T2, **S.T8 and S.T7:** Yes sir

S.T9: *I understand it, but at the same time I am not getting*

R: What is it you are not getting?

S.T9: I will read books and I will ask sir

R: Ok. We can see moon's one side only. Why?

S.T10: Because the moon for its own rotation and revolving around the earth takes same time. It is 27.5 days

R: Yes, it takes 27.3 days. When does solar and lunar eclipse happen?

S.T11: When Moon is placed between Sun and Earth in a straight line solar eclipse occurs.

R: Is it?

S.T11: Yes Sir

S.T12: Sir, on that day it needs to be New Moon Day

R: Yes. Ok. What about the lunar eclipse?

S.T13: It is when Earth is placed between Sun and Moon in a straight line and full moon day, lunar eclipse occurs.

R: Good. I think we could understand all these.

S.T7: Certain extent sir.

R: That's right. Once again go through the textbook and ask if you have any further difficulties.

But during a whole class discussion most of these misconception was not observed. During the whole class discussion student teacher accepted the fact that the season occurs due to earth revolves around the sun with its 23 ½ degree tilted axis. However, most of them could not comprehend the idea due to its complexity of visualization. This was expressed by some of them which can be seen in the whole class discussion. The

researcher's interaction with student teachers during group work as well as a whole class discussion along with a synoptic view of group work is given in **appendix A7.**

Concept Maps:

As the theme emerged accidently the researcher could not have the concept map on this topic. However, the student teacher concept maps on earth included these concepts into it. For the present theme the pre and post concept maps of the same is used. While comparing pre and post concept maps of student teachers it is observed that there was a considerable change in their understanding of the concept earth (including concepts of this theme).

In pre-concept maps individual student teachers generally depicted one or many of the following concepts: earth, solar system, biosphere, hydrosphere, atmosphere, components of the biosphere, various seasons, soil, soil formation, earth rotation on its axis and revolution around the sun, the moon revolution around the earth and the water cycle. However, student teachers concept maps lacked linkages between concepts. They tried to bring as many concepts but fail to connect related concepts in a logical manner.

In post-concept maps student teachers generally depicted few of the following concepts: Imaginary lines, latitude and longitude, earth rotation on its axis and revolution around sun, seasons, biosphere (lithosphere, hydrosphere and atmosphere), biotic and abiotic factors, minerals, moon rotation on its axis and revolution, eclipses, solar system, layers of earth, full moon and new moon days, sources (fossil fuels and others), disasters, stars, renewable and non-renewable sources and water cycle. In the post concept maps the linkages between concepts are clear than the pre-concept maps. However, all the concepts were not logically connected.

Self and Peer Assessment

All the nine groups were submitted the rubric of self and peer assessment. Most of the student teachers from various groups rated their peers as good or excellent or fair against different aspects indicated in the rubrics. Few student teachers rated their peers as poor, fair, good and excellent. However, within the group there is no internal consistency on low rating of any particular member. In one of the group all the members rated 0 (1 – poor) for one of the member. This was observed in all the earlier problem too. The student teacher made use of rubric for self-assessment. Generally student teacher rated

themselves as equal to others. However, in one case the student teacher rated very low (poor).

Analysis:

In this theme, the replacing of new concept with the old concept (misconception) did occur during researcher interaction with student teachers. The student teachers' interactions show the impact of lack of conceptual understanding of a particular concept on meaning making of other related concepts. It is also observed that the student teachers' cognitive structure of concepts related to imaginary lines is widened. This can be observed from researcher interaction with the student teachers and the student teachers' pre and post concept maps. The student teacher interaction in groups, resources helped them to widen the conceptual understanding.

Major observations:

During the group work the researcher visited the group and interacted with the group members. At occasions, the researcher observed some of the misconceptions / novice conceptions. Sometime the researcher addressed those misconceptions with the group interaction itself and at later stage during whole class discussion these were taken up to address if any other student teachers had similar misconceptions. However, the misconception which is observed during discussion when already recorded in the group journal by the student teachers. But they kept the group journal without corrections.

5.1.2 To study learners changing perspectives (conception) about environmental concepts in the constructivist classroom.

In the subsection, 5.1.1 (b) data regarding learners changing perspective about environmental concepts has been analyzed and presented. The data were collected by employing various methods and sources such as cooperative learning, problem based learning, enquiry learning and field visit **(Appendix: B).** The theme-wise analysis of the learners' data is presented below.

5.1.2.1 Theme: Soil

Teacher: I[st] Year Student Teachers

Participants: Learners of Grade IV in 3 different schools

***Approach / Method*:** Inquiry Learning, cooperative learning

***Theme Context*:**

The student teachers were trying to engage on a constructivist based classroom practices during their practice teaching program. During practice teaching four student teachers from three different schools were engaged in four activities on the concept soil through constructivist approach. The activities were:

(i) What is there in (top) soil? – This was done through children observation of top soil,

(ii) what comprises the top soil? – Bottle experiment

(iii) Water holding capacity of different types of soils

(iv) Between soil and water, which one absorbs and releases heat quickly?

Student teachers had carried out all these activities with Grade IV learners. The four activities were carried out in different schools. The fourth activity was carried out in three different schools. In total, 4 student teachers from 4 schools engaged in engaging learners of grade IV in soil related activities in a constructivist environment.

Activity 1: What is there in (top) soil? – Observation of top soil

Approach / Method: Inquiry

School: Panchayat Union Elementary School, Mel Achamangalam

Teacher: I[st] Year Student Teacher **(S.T)**

Participants: Grade IV learners

Context:

In this activity, the student teacher wanted to know the **learners'** idea (conception) on top soil.

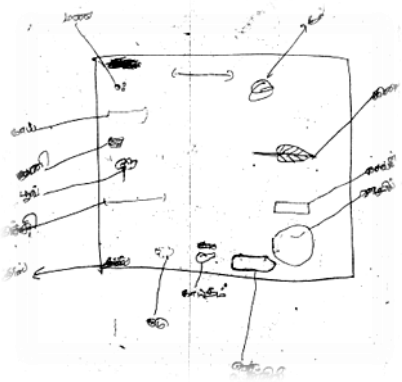
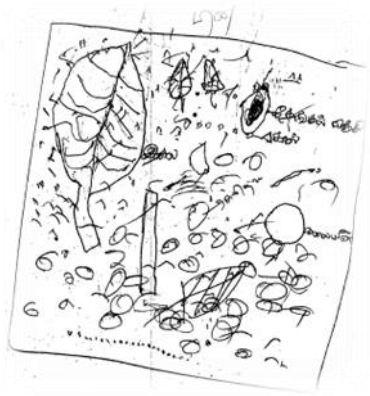
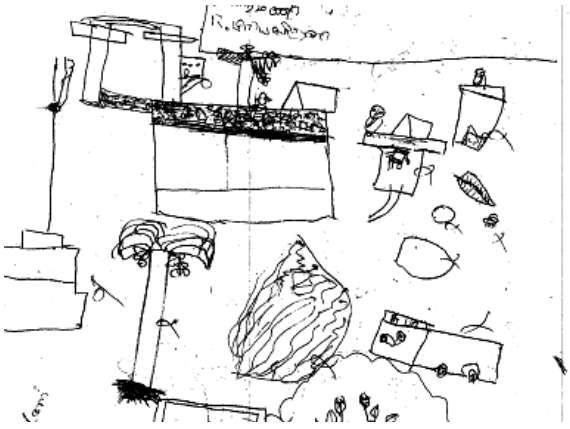
Description of Classroom process:

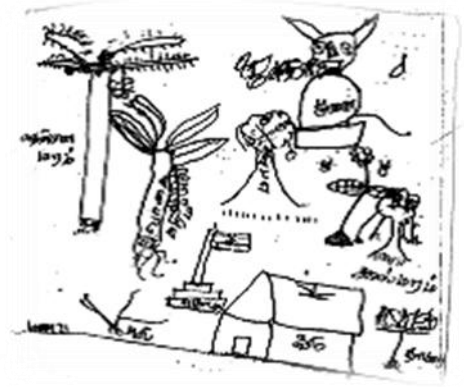
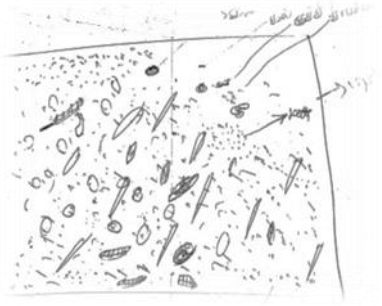
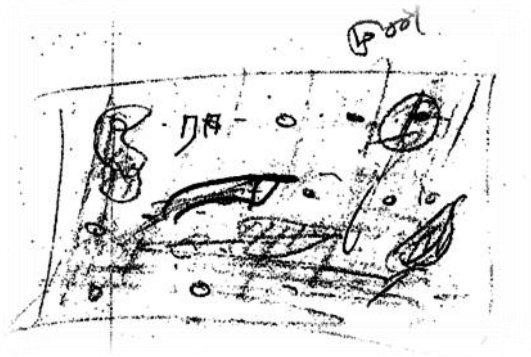
The student teacher asked each group of learners to make the drawing of (top) soil (Figure 5.4) and indicate what may be present in it. The student teacher interacted with each learner group on their conception about top soil before they go for observation. Then student teacher asked the learner groups to observe the soil from outside the classroom where she marked in a particular area. After the observation she asked each

group to make the drawings of what they observed in the soil. She once again interacted with each learner group to know their observations. Learner group's drawings of top soil before and after the observation is presented below.

Figure 5.4: The photograph shows learners group engagesd with top soil observation in Mel Achamangalam

Table 5.2: Learner group's drawings on top soil before and after observation

Group	Before observation	After observation
A		
B		
C		

Group	Before observation	After observation
D		
E		

The learner groups 'drawings indicate that their initial conception of soil is of soil, stones, plants, trees, dusts, birds, house etc. The examples show their conceptions based on their experience of general observations. When they were asked to observe in a given area, they could observe other things or things which they did not think of (but they know) and the post observation drawings show new things such as small roots, sticks, dry leaves, bangles, paper pieces, fly, ant, etc. The pre-observation drawings show that there are variations among the group's conception about soil. There are indications that the learners understood the question that what are there on and above the soil "We thought whatever there on the soil like …. Plants, trees". The student teacher interaction with learners is given below.

Whole class discussion

S.T: What you have thought the things there in the soil, and what you have observed in the soil, are the same?

L1: Some are same and some are new

L2: We could think of thought whatever is there on the ground like

S.T: mm… means…

L2: Plants, trees, house like that

S.T: Ok… *Is there anything which you did not think, but was present in the soil?*

L2: mm

S.T: What is that?

L3: *Fly*

L4: *Ant*

S.T: You did not know these were there in the soil?

L2: No miss. *We know it is there, but we did not think it would be there in the soil.*

S.T: Ok.

S.T: What are the other things you did not think present in the soil, but, you observed it?

L5: Small roots

S.T: mm…

L6: Small sticks, stones

L7: Dry leaves

S.T: Ok.

The whole exercise indicates that developing observation skill among learners (through various activities) helped them widening their understanding of the concept soil. The student teacher interaction with learners during group work as well as a whole class discussion along with a synoptic view of group work is given in **appendix B.**

Activity 2: What comprises the top soil? – Bottle experiment

Approach / Method: Inquiry learning

School: Panchayat Union Elementary School, Mel Achamangalam

Teacher: Ist Year Student Teacher **(S.T)**

Participants: Grade IV learners

Context:

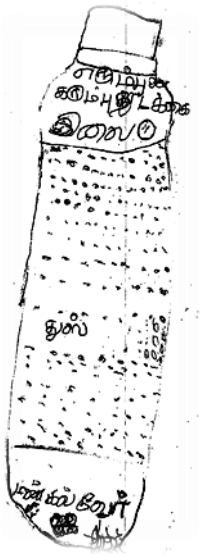
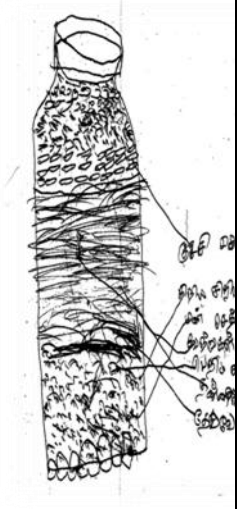
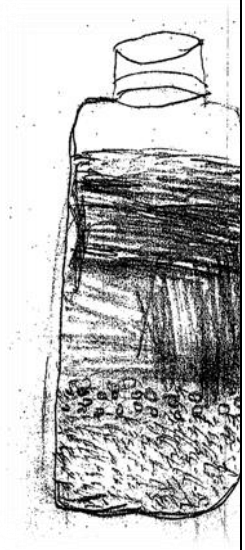
After completing "what is there in the soil?" The student teacher continued with another activity to make more clarity on "what comprises the top soil?" through the bottle experiment in the following week.

Description of Classroom process:

In this activity the student teacher asked learners "what could they see, when some soil is added into a bottle containing water, and shakes it and keep it for a while?". The group wise learners' responses were recorded. Then the student teacher took some top soil and added it to the bottle which contains water. The student teacher then shook the bottle well, so that the soil mixes with water well. She kept the bottle on a window. This was done during the last period of the morning session. After the lunch break, the learners observed the contents of bottle in groups (Figure 5.5). Each group was given around 5 minutes to observe and asked to make their notes after their observation. The student teacher assisted the groups in their observation. The learner groups made the drawings of their observation.

Figure 5.5: Learners of Grade IV observe the matters by using a magnifying glass at Mel Achamangalam

Table 5.3: The student groups' drawings are presented below.

Group A	Group B	Group C	Group E
			

Before the activity for the question, what would they see if a handful of soil is put it in a bottle of water? The learner groups' responses were: stone, paper, bangle, flower, bricks, soil, dust, small leaves, sand, eggshell, sticks, charcoal, ash, hair etc. After the activity the learner groups' responses were: small stones, soil, root like thing, dirt, leave waste, clay etc. This variation is due to the learner's idea before observation based on the previous activity and by engaging this activity they could able to get an idea of smaller things which generally they do not tend to see. During this activity student teacher made the learner realize that partially decomposed leaves (humus) and many things in the different weight presence in the soil through discussion. However, developing idea of student view on layers observed in the bottle was not enquired before the activity. The student teacher could have raised a question that, "Is there any possibility of different layers formed when soil is put in of a bottle and shacked well?" before the activity. The stage of making a student hypothesis by the learners was missed. The student teacher interaction with learners during group work as well as whole class discussion along with synoptic view of group work is given in **appendix B1**

Activity 3: Soil – water holding capacity

Approach / Method: Inquiry

School: Panchayat Union Elementary School, Madavalam

Teacher: Ist Year Student Teacher **(S.T)**

Participants: Grade IV learners

Context:

The comparison of water holding capacity of three soils was done through the activity in the teacher education classroom while student teacher groups were engaged in soil related problem (Figures 5.6 and 5.7) . As the activity was prescribed in the textbook of Grade IV, the student teacher had chosen this activity.

Description of Classroom process:

The student teacher planned to engage the learner groups in an inquiry mode. The student teacher requested the learners to bring a different type of soil in an earlier class. As the learners failed to bring the soil, the student teacher collected the soil from behind the school (appeared red), under the tree (appeared like garden soil) and from the playground soil (appeared sandy). These three sample soils were kept on the teacher' table along with other things needed for an activity for learners observation.

The student teacher engaged the learner groups for this activity in five stages.

- Student teacher engaged the learner-groups to observe the soils and identify them with colour and make their hypothesis on soil's water holding capacity
- Learner groups were engaged in group discussion to plan and devise a method to identify soil's water absorbing capacity and rate of absorbing
- Whole class discussion on planning the activity (consolidation)
- Conducting the activity in demonstration mode
- Final observation and discussions

Figure 5.6: The student teacher was listening to the learner's observation about the nature of the soil in the class (Grade IV) at Madavalam

Figure 5.7: Water holding capacity of different soil-after the activity in Grade IV at Madavalam

In the first two stages the student teacher called each learner group to the teacher's table and interacted with them. The interaction is presented in a tabular form below. During these stages different soils were kept in the disposable transparent cup on the table.The transparent polythene cups, coconut shells, cloth pieces were also kept on the table **5.4** during the individual group's visit for observation.

Table 5.4: Activity on the theme of soil by various groups

Criteria	**Groups →**	**A**	**B**	**C**	**D**	**E**
Soil Colour (Stage 1)	Soil 1 Soil 2 Soil 3	Reddish Beach Coconut cover	Red White - Black Jiguna - White	Red Light white White	Red Black White	Red White White
Soil Nature (Stage 1)	Soil 1 Soil 2 Soil 3	Nice Nice Nice	Little nice Little rough Rough	Nice Stony Stony	Stony Stony Nice	Nice Little stony More stony
Soil Name (Stage 1)	Soil 1 Soil 2 Soil 3	Red soil		Red soil	Red	Red
Water absorbing capacity (order) (Stage 1)	Soil 1 Soil 2 Soil 3	Third Second First	Third (Third) * First (First)* Second (Second)*	Second (First)* First (Third)* Third (Second)*	First Third Second (First)	First (Third) Third (Second) Second (First)
Planning to find Water holding capacity (Stage 2)		Planning was done after the discussion with the student teacher	Could not plan	Could not plan even after the discussion with student teacher	Could not plan	Planning was done after the discussion with the student teacher

Most of the learner groups' could not plan the activity after the group's discussion and so the student teacher organised whole class discussion to plan the activity. The groups could plan the activity during the student teacher interaction, actively participated in whole class discussion to devise the plan. The whole class discussion for planning the activity is given below.

Whole Class Discussion

S.T: Ok, Group B, are you ready with the plan?

(No response)

S.T: L6, can you say something about what your group discussed.

(No response)

S.T: Ok, what about Group C

L1: We will take soil in the coconut shell, I pour water into it, the excess water will go through the hole and we will collect it with glass and say which one absorbs more water.

L2: We have to place pieces of cloth coconut shell and we should put soil in it

S.T: Oh Yes. I forgot to say that

S.T: *Will you take equal amount or different amount of soil to identify which one absorbs more water?*

S.T: Different amount

L2: Then, how will you find which soil absorbs more water?

(No response)

S.T: Listen everyone, to find out which soil absorbs more water, do we have to take an equal amount of soil and equal amount of water or not? What do you think?

L2: If we are not taking an equal amount of each of the soil and equal amount of water, how can we find out which particular soil absorbs more water?

L2: Yes.

S.T: L1, what do you think? Other groups, what do you think?

L4: *(from Group) we also initially thought different amounts because they are different soil, but later during discussion we understood that it should be the same amount.*

S.T: Yes it should be the same amount.

S.T: Is the size of holes in the coconut cover are to be same or not?

L5: Same only, I observed when you were making holes with compass and nail, and threw away those coconut shells which has bigger hole.

S.T: Ok, it also needs to be same in size. So who will consolidate on what we are going to do?

L2: Sir, first we have to take three glasses and keep the coconut shell on each of it. Then placing pieces of cloth on each cover. Then we have to take the same amount of these three samples of soils and put it in different coconut shells. After that, we take equal amount of water and pour it on each of the soil. After some time, the excess water will drain out through the holes and we can see from which soil less water drains out.

S.T: Good. Can we do this on the table with one set up, as we have only three coconut covers and few cups?

Chorus: Ok sir.

After the whole class discussion the student teacher conducted the activity with the help of learners. After the activity it was found that the water holding capacity of different soils was almost same. It is because the soils were taken around the school premises. The student teacher realised that the soil was taken in and around the school from different locations. So the student teacher informed the learners that, this problem could have been avoided if the soils were taken from different places where soil is of varied nature. The student teacher interaction with learners during group work as well as a whole class discussion along with a synoptic view of group work is given in **appendix B2**

Activity 4: Which one absorbs/ releases heat first: soil / water?

Approach / Method:Inquiry learning /cooperative group learning / whole class discussion

School: (1) Panchayat Union Elementary School, Mel Achamangalam

(2) Panchayat Union Middle School, Kalaroor

(3) Panchayat Union Middle School, Kurumbar Colony

Teacher: Ist Year Student Teachers **(S.T)**

Participants: Grade IV learners

Context:

This activity was prescribed in the textbook of Grade IV. In continuation with the other soil related activities, student teachers were interested in engaging this activity with their learners.

Description of Classroom process:

Even though the activity is same but all the three student teacher adopted different strategy to engage their class **learners** in the activity. The student teacher at Mel Achamangalam engaged whole class discussion with group (Figure 5.8) wise activity, whereas, student teacher from Kalaroor engaged group wise activity and discussion after explaining the process of conducting the activity. In Kurumbar Colony the student teacher explained about how the activity to be carried out and demonstrated it. After the demonstration the student teacher tried to know the reasons from the learners.

Figure 5.8: The photograph shows an activity of "Which one first absorbs heat: Water or Soil?"Learners of Grade-IV engagement at Mel Achamangalam

Mel Achamangalam:

In Mel Achamangalam the student teacher engaged the whole class discussion to plan the activity and the activity done by learners, followed by the whole class discussion to consolidate the ideas. When the student teacher asked learners in the whole class discussion "among soil and water which one absorbs heat first?", Some learners responded as soil and some other as water. Student teacher gave some clues to plan the activity in terms of the amount of soil and water. The student teacher engaged the learners in conducting the activity. Then learners accepted that soil absorbs heat first after conducting the activity. When the student teacher asked the **learners** to provide the reasons, the learners' response was *"soil gets heat first, because it gets heated and stays there and water gets evaporated and goes higher".* Later, the student teacher asked the learners "among soil and water which one loses / releases heat first?", all the learners responded by saying water. The student teacher continued the discussion once again to plan an activity to examine which one releases heat first and engaged the learners in the activity. After the activity the learners accepted that soil releases heat first. The learners could not give the reasons for it. It is because the learners as whole, initially thought water will lose heat first. The result surprised them all.

Kalaroor:

In Kalaroor, the student teacher explained the process of conducting activities and engaged learner in conducting activity group-wise. After keeping the soil and water in the sunlight the student teacher interacted with individual learner groups to know the learners view about which one absorb and release heat first with the reasons. The learners had an understanding that soil gets heat first because it is generally there in the outside. The activity also strengthened their understanding of soil gets hot first. However, the second part of the activity except one group of learners, most of the groups arrived at wrong conclusion and stated water gets cool first. This is due to the student teacher did not visualise the need for keeping both soil and water outside to get warm. While conducting the activity learners brought back the soil and water plates when soil gets warm. As the water did not get warm in the first part of the activity, learners could not able to identify whether soil / water gets cool first. The student teacher engaged with interacting learner groups, failed to instruct / see whether water gets warm in the first part of the activity.

Kurumbar Colony:

In Kurumbar Colony the student teacher explained about how the activity to be carried out and demonstrated it. After the demonstration the student teacher tried to know the reasons from the learners. The student teacher asked the learner to provide reasons for why soil is getting hot before the water when kept in sunlight? Learner groups' responses were "sunlight like a fire which makes soil to get hot" first than water, "water is previously cool", "some soil from bottom moves to top and soil gets hot", "due to its cool nature water does not get hot", "It (soil) quickly works, But water will do slowly".
For the student teacher's question on "why soil gets cool first?" The learner group responded that "*When air is blowing it loses its heat quickly. But water won't lose its heat quickly"*. Even though the activity focused on heat absorbing / releasing capacity of soil and waters, the main purpose of the activity was to bring the conceptual understanding on sea and land breeze.

In first two schools, learners had a misconception that water loses heat first. The activities conducted by learner groups gave clarity on the concept to the entire three situations. But lack of post group activity discussions and lack of organisation of activity by student teacher lead the 'content' less discussed and clarified. The student teacher interaction with learners during group work as well as a whole class discussion along with a synoptic view of group work is given in **appendix B3**

5.1.2.2 Theme: Water

Teacher: Ist Year Student Teachers

Participants: Learners of Grade I, II and Grade V in two different schools

Approach / Method: Inquiry Learning, cooperative learning, PBL

Theme Context:

Four students-teachers engaged with two different school learners on water related topics. The topics were:

(i) Water! Water!
(ii) Purification of muddy water
(iii) Rain Rain and
(iv) Improving the surrounding of the lily pond.

The first three themes were engaged in Kathirampatti school where as the last theme was held at Mel Achamangalam. The first two themes were engaged with Grade-I learners

separately by two student teachers. The third theme was engaged with Grade-II learners. The fourth theme was engaged with learners Grade -V level.

Topic 1: Water! Water!

Approach / Method: Whole class discussion

School: Panchayat Union Elementary School, Kathirampatti

Teacher: Ist Year Student Teachers **(S.T)**

Participants: Grade I learners

Context:

This topic was presented in pictorial form in the Grade I EVS textbook prescribed by the Government of Tamil Nadu. The student teacher engaged the topic in a whole class discussion mode to enable children of Class I engage dialogue with the student teacher and peers.

Description of Classroom process:

The problem was introduced by the student teacher to **learners** in the following manner:

S.T: Babies (Kuttis) you see the pictures in the book (Showing the pictures from the book). Here, the young sparrow felt thirsty and her mother has taken her to different water bodies. The younger one did not drink water from all these (showing pictures) places and drink water from this place only. Why is it so? You have to carefully observe each picture and say what could be the reason?

Initially the student teacher tried to get the learners to recognise different water bodies. The children were able to name most of the water bodies. They could not differentiate some (like well and pond or lake and river). Wherever the children find difficulty in identifying by name, the student teacher introduced the vocabularies of that particular water body.

Once it was over, the student teacher asked children to observe carefully in each picture and tell the reason for which the younger sparrow refused to drink water. With slight initial difficulty children could identify the reasons from the picture and responded. It is also observed that few children just repeat the same answer for each water body and few children include the reasons to a particular water body by their observation. While asking the reasons for why the younger sparrow has refused to drink at well, the children said by showing well (in less distance) angaaadu, madukaluvuranga (goats and cows were given bath there – Researcher observation). They also included what they thought as the water

bodies based on their experience. For example they included the water tanker and the tap as water bodies, from where they get water.

The student teacher's interactions with learners showing learner's imagination is presented below:

S.T: Is it so? From hand pump, how did young sparrow drink the water?

S6: That is, the mother sparrow pumps out water.

From the interaction we can observe that children could define what is good water based on their understanding. Children mixed their imagination, observation and textbook visual information to explain the reasons for why the younger sparrow did not drink water from various water resources. The belief system (existence of ghost) which they acquired from family, cultural background also played an important role in their imagination. They also interconnected the water and its importance within the existence of life.

Through their interaction among themselves along with the student teacher the children expressed themselves on their understanding on the need of clean water for life, and get to know the common ways in which water bodies get polluted. The literature also indicates that role and importance of Imagination in learning. Vygotsky stresses that imagination does not develop all at once, but very slowly and gradually. It evolves from more elementary and simpler forms into more complex ones. At each stage of development, it has its own expression; that is, each stage of childhood has its own characteristic form of creation. Furthermore, it does not occupy a separate place in human behaviour, but depends directly on the forms of human activity, especially the accrual of experience.The student teacher interaction with learners during whole class discussion is given in **appendix C**

***Topic / Activity 2*:** Water purification

***Approach / Method*:** Whole class discussion

School: Panchayat Union Elementary School, Kathirampatti

Teacher: Ist Year Student Teachers **(S.T)**

Participants: Grade I learners

Context:

In this activity the student teacher intended to make the learners to understand how water gets cleansed in a natural course.

Description of Classroom process:

The student teacher planned to keep the muddy water in a glass undisturbed for some time, so that the soil particle will go down and settle. Later the water above the soil could be separated and filtered to get clean water. To conduct this activity student teacher brought a bottle of muddy water and some transparent glasses to the class, and poured it into a glass and show to the **learners**. The student teacher intended to plan activities through whole class discussion. The student teacher initiated the discussion by asking the learner that, "How to purify this (muddy) water?"

The initial responses of the learners were to use a sieve to filter water. Sieve is used to filter many things, so student teacher asked for the situations where water like thing filtered through sieve. The learners gave examples of coffee filter. As the student teacher kept cloth pieces for the filtering, she filtered the muddy water through sieve. The water after filtering also had some fine soil in it. While student teacher pointing this, a student suggested the water to be thrown out and clean water is to be taken in the glass. In this context the student teacher suggested to keep the water idle for some time and the post discussion helped the learners to get the idea. The whole activity, the learners' suggestion and discussion show that they were trying to suggest the solution from their own experience (observation of filtering of coffee at home), though the learners' experience of their immediate environment (pond water), was not recalled by them. The student teacher interaction with learners during whole class discussion is given in **appendix C1.**

Topic / Activity 3:"Rain! Rain!"
Approach / Method: Whole class discussion
School: Panchayat Union Elementary School, Kathirampatti
Teacher: Ist First Year Student Teachers **(S.T)**
Participants: Grade II learners

Context:

The student teacher engaged the learner with the topic "Rain! Rain!", from Grade II EVS textbook prescribed by the Government of Tamil Nadu. In textbook the topic is presented by explaining the sources from which we get water for our requirements, followed by a small story "Visit to friends" where cloud visits to its friends (water sources) and asks about their well-being. The friends expressed their difficulty of various types of water pollution.

Description of Classroom process:

The student teacher began the lesson by reciting a poem (not from a textbook) on water. In the poem she invited the rain to help to increase soil fertility; survival of plants / crops and all other life forms. After reciting the poem student teacher initiated whole-class discussion on various water sources and its uses. She had drawn learners' attention on the way in which various water sources were getting polluted by the way we use it. Learners responded to these questions based on their experience and by observing visual contents of the textbook. During the whole-class discussion their responses showed their misconception on equating water sources and the locations water is stored and on the mode we get; their conception of sea pollution was mixed with imagination and what they heard. The learner's imagination on sea pollution is given below.

S.T: Ok. *How sea water gets polluted?*

S3: Ship is going (By movement of ships)

S.T: mm

S5: In that they go and take a bath.

S.T: mm. They get bath in sea!!!, then,

S5&S3: They are fishing it & washing it, there only

S.T: What do they wash there?

S5: Fish

S.T: mm, then, what they do?

S5: *We have to put a net for catching fish.*

S7: Hey, we said it before

S5: *The dirt on the net goes with it (the sea)*

S.T: Is it?

S5: mm miss

The whole class discussion indicates the children of Grade II have an understanding of various water sources and used by human for various purposes. They could also recognise the water pollution related problems and its effects. Student teacher could engage the discussion on their misconception of water sources and the location where water is stored and the mode in which water is collected. Their conception of the sea and sea pollution is a mixture of what they learned from their teacher and their imagination and the understanding of water pollution they acquired in earlier classes. They could see water pollution leading to extinction of life forms in the sea. However they think pollution can harm only smaller life forms in the sea. The student teacher interaction with learners during whole class discussion is given in **appendix C2.**

Topic 4: Improving the surrounding of the lily pond

Approach / Method: PBL

School: Panchayat Union Elementary School, Mel Achamangalam

Teacher: First Year Student Teachers **(S.T)**

Participants: Grade V learners

Context:

Before presenting the problem the learners were taken for a visit to observe the Lilly pond (AlliKulam) and its surroundings. It was felt by the student- teacher and the researcher that once learners are made aware of the situation of that place, they would be able to visualise the solution to the problem more contextually. After observing the lily pond the student teacher interacted with each group to know what they observed. Later the learner groups were asked to make a drawing of lily pond based on their observations (Figures 5.9 and 5.10). It was to make the learner recall what they observed and put their observation together, so that a collective visualisation of the situation be made as a basis. Through the student teacher's interaction with learner groups the following aspects emerged.

- Things Observed inside the pond and around the pond by each group
- General perception of each group about the environment around the pond

Figure 5.9: Learners (Grade V) are taking a look at the lilly pond during the field visit at Mel Achamangalam

Figure 5.10: Learners (Grade V) groups are making a sketch on lilly pond at Mel Achamangalam

PBL problem:

You made a visit to observe the lily pond in Keel Achamangalam. The waste water of the village is connected to the lily pond, so it has become a Store of drains (almost anything, including trees, cattle, etc.). Think that your group is asked to improve the prevailing condition of the pond. You will be given Rs. 50,000 to accomplish the task. How will your group use that money to improve the condition?

Description of Classroom process:

The PBL problem is introduced in the classroom by providing photocopies of problem for all the groups. From few groups learners were asked to read the problem aloud and the student teacher asked if any group has difficulty in comprehending the problem it can be addressed.

After this, the learner groups were asked to make their drawing on how the lily pond looks like after making it clean and improving it. The groups were allowed to work in for an hour. After an hour the student teacher interacted with each group about their group work.

Group Work:

The learners mixed the things they observed along with their imagination. For example, even though the learner groups did not see a fish or a snake in the pond, they mentioned that they were present. The researcher's informal interaction with the learners shown that, they viewed the larva of a frog as fish. Somehow on this aspect the student teacher did not enquire with them. During the initial interaction with the student teachers the researcher had an idea that the lotus present in the pond (generally referred by lotus pond), but while visiting the pond the researcher and student teachers came to know that it is not a lotus pond, instead it is lily pond. But throughout the work, both lotus and lily ponds were interchangeably used by the learner.

One of the group work (Group A - drawings) is presented in figures 5.11 and 5.12.

Things observed during the visit

Lilly flower, sewage water, fishes, frogs, herbs, creeper, snakes, passi (algae), bamboo basket

Figure 5.11: After (field visit) observing the pond

General Perception on environment around the pond

Mixing of sewage water and dumping of wastes in around pond lead to pollution. These are the sources of diseases like skin diseases, malaria and other general illness.

Figure 5.12: Learners' Visualisation of pond after cleaning

Student teacher interaction with learner groups:

The student teacher interacted with the learner groups' during the group work in progress. Some group had a view that, the trees grown around the pond will provide better air for the local people ("It will give good air to breathe madam"), keeping fishes in the pond one can't drink water from it ("We can't make it for drinking purposes, because, we leave fishes in the water"). The other group vowed that making a park and planting flower plant could be a good idea. There are misconceptions observed during the student teacher interaction with the learner groups. They were *"Keep quiet. Why do we need frog?" To keep the pond clean, "It (algae) won't have life".* The student teacher tried to address these misconceptions through questioning their thinking. Learners misconception of algae doesn't have life related interaction is presented below.

S.T: Ok. Why do you want to put fish into the pond?

S2: To eat pasai (algae)

S.T: Why?

S3: Otherwise passi will grow and spread into whole pond.

S.T: Is it?

Chorus: Yes

S.T: Does passi have life?

S2: No miss, *It (algae) won't have life*.

S.T: mm

S2: *No miss, it won't have life. Miss, herb, human and living things have life but those don't have a life like algae (Passi) etc...*

S.T: *Ok Dear. Then, why is it grown?*

S2: *Miss…… (Starts thinking)*

S.T: Ok, we put wood in water, will it grow after some time.

S2: No miss. It won't.

S.T: Ok. If we take passi from pond and put it out for two three days in sunlight, what will happen?

S3: It gets dry.

S4: It dies miss

S.T: You all said that, it won't have a life

S2: *Madam, It won't grow. If it doesn't have life it won't grow.*

S.T: Ok, When you are seeing does algae grows or not?

S3: Grows miss.

S2: It won't grow miss.

S1&**S4**: It grows miss.

S.T: Ok. One thing we will do. Everyone has some pot in your home. Is it not?

Chorus: Ok miss

S.T: *We put some algae in it with some water and see it after a week and tell me whether it grows or not.*

While observing all the group works it was observed that all the groups felt waste water collection in the pond to be stopped. Group A viewed that the pond can be recharged with rain water regularly. Whereas the other groups had a view that the drainage connection completely removed from pond and water may be poured or pumped into the pond. All the groups viewed that the dumping wastes around the pond to be stopped, group D viewed that waste tank may be kept near the pond and need to be cleaned regularly. All the groups had a view that around the pond flower plants to be planted, group A viewed those trees to be planted around the pond. Almost all the groups viewed that the ecosystem in the post cleaning of the pond consists of fish and lily plants. There is a clear evidence of lack of understanding of ecosystem and more of human centric view was observed. One of the learner groups explicitly expressed that keeping pond pollution free by removing frog, snakes and other living creatures from the ecosystem. The student teacher raised questions about this which made the learner to think. However, the student teacher did not carry forward this discussion with the learner group. The student teacher interaction with learners during the group work and whole class discussion is given in **appendix C3.**

5.1.2.3 Theme: Ecosystem

***Teacher*:** Ist Year Student Teachers

***Participants*:** Learners of Grade III, IV, V and VI in four different schools

***Approach / Method*:** Inquiry Learning, cooperative learning, field visits

Theme Context:

The topics engaged under this theme were:

(i) Ecosystem

(ii) Bird house

(iii) Usefulness of animals

(iv) Living and nonliving things (biotic and abiotic; do plant has life)

(v) Difference between trees, plants and creepers

(vi) Do the leaves perspire?

(vii) Seed germination and

(viii) Seed dispersal.

Ten student teachers engaged the learners of various Grades from four different schools undertaken in these activities. Some of the themes were undertaken by topics engaged in more than one student teacher in different schools.

Topic / Activity 1: Ecosystem

***Approach / Method*:** Cooperative Learning, Whole class discussion

School: Panchayat Union Elementary School, Kathirampatti

Teacher: Ist Student Teachers **(S.T)**

Participants: Grade V learners

Context:

The student teachers took Grade IIIrd and Vth learners (on the themes (i) and (v)) for a field visit to the neighbouring area, to observe their immediate environment. The learners were asked to note down whatever they observe in their immediate environment for a later discussion. The visit was organised during lunch break after the learners took their lunch. The student teachers took necessary permission from the Head Master for the first and second period of the post lunch-break for this purpose. The Grade V learners were asked to observe their ecosystem by the student teacher and the Grade III learners were asked to observe more on various plants and their nature. During their visit learners used magnifying glasses to observe very small things.

Figure 5.13: Learners field visit at Kathirampatti

At the end of the visit Grade V learners (Figure 5.13) were asked to write/ draw what they have observed during their visit. The post visit work took almost 40 minutes by the learners. The student teacher interacted with the student groups during the group work. After that student teacher collected learner works. The class decided to discuss what they observed on their ecosystem in the next class (next day). The field visit and consolidating what they observed during field visit took the 2nd half of the school day. The student teachers interacted with their respective learners in whole class discussion in the following 4th period.

Description of Classroom process:

During the whole class discussion the student teacher tried to bring to everybody's notice various kinds of living things in their environment from their observations. The discussion focused on the location(s) in which the living things were observed (lives), their nest and the way it was made (for ex. Formicary, Spider net), the method in which they get their food (prey), their predator and other habitats.

During this interaction the student teacher clarified learner's misconceptions such as

"Spider eats leaves",

"Mosquito feeds water",

"All mosquitoes suck blood",

"Earthworm eats fertilizers",

"Earthworms eat other small worms in the soil",

"Butterfly gives silk"

"Snakes remove its skin in every 2-3 days"

"Python has bones in their stomach to break the prey"

"After swallowing human, it (python) winds on to a tree teacher, and then it breaks the bones of its food"

"Python does not remove its skin"

Learners differed in their view on acceptable conceptions like

"*Spiders eat mosquitoes, housefly",*

"Earthworms eat plastic paper" and etc.

The learners were also curious to know the reasons when they came to know new information. For example while student teacher made clarification on "all mosquitoes suck blood", she said only female mosquitos' suck blood. This was new information to the learners and they wish to know the reasons for that. When the student teacher asked them to think about that and provide reasons, they responded that they do not know. The student teacher directed the learners to find the answer from other sources at first, if not the next day, she will respond to the query. The next day the learners approached the teacher to know the reason and the student teacher explained the need of blood for making mosquito eggs (this was not recorded by the researcher as on the next day the researcher visited some other school, but came to know from informal interaction with the student teacher). The student teacher interaction with the learners on mosquito is given below.

S.T: Then, you were writing about mosquito

S2: Mosquito is in drainage ditch, if it bites us, Chikenguniya will affect.

S.T: How mosquito breeds?

S2: On water.

S.T: Does it breed in water?

S2: In drainages.

S.T: Does it directly come as a mosquito or does it transforms?

S2: On water it lays eggs;

S.T: Does it lay eggs. mm?

S2: Those eggs after laid and become mosquito; and night times it bites.

S.T: mm

S2: If we keep mosquito coil we can kill them

S.T: What are their foods?

S2: Blood

S.T: It will come and take blood from us. What else it does?

S3: Mosquito drink water.

S.T: Does mosquito drink water?

S3: Yes

S2: No

S.T: Others, Does mosquito drink water?

(No response)

S.T: For drinking water does it go to plant?

S3: mhoom (No) towards plant side.

S4: On plants, flowers are there, so it goes.

S.T: Then, in flower what may be there?

S4: Honey

S.T: Honey, so mosquito goes and sucks honey.

S4: mm teacher.

S.T: Is it honey? Or a kind of sweet water?

S4: It is a kind of sweet water.

S.T: Yes mosquitoes feed that (nectar). It also takes plant juices. But they don't drink water.

S3: Is it teacher!!

S.T: Yes. *Do all mosquito's sucks blood?*

Chorus: *Yes miss*

S.T: Do everyone agrees with this?

S1: *Miss, sometime mosquitoes on our land do not bite us like the once at home.*

S.T: Is there any other view?

(No response)

S.T: *Yes. It is true. Generally male mosquitoes' do not bite human or any animals. Only female mosquitoes' bite animals and sucks blood*.

S2: Why Madam?

S.T: What do you think? Why is it so?

S2&S3: We don't know madam

S.T: Try to find out from others, otherwise next class I will tell you.

When differed in their view on "earthworms eat plastic paper" the discussion lead to an understanding that earthworms don't eat plastic paper, and how plastic pollutes the land. The learners suggested that we should avoid using plastic bags, instead using Manchalpai ("Yellow colour bags" – generally people get while purchasing clothes etc.) to be an environmental friendly. Learners also discussed on disposing of plastic wastes and the impact of burning plastics; they had a suggestion of reuse of plastics. The student teacher interaction with the learners on earthworm is given below.

S.T: Ok, You wrote that, you have seen worm, which worm have you seen?

Chorus: Earth worm

S.T: Earthworm, what did it eat?

S5&S4: It eats soil

S.T: What else it eats?

S3: *Fertilizer*

S.T: mm??!! *Does it (earth worm) eat fertilizer*?

S3: *Yes*

S1: *No miss. It will die*

Chorus: *Yes miss, it will die.*

S2: It will die miss.

S.T: What else do they eat?

S4: *The things in the soil, it will take small worms in the soil*

S.T: Is it? Earthworm eats small worms in the soil?

S1: *No miss. It eats soil, not worms*

S.T: *Yes. Earthworms won't eat other worms but it eats maggana ilia (humus) and other minute things*

S3&S4: It keeps the land clean.

S2: Plastic paper.

S3: Those are all it eats.

S.T: mm!! *Does it eat plastic paper?*

S2&S3: *Yes Miss*

S4: *No miss. Plastic, it cannot. Even big animals die after eating plastics. In Newspaper I have seen*

S.T: Ok. What do you think? (Looking at **S3&S4**)

S3: he he…..

S4: If we put a plastic cover in land earthworm will die.

S.T: What if we throw a plastic sheet on the ground?

S4: If we put it, when rain comes

S2: Water will stay (above), it won't be absorbed by plants

S5: For roots water won't go.

S.T: By putting plastic, the water won't go to the roots. Why?

Chorus: Plastic covers the root.

S.T: Speak one at a time.

S5: Above plastic cover water is there.

S.T: mm

S5: Due to that water won't go.

S.T: Ok. How does plastic go into the earth / soil?

S5: During ploughing?

S4: By carrying waste/manure (to put it on land)

S2: No teacher. We bring rice in plastic cover; later as a waste we dump that plastic cover in waste pit. i.e. due to air/wind it fly and go and fall on the land, when rain comes that water goes to earth and goes to roots, at that time this plastic cover obstructs the roots of the plant; so water won't go to the roots that plant becomes dry and die.

(All the learners want to say)

Chorus: We should not put wastes in sort. Due to that pollution happening.

S.T: One at time, not all at a time.

S3: We are also, when we for purchase, we should purchase things yellow (cotton) bag only, if we bring it in plastic cover it won't be good.

S.T: So, what can we do with plastic bags and other things which already we are using it?

Chorus: We should not throw it on the ground.

S3: We should keep all this in a cover.

S5: We should burn it.

S3: Yes burn it.

Chorus: Yes

S.T: *If we burn plastic, does air not get polluted?*

S3: Pollution…

S.T: Does air get polluted or not?

S1&**S4**: *mhoom(no)*

Chorus: *No. It gets polluted*

S.T: For that, what can we do?

S5: How can we eliminate using plastic? We should not insert that anywhere. Whenever we bring plastic (intending plastic cover) we have to keep it in a bucket. We should not put in the waste bin. After closing it, we should not put it on land, but whenever we need we can reuse that (using many times).

The learners had confusion about the moth and butterflies. In one way it is due to the fact that the name of both butterfly and moth are quite similar in Tamil. The butterfly is called as "pattampoochu" and moth called as "pattupoochu". The student teacher clarified the concept and explained the process in which silk is produced. After that, she raised a question to the learners as to why are the silk clothes purchased in marriages. The learners replied that silk sarees and silk dhotis are used in the marriages and we should avoid the practice of purchasing silk sarees' and silk dhotis' during marriages to avoid large scale killing of moth. The student teacher interaction with the learners on silk worm and other interaction can be seen in **appendix D.**

Learner's observations also include plants. Learners discussed about trees and herbal plants and their use in the day to day life. Seed dispersal was discussed with examples. Their discussion also included Thulasi, neem tree, papaya, coconut, sunflower, honey comb, locust, goat, monkey, crow, cock and fish. Learners also shared their experience on how monkey, and crow snatching food / things from children. They also shared how hen hatches its egg, and how young chicks fall prey to other birds and animals. At the end, the student teachers tried to bring the ecosystem concept by explaining the interdependence of living things. But it was also observed that the fear of particular living thing etc. was still an obstacle in bringing any behavioural changes towards a better ecosystem.

***Topic / Activity 2*:** Bird House

***Approach / Method*:** Cooperative Learning, Whole class discussion

School: Panchayat Union Elementary School, Kathirampatti

Teacher: Ist Student Teachers **(S.T)**

Participants: Grade III learners

Context:

During the practice teaching the student teacher and the researcher observed that in a school birds' nests were kept in a cupboard, where Teaching Learning Materials were kept. The student teacher expressed interest in creating learning situations around birds' nests.

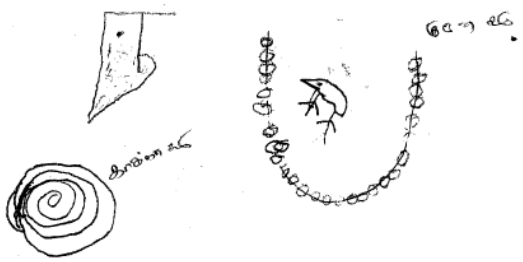
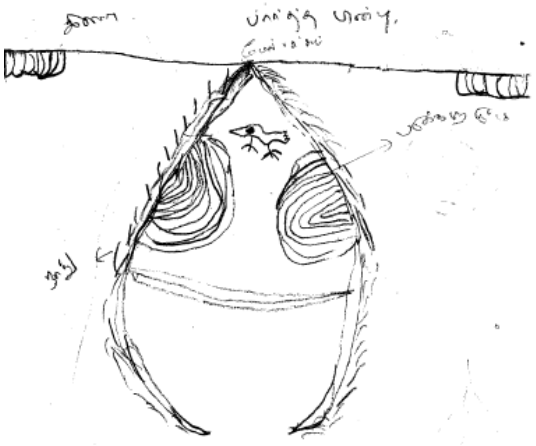
Description of Classroom process:

The student teachers initiated the conversation where the learners shared with various household animals / pets in their locality as well as on what they own or they rear. The common animals / pets were cow, dog, cat, sheep, and goat in their home. The uncommon animals were of parrot, rabbit etc. The discussion covered different types of plants and foods the animals eat. They also discussed about wild-animals, insects and other animals and their living place. The discussion moved to why learners go to the plot of land on mornings and evenings when they cultivate food crops. They responded that to drive away birds and animals that come to eat grains. Gradually the student teacher directed the learners focus towards where do the different birds stay and live. At the end the student teacher asked each group of learners to make the drawing of sparrows' nest how it may look like.

The learner groups were given some time to draw the diagram. At the end the student teacher taken out the nests from the cupboard and given nest (Figure 5.14) to each group separately and asked them to draw the nest after seeing it. The student group's drawings on sparrows nest are given in figures **5.15, 5.16, and 5.17.**

Figure 5.14: Bird nest examination by one of the learner groups

Figure 5.15: Group A drawing on sparrows nest

Before seeing	**After seeing**
(i) Sparrow and crow nests  (ii)Sparrow nests	

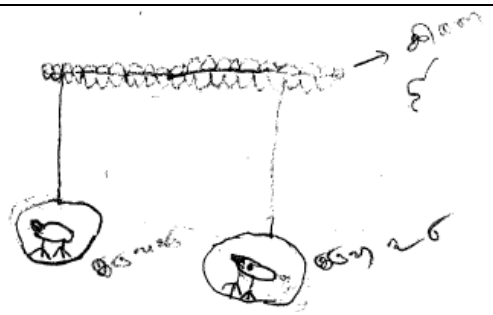


Figure 5.16: Group B drawing on sparrows nest

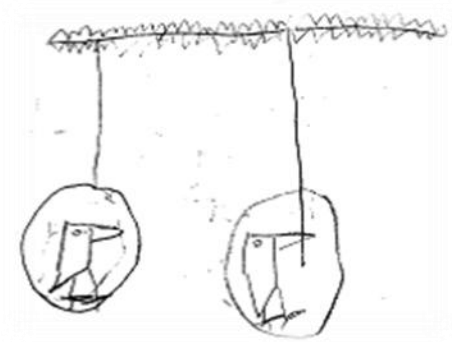
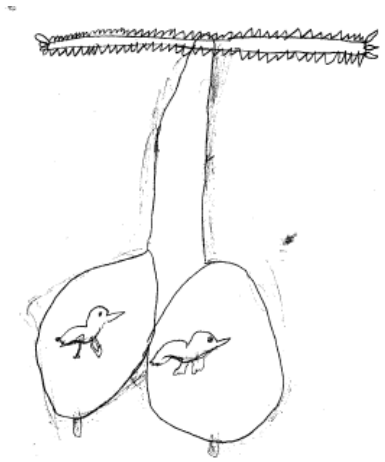
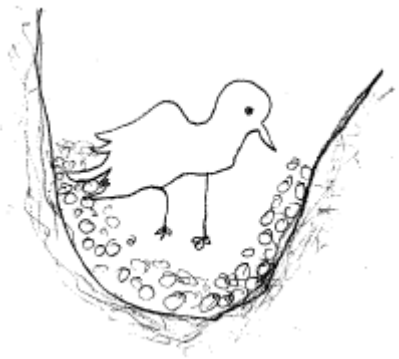
Before seeing	**After seeing**
(i) Sparrow nest 1  (ii)Sparrow nest 2 	

Figure 5.17: Group C drawing on sparrows nest

Before seeing	After seeing
(i) Sparrow nest 1  (ii)Sparrow nest 2 	Drawing 1  Drawing 2 

Later the student teacher interacted with the learners in a group and discussed whether any differences they observed. The student teacher asked how different birds make their nest and how cuckoos keep their eggs in crow nests for hatching. They also discussed about owl, bats and their nest and the way in which they catch their prey. The drawings made by each group on pre and post observation showed great difference. The student teacher interaction with learners during the group work and whole class discussion is given in **appendix D1**

Topic / Activity 3: Uses of Animals

***Approach / Method*:** Cooperative Learning

School: Panchayat Union Elementary School, Mel Achamangalam

Teacher: Ist year Student Teachers **(S.T)**

Participants: Grade IV learners

Context:

The student teacher was interested to know learners understanding about various animals, their use in human activities and their importance.

Description of Classroom process:

The student teacher made a table in worksheets indicating animals name, whether (a) gives milk, (b) helps in transport of groups, (c) give skin for human use, (d) used as meat, (e) provides bio fertilizer (through its waster matter), (f) used as medicine, (g) food habit, (h) lay eggs or give birth to young ones, (i) habitat, and (j) used for any games?. The student teacher distributed this worksheet to each learner group and asked them to discuss and fill the table. Learners group was engaged in one period for preparing the list. In the next period the student teacher interacted with each group. During the student teacher interaction with learner groups, the student teacher clarified some of the learners' misconceptions. Student teacher clarified when the group members disagreed with each other's idea and on certain occasion whole group had misconceptions. The misconceptions were

"Elephant eats small camel"

"Rabbit is a bird"

"Tiger eats plants"

"Crocodile gives birth to younger ones"

The student teacher interaction with the learners group on what does tiger eat?, is given below.

S.T: *What does tiger eat?*

L1: *Plants*

Chorus: *Plants*

S.T: *Which type of plant*?

L1: *Shrub (sedi)*

L2: *Shrub, creeper*

S.T: *What does lion eat?*

(No response)

S.T: What does a horse eat?

L3: Grass

S.T: Camel, What does it eat?

(No response)

L1: Camel?

S.T: Camel, What does it eat?

(No response)

S.T: Buffalo, what does it eat?

L4: Grass

S.T: Dog?

L1: Paper, Sooru?

Chorus: Sooru?

S.T: *Did you see tiger eating grass?*

L1: *All animals eat grass.*

S.T: Did you see?

L1 and L2: Cow, Ox, horse, buffalo, goat and all, we have seen.

L4: *No miss. The tiger will eat other animals?!*

S.T: How?

L4: *My father said.*

S.T: *Yes. Tiger won't eat grass. They eat animals. Similarly lions eat animals. But camels eat plants.*

Even though the student teacher clarified the student's misconception only at individual group level but the whole class discussion did not happen. The student teacher's complete interaction with learners during the group work is given in **appendix D2**

Topic / Activity 4: Living and Non-Living

Approach / Method: Cooperative Learning, whole class discussion

Schools:

(i) Panchayat Union Elementary School, Mel Achamangalam (Grade III learners)

(ii) Panchayat Union Middle School, Kalaroor (Grade VI learners)

(iii) Panchayat Union Elementary School, Madavalam (Grade V learners)

Teacher: First and Second Year Student Teachers **(S.T)**

Participants: Grade III, V and VII Learners

Context:

The content of difference between plants and animals was prescribed in the textbook of Grade III. In Grade VI the topic our environment begins with ecology where the topic begins with the difference between living and non- living things as a pre-requisite knowledge. Due to learners lack of understanding of pre-requisite knowledge the topic become a learning aspect. After observing the Grade VI classroom experiences, the researcher asked the student teacher to engage the topic with Grade V learners.

Description of Classroom process:

Mel Achamangalam:

Initially learner groups were asked to make a list of things around them. After that they were asked to classify the things based on the common characteristics. (The idea was to classify the things into living and non-living). After some initial discussion the learner groups were asked to classify them into living and non-living things. Through discussion the learner groups classified the things into living and non-living things. Once the groups classified, the student teacher interacted with each group and observed their work and clarified some of their misconceptions / queries through discussion.

During the student teacher interaction with learner groups, the student teacher clarified some of the learners' misconceptions and their queries. The queries raised by learners were:

"*Is the paper a living thing?"*

"Is Poosanikaisedi (herb) has a life?"

The misconceptions observed among learners were:

"Rat is non-living thing"

"Is cycle living?"

"Triangle is living"

"Soil is living thing"

"Ball is living thing, because it runs"

"Fish and bees are non-living things"

The learners' group conception of "Soil is living thing" expressed during interaction between student teacher and learners group is given below.

L1: *Soil is living thing, miss*

S.T: *Is soil is living?*

L1: Living thing miss

S.T: mm

L1: Living thing

S.T: Is it living?!

L1: Yes, miss. It is living.

S.T: *Is it living? How do you say that it is living?*

L1: *That is, when rain comes, water comes.*

S.T: *How, when rain comes, from soil water comes?!!*

L1: *It is not living.*

S.T: *Ok. How do you say it is non-living?*

L1: It does not have arm and a leg.

S.T: mm

L1: *It is not having arm and leg. Someone when walking, when they kept on their leg on it, it dies miss (merichasethuduthu miss), and because if it does not food it dies (athukkusappaduillathamisssaguthu miss). It becomes dry, miss, and so it is not living.*

S.T: *If some place, where no one walked before, then in that place does soil lives?*

L1: *mm...(thinking)… No miss. It is* not living.

S.T: *Yes. Soil is not a living thing.*

Even though the student teacher clarified the student's misconception at group level, it was not made known to the whole class. During this topic when student teacher was interacting with the one of the learners group the researcher was engaged in helping an injured child with first-aid related task. During the analysis the researcher while listening to the audio cassette came to know that the student teacher helped the learners in answering the questions. After asking questions, the student teacher gave the answer in a low voice the learners responded the same. This subtly indicates two possibilities, student teacher may feel that the time taken for content transaction is more than what it is supposed to be done, or student teacher believed that learners do not know the answer. The transcription of the related portion was not taken for analysis.

Kalaroor:

In VIth Std. Science textbook the topic our environment includes ecology (biotic, abiotic factors), different ecosystems, and the role of plants, animals and human in the

ecosystem. But the present discussion focused only on the first part i.e. ecology. The student teacher asked learner groups "*what do they understand the term environment?"*

The learner groups' responses were:

"Things around us",

"Trees, plants, sun, rain"

"Co-existence of biotic and abiotic components"

"Interrelationship between living and non-living things"

"A book"

"It is about physics, chemistry, zoology, botany all that comes i.e. living and non-living"

"Living things and surroundings"

The groups were asked to list down what are all they observed and observe in the environment. Through discussion (between student teacher and individual groups) the groups were engaged towards classifying their list into living and non-living things. All the learner groups had easily classified living and non-living things. One of the learners group had some misconceptions which led to the whole class discussion on what makes living and non-living things different? The student teacher interaction with the learners group is presented below.

S.T: What do you mean by living things?

S2: Stone, soil

S.T: Living thing (stress)!!?

S3: Hey, plants, animals, birds, water, robot (doubtful – slow voice)

S.T: Ok. *What are non-living things?*

S4: *Stone, soil, trees, plants.*

S.T: Is it so? What is the difference between living and non-living things?

S4: Living things sir, move from one place to another place.

Chorus: Non – living things are in the same place sir.

S.T: Ok, What else?

S4: Plants….. (Thinking)

S.T: Ok, Which are all non-living things?

S4: *Non – living things are plant, creepers, and trees*

S.T: *Hey, those are all living things, vengayathaleiya (abusing student – by saying one who having an onion kind head)*

S4: mm

S.T: Ok, what are all living things?

S4: *Living things…. (Thinking -avoiding answering)*

S.T: Ok, which are non-living things?

S3: Deer, goat, cow

(Researcher calls the student teacher and interacts with him personally and informs him that the need for patience and about potential of wrong responses to understand learners misconception. The next ten minutes were spent on planning to carry out the task in whole-class discussion)

During the whole class discussion many other concepts were discussed and some other misconceptions were clarified through discussion.

The Misconceptions clarified were:

"*Robot is a living thing"*

"Non – living things are plant, creepers, and trees"

"Living things can do reading and writing"

"Elephant, dog won't take (eat) grass"

"Tiger is ottunni (parasite)"

"Ottunni (parasite) is the one which eats the same thing"

"Bear doesn't eat grass"

The learners also raised the question to student teacher to clarify. The question was

"*What is sarunni (Saprophyte)"?*

A small part of student teacher interaction with learners during whole class discussion is given below.

S.T: Among living things, what difference do you see between plant and animal?

S5: Animals eat plants sir. But plants take water, air.

S.T: Do all animals eat plants?

S3&S5: No, sir.

S5: Even if it is hungry, tiger won't eat grass (poolipasithalumpullaisappidathu i.e. A tiger won't eat grass no matter how hungry it is – a proverb from Tamil)

S.T: Ok. Tiger won't take grass. What else won't take grass?

S5: Lion, elephant, dog

S2: Dog won't take grass, sir

S.T: mm…

S3: Elephant

S4&S5: Hey, it eats grass

S3: Does it eat grass?

S5: mm sir. The elephant will eat grass, sir.

S1: Goat eats grass sir.

Chorus: Tiger eats meat, sir

S.T: Human?

Chorus: Anaithunni (Omnivorous)

S.T: *Tiger?*

S1: *Ottunni (parasite) (in low voice)*

S.T: *What is Ottunni?!!*

S2: *If it depends on something else.*

S.T: *Depending means, on what it depends?*

(No response)

S.T: What is Ottunni?

S1: *The one which eats same one.*

S.T: What?!!

S1: *The one which eats the same thing.*

S.T: If it eats the same thing, then is it Ottunni?!!

S1: Yes sir

S.T: *Is it so?*

S3: I don't know

S5: *No sir, unnipoochi (Botfly) is aottunni sir.*

S.T: Ok. What is Ottunni (Parasite)?

(No response)

S.T: Is paen (head lice) is ottunni?

S5: Yes sir

S.T: Then, now you say, lice and unnipoochi are parasite. What do you mean by parasite?

S5: It stays in our body and it lives by taking our blood

S.T: What else?

(No response)

S.T: *Yes. Parasites are depending on their host. For example lice depend on us, unipoochi depends on dog, cow etc. Even in our stomach some small worms live and are parasites.*

The student teacher's complete interaction with learners during the group work is given in **appendix D3**

Madavalam:

The student teacher intended to discuss on living and non-living things and the difference between them. He engaged the class by raising questions and getting learners' responses. He neither facilitated learners' discussion for their understanding of concepts nor explained about it. The learner disagreed on the concept plant has life. "Is plant a living?" the answer is "No"

The student teacher also did not make any effort to explain to strengthen learner conception of plant food preparation.

L4: "Plants prepare food using that (water, sunlight, air)"

S.T: How?

L1: Don't Know

The student teacher's interaction with learners during the group work is given in **appendix D3**

Topic / Activity 5: Differences among Trees, Plants and Creeper

Approach / Method:Cooperative Learning, whole class discussion, Field visit

School: (i) Panchayat Union Elementary School, Kathirampatti

(ii) Panchayat Union Elementary School, Mel Achamangalam

(iii) Panchayat Union Elementary School, Madavalam

Teacher: **Ist** Year Student Teachers **(S.T)**

Participants: Grade III learners

Context:

This topic was presented in the Grade III Environment Science textbook prescribed by the Government of Tamil Nadu. Three student teachers engaged the topic in three different schools. The procedure for engaging the Grade III learners was varied in different schools.

Description of Classroom process:

Kathirampatti:

Two students-teachers took Grade III Learner along with the Grade 5 learners for a field visit to the neighbouring area to observe their immediate environment. The Grade IIIrd learners were asked to note down whatever plants and trees they observe in their immediate environment for later discussion. The visit was organised during lunch break

after the learners took their lunch. The student teacher took permission from the Head Master for; the first and second period of the afternoon could also be used for this purpose. After the field visit the learners were asked to list down the plants they observed and classify them into trees, plants (smaller plants) and creeper. The leaner's groups took an hour to complete this task. The student teacher collected their work and on the next day the student teacher engaged in interacting with learner groups and with the whole class discussion (Figure 5.18).

Figure 5.18: The researcher, student teachers and learners of Grade III and V is seen in the photograph

The student teacher clarified some of the learners' misconceptions and their questions during the whole-class discussion. They were:

Trees life is of "2 months"

Plant's lives are of "1 month"

Cotton plant live only "one month"

Tamarind tree lives "4 years"

During the interaction learners also expressed that tree life is just 10 to 12 years, because after that it will be cut down by people even though it can live 50 to 60 years. They also expressed that trees are very important for getting pure air and other benefits. On the question "what if, trees are not there" learners responded that, "we will die".

The student teacher's interaction with a learner during whole class discussion is given below.

S.T: (what about) Plants?

LI: *For plant may be …. 1 month*

S.T: Will it be one month?

L1: Yes (very confidently)

S.T: Ok, is cotton a plant or creeper?

L2: Plant

L1: Plant

S.T: How long it lives?

L2: 1 month

L1: 1 month

S.T: *Cotton crop lives only a month?*

L1: *It will live 10 months*

S.T: (about) Trees, how long it may be? How many years?

L1: *it will live 3 or 4 year*

S.T: About tamarind tree? When did it planted? Before your birth or later? Do you have any idea?

L1: It was before that (before birth)

S.T: *How old are you?*

L1: 8 years

S.T: How many years (tamarind) maybe?

L1: 10 years

S.T: *Still how long it may live?* What do you think how many years it will be there?

L1: *Another 2 or 3 year it will be there*

S.T: *That much only? Beyond that…?*

L1: *People will cut it*

S.T: They will cut it, if it is left as it is how long it may live?

L1: Fifteen years it will be there

S.T: Then…..?

L1: People will cut it

S.T: Ha… ha… Ok, if they do not cut it?

L1: If they don't cut it means? (With surprise)

S.T: *If they do not cut it, how many years it may be there?*

L1: *May be for 50 or 60 years it will be there*

S.T: Beyond that…..?!

S.T: Ok, the tree which is supposed to live 50 to 60 years, if we cut it that is it a loss or gain for us?

L1: Loss

S.T: How?

L1: We won't get good air. If trees are more on the road side, then, we get more air

S.T: From that, what we get? i.e. from tree

L1: From that we get more food

L1: Tamarind, mango

S.T: What if tresses are not there?

L1: More heat falls on us, we won't get more enough air

L2: Air get polluted

S.T: mm (I see)

S.T: Then, what will happen?

L1: Then breath will stop.

S.T: Then?

L1: We will die.

The student teacher's interaction with learners during the whole class discussion is given in **appendix D4**

Mel Achamangalam:

The learner groups were asked to list down the plants they know and then classify them into tree, plant and creeper. This task was completed easily by learner groups due to their day to day observations and experience. The student teacher moved around each group and interacted with them. At occasions learner groups kept a particular plant in two or all the three categories (trees, plants and creepers). While student teacher asked for these, the group responded correctly. Occasionally they had differences in their classification.

The student teacher's interaction with learner groups during group works and during whole-class discussion some of their novice conceptions, their disagreement on each other's ideas, and their queries on a particular plant were clarified through discussion.

The learners had initial ideas like:

"Seetha (custard apple) is a plant"..... "Seetha is a tree"

"While it (Custard apple) is small, it is plant; when it became big, it is a tree miss"

"It (plant) is very small, and then it will become big"

During the discussion the learners moved from their idea of "Seetha (custard apple) is a plant"….. "Seetha apple is a tree" to "Seetha and madulam are small trees". At this stage the student teacher introduced the term 'shrub'.

A learner raised a question that "Miss, Is Annasi (Pineapple) tree or shrub?" when student teacher redirected the question to whole-class, the responses were

"Annasi (Pineapple) is a tree"

"*Annasi (Pineapple) is a shrub"*

Another student clarified their query by stating that, "Annasi (Pineapple) is a plant" as we planted on our land.

The student teacher posed a question "*Is a banana a tree or shrub or herb?"* the learners responded that

"We all call it as valaimaram" some other learner contradicted it by saying "we also call it as valaisedi", "It is a shrub".

When a student - teacher clarified that "Actually, banana is a large herb" the learners did not get convinced of the answer. The student teacher and the learners' interactions are below.

S2, **S4**: "*Herb?!! Miss, don't confuse"*

Priya: Ok. What confusion do you have?

S2: You are saying that it is neither a shrub, nor a plant and saying it is an herb. Then what is an herb?

S.T: *Yes. Mooligai (herb) is a plant but does not have strong stem, so banana is a herb.*

The student teacher's interaction with learners during their group work and whole class discussion is given in **appendix D4**

Madavalam:

Two student teachers took Grade III learners for a field visit behind the school to observe their immediate environment. The visit organised just before the morning assembly. After the field visit the learners were asked to list down the plants they observed and classify them into trees, plants (smaller plants) and creeper. The learner groups took an hour to complete this task. After 30 minutes of group work the student teacher engaged in interacting with learner groups.

The student teachers made two crucial mistakes during the field visit. First, the chosen field area which is just behind the school has a lot of weeds and only few plants trees to observe and small way for some distance. This has limited the field experience. Second, it was organised in just 15 – 20 minutes before assembly and learners were not given adequate instruction on the observation and recording (noting down what they observed).

The student teacher interaction with the learner groups during group work was observed to be following novice conception.

"No difference between tree and herb"

"Banyan tree is big, but banana tree is in small size"

Student teacher did not make any clarification on "banana tree". The student teacher asked each group to make drawing on what they observed. But, they did not make any discussion with the learners on that.

The student teacher's interaction with learners during their group work is given in **appendix D4.**

Activity 6: Are the leaves perspiring (transpire)?

Approach / Method: Inquiry Learning, Cooperative Learning, Whole class discussion

School: Panchayat Union Elementary School, Madavalam

Teacher: Ist Year Student Teachers **(S.T)**

Participants: Grade IV learners

Context:

This activity was presented in the Grade IV Environment Science textbook prescribed by the Government of Tamil Nadu. The student teacher was interested in engaging the learner groups' to do this activity.

Description of Classroom process:

The student teacher intended to teach transpiration concept through learner's activity. The student teacher initiated the process with a question "Do leaves sweat (perspire?)". After getting learners' responses, the student teacher asked the learners to plan an activity through which it could be proved. Once the learners got the idea of conducting an activity (both group and whole class discussion) they were asked to conduct the activity in groups. After the activity and observation, through whole class discussion, the content was summed up. The student teacher discussions with the learners at different stages are presented below.

The student teacher interaction with leaner groups during group works and during whole-class discussion on some of their misconceptions / novice / tenacious conceptions, their disagreement with each other's ideas were clarified through activity and discussion. Within the whole-class discussion the student teacher tried to get responses from individual groups. For the question "Do leaves on the plants and trees sweat (perspire)?" most of the student felt "No" or "We don't know". In one group some members said 'yes' and some said 'no'. When a student teacher further probed, one of the learners who responded "yes" said "lower (side of the leaf) evaporation takes place, not on the leave's (upper part), here (lower part) it evaporates, not in upper part". Unfortunately the student

teacher could not understand what the learner intended, and the further discussion led the student to say "No" (leaves won't perspire).

Further the student teacher made an observation "You all think that plants won't sweat", but "I think they sweat". The student teacher continued by saying "I am going to give a plastic cover and a thread to each group. By using this you have to identify whether plant sweat or not. Take two minutes to discuss in your group".

Student groups' expressed the plans such as

"By putting mud on it (plastic cover) we can plant herbs in it, sir. Then we keep that (thread) and see whether plant grows or not"

"A plant is there, we have to take a herb, we have to take a cover and fill it with soil. In that the herb has to be planted. If we keep it in water, it will grow"

When a student teacher further probed, one student expressed his tenacious conception on "leaves won't perspire" and had a misconception that "during winter leaves may sweat".

This led the student teacher to ask a question, *"When were water herbs and trees, where does the water go?"*

The novice ideas expressed by learners were:

"It goes to the leaves and in leaves it becomes bitterness is there like that"

"Water goes to the root, and then it goes to leaves then from leaves to stem"

At this stage, the student teacher stated that the "water gets evaporated i.e. water vapour gets out from leaves". But the learners did not agree with the idea by saying "No", "It won't".

Later the student teacher switched over to a whole class discussion and posed question "*What will happen if we cover a twig with this polythene bag and tie it with thread for two hours?"*

The learners' responses were *"Leaves will get little bit dry", "Nothing will happen".*

Then the student teacher asked the learner groups to conduct the activity. After the activity the learners agreed that leaves perspire in the whole-class discussion. The student teacher introduced the term 'transpiration' while summing up the whole - class discussion (Figure 5.19).

Figure 5.19: Learners are observing the leaves whilst engaging the activity on "are leaves transpire?

While observing the whole activity, it was observed that the student teachers belie ve that, "learners do not know the content" whereas "teachers know". Instead of planning the activity through learners by engaging discussion the student teacher explain the processes of conducting activity. All these are work contrary to constructivist principle. Even though this activity indicated learner's novice / tenacious misconceptions, the student teacher's engagement with the learners showed the extent to which there was a need for teachers' belief in constructivist principle necessary for engaging the constructivist based classrooms. The student teacher's interaction with learners during their group work is given in **appendix D5.**

Activity 7: Essential Requirement (Factors) for seed germination?
Approach / Method: Inquiry Learning, Cooperative Learning, Whole class discussion
School: Panchayat Union Elementary School, Kathirampatti
Teacher: Ist Year Student Teachers **(S.T)**
Participants: Grade V learners

Context:

This activity was presented in the Grade V Environment Science textbook prescribed by the Government of Tamil Nadu. The student teacher was interested in engaging the learner groups' to do this activity.

Description of Classroom process:

The student teacher intended to engage the learners to learn the content on seed germination through inquiry method. The student teacher began the class with a brainstorming session to identify the necessary things required for seed germination. After this, the student teacher asked the learners to devise an activity to prove that seed germination (Figures 5.20 and 5.21) is possible only when these necessary conditions are available present. The activity was planned in whole class discussion using inquiry learning and instead of group wise activity a single activity was conducted by the student teacher. This is because the activity needed six to seven days to see the result of that activity. In the following week, the student teacher engaged the interaction with learners groups' to consolidate their understanding and record their observations.

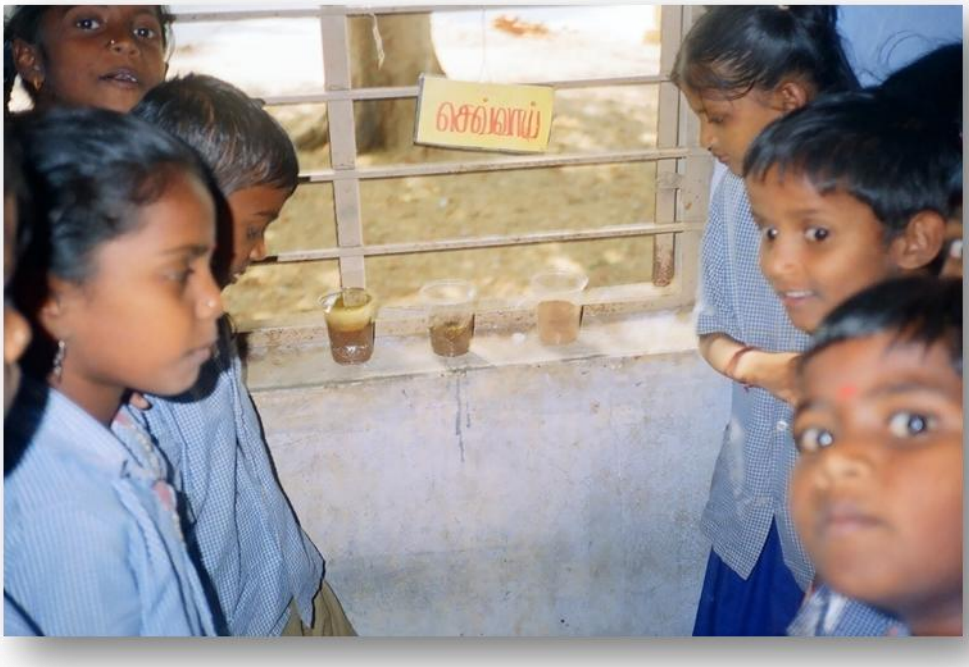


Figure 5.20: Learners practicing the seed germination experiment

Figure 5.21: Seed germination experiment set up in the classroom at Kathirampatti

Through this discussion, the student teacher clarified some of their misconceptions novice conceptions, their disagreement on each other's ideas.

The learners were aware that soil, water, air, sunlight is important for the seed germination. This shows their factual knowledge. But when they were asked "How will you prove that the seed won't germinate if these are all not available?" they started explaining from their experience of plant growth. When the student teacher emphasised seed germination, they try to apply their understanding of plant growth on germination of seed. The question has triggered the discussion toward devising an activity to prove how these factors are important for seed germination. The learners could easily bring their experience of plant growth to devise the activity to prove that water is necessary for seed germination. But when they were asked to devise an activity to prove that air and sunlight (heat) are necessary for seed germination, the discussion brought their misconception / novice conceptions. They were:

"Keep it in the house by closing all the windows ensuring no air enter into it"

"One seed bag (seed sown in soil in the polythene bag) to be kept in a room which is completely closed where air should not enter even through a small gap"

When the student teacher asked the question "If we close the room completely, will air be present there in the room?" the learners disagreed on each other's idea by saying "Yes" and "No".

This helped the student teacher raise another question *"If all the doors and windows of this room are closed, can we live here (inside) for 10 minutes?"* the learners disagreed by saying "we can't". When a student teacher related the question with their life experience, by asking *"In winter don't you close windows and doors?" they could accept the presence of air.*

Similarly the student teacher cited the learners' life experience of pearl millet germination helped to devise the activity and to clarify the need of warmness (heat) for seed germination. One learner expressed a novice conception to avoid the heat is to keep the seed germination set up in the fridge! *"We can keep it in that shop's bridge (fridge)".* The student teacher asked "What will happen to soil in the glass where we poured water in it?" the learners responded "*It (soil) will become tight" and the successive question of "Do we sow seed in tight soil?"* learners responded "No" because seed won't germinate. The post activity student teacher interaction with learner groups confirmed their understanding of the factors / conditions required for seed germination as well as on experimental procedures (procedural knowledge) on how to prove about each of the factors.The student teacher's interaction with learners during their group work and whole class discussion is given in **appendix D6**

***Theme / Activity 8*:** Seed Dispersal
Approach / Method: Cooperative Learning, Whole class discussion
School: Panchayat Union Elementary School, Madavalam
Teacher: Ist Year Student Teachers **(S.T)**
Participants: Grade IV learners
Context:
This activity was presented in the Grade IV Environment Science textbook prescribed by the Government of Tamil Nadu. The student teacher was interested in engaging the learners in understanding various modes of seed dispersion.

Description of Classroom process:
The student teacher interacted with learners through whole class discussion on seed dispersal. The student teacher began the discussion by asking the learners about various plants they see around the school, and preceded with the question "How it might have grown here?" learners responded that "somebody may have planted it". The student

teacher further probed on which form plants are grown, and got the response "from seed, offshoots" from the learners. Later student teacher asked about thorn plant. The student responded by saying "That comes by its own". Through further discussion and the student teacher made the learners to get an idea of different ways in which the seed dispersal happens (wind, water, human, birds and animal) based on different contextual questions. The student teacher raised appropriate questions which facilitated the discussion and to bring the understanding on different ways seed dispersal takes place.
The student teacher's interaction with learners during their group work and whole class discussion is given in **appendix D7.**

5.1.2.4 Theme: Energy Resources
Teacher: II Year Student Teachers
Participants: Learners of Grade VI, VII and VIII in two different schools
Approach / Method: PBL, cooperative learning
Theme Context:
Four student teachers and learners of the two schools have engaged in Energy Resources related topics. The topics were:

(i) Energy Resources
(ii) Energy Flow
(iii)Cloud Formation.

The first topic was engaged in Puthagaram Middle school whereas the last two topics were engaged in Kurumbar Colony Middle School. The first topic was engaged with Grade VIII by two students-teachers as a team. The Second topic was engaged with Grade VII. The Third topic was engaged with Grade VI and VII by a student teacher.

***Topic / Activity 1*:** Energy Resources
***Approach / Method*:** PBL, Cooperative Learning, Whole class discussion
School: Panchayat Union Middle School, Puthagaram
***Teacher*:** Second Year Student Teachers **(S.T)**
Participants: Grade VIII learners
Context:
The student teachers were engaged in a PBL problem on Energy resources in the teacher education classroom. The student teachers were interested in engaging Grade VIII learners in similar PBL problem related to Energy Resources. Before presenting the

problem, the student teachers oriented the learners to PBL approach. The learner groups were made and the ice breaking session was done to make the group know each other's strength and other aspects. After two sessions of making learners get into the group understanding, the theme was presented in the class. As the numbers of learners were more and it was Grade VIII, the student teachers were interested in engaging the problem with two member team.

PBL problem:

The electricity and fuel need / demand are increasing day by day. Consider yourself as an expert team in the area of energy and fuel, what kind of suggestions and solutions will you provide to the public and the government?

After presenting the problem, the student groups were asked to work in individual groups. The student teachers moved around the groups and clarified their initial queries. After an hour the student teachers interacted with each group for their group work.

Description of Classroom process:

The PBL problem was introduced in the classroom by providing photocopies of problem for all the groups. From few groups learners were asked to read the problem aloud and the student teacher asked if any group has difficulty in comprehending the problem it can be addressed. During the group work the student teacher visited each group and interacted with learners about the progress of group work. Each group worked with their own pace. Hence, the content of student teachers' interaction with each group varied depending on the group's progress.

During this PBL problem learners' group discussions mainly relied on textbook information and their own experiences.

Group Work:

Most of the group works indicated that the location in which electricity generated from various types of power stations, uses of electricity, various fossil fuels and its formation, the purpose and use of various fuels, various energy sources, electricity conservation, uses of fuels and atmospheric pollution, precautions to be taken while using electrical appliances and alternate fuel sources (biogas etc.). Even though groups appear to have understood the problem (first table 'what you know 'column), most of the group work did not reflect the problem posed to them. This was because learners focused the

problem within the boundary of textbook content. The learners groups' work indicates many misconceptions of the learners. Their list of misconceptions were :

"Electricity industries use the heat generated from thermal power station to generate electricity".

"Petrol, diesel, kerosene, fire wood and gobar gas are used as a fuel in coal".

"Due to use of vehicles, burning of papers and plastic materials ozone layer gets a hole and releases heat at 100 degree Celsius temperature"

"Energy is stored in Trees, coal, petrol, diesel and fuels in gaseous form. These energies we call it as chemical energy".

"While burning firewood, kerosene and petrol heat energy is emitted. These properties we call it as fuels".

"Michael Faraday invented electricity"

"Places from which we get fuel: Sathanur, Tuticorin, Dharmapuri, Kalpakkam and Chennai".

"Electricity used in industries such as hydro power station and thermal power station"

"Fuel is formed from matchstick, firewood, petrol, diesel, bio gas and natural gas"

"Electricity generated from lamp".

"Fuels are generated from water"

Student teacher interaction with learner groups:

The student teacher's interaction with the learner-groups during the group work and during whole class discussion some of their misconceptions were identified through discussion.

The misconceptions expressed by learners during student teachers' interaction with them were:

"Wind flow from tree"

"Wind flow from sun"

"Tree leaves fell down, then it became together, it goes to the soil, by become together and dry. It gets crushed and become black and coal taken from it"

"Due to smoke Ozone gets holed. Because of that air won't come".

"Electricity can be generated from underwater of sea"

"Underwater of seas wherever sunlight is there we can generate electricity"

"They make holes in the earth and insert the wire and pour water in it. Then we get earthing"

However the student teacher did not address the learners' misconceptions expressed in the group works as well as during their interaction with the learner groups. The student teachers try to clarify the misconception which they had with the learners during whole class discussion and fail to notice the learners' misconception in the group work. This may be due to lack of student teachers' own understanding of the content. The student teacher's interaction with learners during their group work, whole class discussion and learners groups' group work (translated) is given in **appendix E.**

***Topic / Activity 2*:** Energy Flow
***Approach / Method*:** Cooperative Learning, Whole Class Discussion
School: Panchayat Union Middle School, Kurumbar Colony
Teacher: II Year Student Teachers **(S.T)**
Participants: Grade VII learners
Context:
This topic was presented in the Grade VII Science textbook prescribed by the Government of Tamil Nadu. The student teacher was interested in knowing learners understanding on concepts energy flow and food chain. She raised a question, how solar energy flows in living things on earth? She asked the learners to work in groups. She moved around each group and interacted with the learners.

Description of Classroom process:
The student teacher's interaction with student groups during group works and during whole class discussion on some of their misconceptions / novice conceptions, their disagreement with each other's ideas were clarified through explanation and discussion.
The novice / misconceptions expressed by learners group and contradiction of their own idea, student teacher scaffolding and student conceptual change is presented here:
Misconception
"*Plants take solar energy through root*"
"*That root is absorbed* (the solar energy in the form of heat)*, then it gives to stem".*
"The way it absorbs water like that it absorbs (heat) *madam".*

Learners' contradiction on their own ideas and change in their conception
S.T: *Then, in plant, what do leaves do?*
L1: *The sunlight is required for the leaves of the plant for photosynthesis to occur.*

S.T: *What is mean by photosynthesis?*

L1*: Sun… i.e. energy comes.*

(Student teachers scaffolding)

S.T: What is photosynthesis? anyone…

(No response)

S.T: Don't know?

L1 and L2: mm..(yes)..

S.T: (Explains the photosynthesis process)

(Change in their idea)

S.T: *If, a plant gets sunlight through leaves for energy, why is taking from the root? What does it do with it?*

L1*: We thought plant takes sunlight energy through the roots.*

The novice / tenacious / misconceptions expressed by learners group and contradiction of their own idea, student teacher scaffolding and student conceptual change are presented here:

Misconceptions:

a) "*That is* (photosynthesis occurs) *in the centre of the stem of its plant food; it plant prepares".*

b) *"From that (sun) soil gets* (heat energy)*, from soil plant gets".*

"Miss, when we are planting miss that time we are pouring water, soil is absorbed that water. From soil water goes to plant miss, is it not? Along with water, it takes heat also miss".

c) "O_2 is there in solar energy"

Learners' tenacious conception and contradiction on their own ideas and change in their conception

a) S.T:*"Which part of the plant gets that light?"*

L1*: "Through leaves and Kambu (tender leaves – leaf primordia)".*

S.T: *What do leaves do with sunlight?*

L2*: Through photosynthesis it produces its food.*

The student teacher at this stage raised the question on things required for photosynthesis, the responded that Sunlight, soil, water, air (CO_2).

S.T: *Ok. Where Photosynthesis takes place?*

L2*: In centre of the stem,*

S.T: *Just you said photosynthesis happen at the leaves.*

L2*: Yes madam.*

S.T: *Where does the soil come for photosynthesis?*

L1*: It is already there.*

S.T: *Where?*

L1*: In the root.*

S.T: *But you were saying that photosynthesis happening at the centre of the stem. The soil is in the town. If all the four requires means how is it possible?.*

L3*: The soil is there in the centre of the stem itself.*

L2*: How is it available in the centre of the stem?*

S.T: *In case, if you break the stem, in the centre, does soil will present there?*

L1*: No madam, it won't be there, from the root the nutrition of the soil it will get sir.*

S.T: *Ok, for photosynthesis, whether the soil is required or not?*

L1*: Not required*

S.T: *Where does the plant take sunlight for photosynthesis?*

Chorus*: Leaves*

S.T: *Then how photosynthesis happensinthe stem?*

(Silence)

S.T: *What do you think, where does photosynthesis happen?*

Chorus*: Leaves.*

b) S.T: *"Ok, in that case we keep the root part of the plant outside for solar energy and our place the plant inside the room, Will it grow?"*

"It won't grow miss.By getting solar energy only it (plant) will grow".

c) S.T: *"Is inside the room Oxygen is not there?*

L1*: It is there.*

S.T*: "Then, What is there in the sunlight?"*

L1, L2 and L3:*"Light"*

The other learners' group drawing did not reflect the energy flow idea clearly. But the student teacher's discussion with a learners' groupdidn't reveal that as the discussion was very general.The synoptic view of group work (translated) is presented in the **appendix E1.**

Topic / Activity 3: Cloud Formation (Water Cycle)

Approach / Method: Cooperative Learning, Whole Class Discussion

School: Panchayat Union Middle School, Kurumbar Colony

Teacher: II Year Student Teachers **(S.T)**

Participants: Grade VI and VIII learners

Context:

This topic was presented in the Grade VI Science textbook prescribed by the Government of Tamil Nadu. When the researcher reached the school, the student teacher informed that there was a festival in the village, due to that many learners were absent and also few teachers were on leave. Therefore grade sixth and grade eighth learners were combined and classes were engaged.

The student teacher intended to engage the sixth grade learners with the theme water cycle. Student teacher was also interested in engaging the eighth grade learners with the same theme. The student teacher began the class with a whole - class discussion followed by the student group work on cloud formation.

Description of Classroom process:

The student teacher's interaction with student groups during group works and during whole class discussion on some of their misconceptions, their disagreements with each other's ideas were clarified through explanation and discussion.

The misconceptions expressed by learners were:

(VI grade)

For the question how cloud forms

"Miss, when we burn something those smokes goes out (up) miss that smoke will go".

For the question how smoke goes to the cloud

"*We are growing trees, when the wind blows; the smoke coming out of material burning that goes up".*

For the question how the rain comes?

"*Miss, smoke goes up and cloud gets cool".*

"It (smoke) *goes and hides miss; it won't rain miss. When it opens like this rain comes miss".*

"Yes miss (Is smoke form cloud?)"

(VIII grade)

"*If we burn wastes smoke will go up in skymiss. ….that smoke becomes cloud".*

"The water in the sea gets evaporated and goes up and becomes cloudy. For that another example also can be given, fire, which is what we make smoke, that also goes to up and becomes cloud".

"Water, due to evaporation of water, cloud forms, also by burning wastes cloud forms".

"The smoke which is burned goes up due to that cloud moves. Due to that smoke the sky becomes dark; that time the rain will come"

"The smoke of burning of materials goes to the cloud and due to its warmthness the cloud gets melted and rain pours".

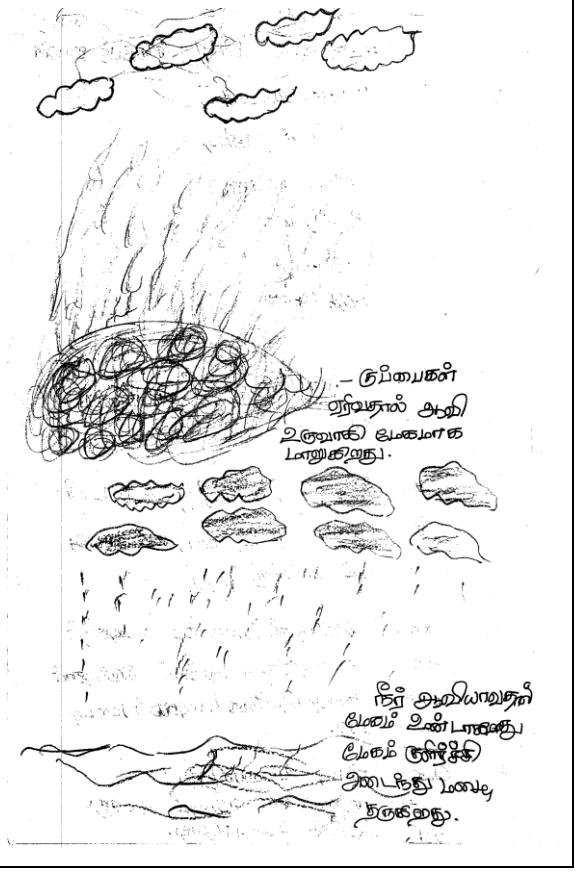
"*When the smoke goes up, i.e. when petrol, diesel burns, smoke goes up and become cloud"*

"*Plants. When we cut it, it becomes dry, when we partially dry it, and become vapour and goes up. When we are burning wastes it becomes vapour".*

Group work:

Even though Group B's (grade VI) group work showed cloud forming from sea water, the student teacher interaction with them reflect that they also accept the idea of smoke forming as a cloud. Group C's (grade VI) group work did not show cloud forming from water. The student teacher interaction with them clearly reflects they think that cloud forms through evaporation. Group D and Group E's (grade VI) group work shows they do not have any misconception. The drawing of Group A (grade VI) and Group B (grade VIII) shows the smoke which comes out while burning the waste, forming as the cloud. The drawings are presented in figure **5.22**. The synoptic view of group work (translated) is presented in the **appendix E2.**

Figure 5.22: Drawings on water cycle by group A and B

Grade VI, Group A	Grade VIII, Group B
	

The student teacher's interaction with learners during their group work, whole class discussion and learners groups' group work (translated) is given in **appendix F**

5.1.2.5 Theme: Environmental Problems

Teacher: II Year Student Teachers

Participants: Learners of Grade VII and VIII in two different schools

Approach / Method: PBL, cooperative learning

Theme Context:

Four student teachers and learners of the two schools have engaged in Environmental problems related themes. The themes were:

(i) Improving Environmental Conditions of School Premises

(ii) Human-Elephant Conflict

(iii) Agricultural Problems

(iv) Wastes

The first three themes were engaged in Puthagaram Middle school where as the last theme was engaged inKurumbar Colony Middle School. The first three themes were engaged with Grade VII learners by student teachers. The last theme was engaged with Grade VIII learners by a student teacher.

Topic / Activity 1: Improving Environmental Conditions of School Premises

Approach / Method: PBL, Cooperative Learning

School: Panchayat Union Middle School, Puthagaram

Teacher: II Year Student Teachers (S.T)

Participants: Grade VII learners

Context:

Whenever I (researcher) visited Puthagaram school we (me and student teachers) used to visit to the nearest mango farm during lunch time. We generally pass through behind the school and every time we observed that lot of waste spread over there. The school learners were throuing the wastes from the windows behind the school.

The school has classrooms in 5 different buildings and a single room. Out of this, four building are located an one side of the road and a building located on the other side. The first building comprises of two rooms out of which one is principal's office cum staffroom and the other one is a store room meant for broken things and other unusable materials. The second building had two rooms with a damaged roof so it was not used. The third building had two rooms and a veranda where Grade I and II learners sit in one room, Grade III learners in another room and in veranda used to function as a Grade V learners' class.

The fourth building had two rooms and a veranda where Grade VIII and VII learners sit in rooms and Grade IV learners sits in veranda. Along side of this building, a single room is there, where kitchen functions for midday meal preparation. The other building located on the other side of the road where two sections of Grade VI learners classroom.

The school premises had an unused toilet, 2 water storage tanks. One was used as dustbin and the other (syntax) without water. The learners rely on hand pump outside the

school for water. Even though the school had a well, the water was polluted due to waste dumping. The student teachers were sharing this information and one day during our discussion it was thought of why not we can take up this issue as a problem in PBL approach. While working out the problem, the student can become aware of their immediate problem. As a group we all liked this idea and we felt as two of our student teachers teaching in Grade VII this could fit well in that class.

PBL problem:

The Panjayat intended to provide Rs. 1 lakh to improve your school premises. In this regard your group is asked to make a detailed plan of expenditure to improve the condition of school premise. Before making a plan let your group visit the school premises and make a drawing depicting the present condition of the school. Work out your plan of expenditure and make a drawing depicting how the school will look like, once the money is spent on its improvement.

Description of Classroom process

The PBL problem is introduced in the classroom by providing photocopies of problem for all the groups. From few groups learners were asked to read the problem aloud and the student teacher asked if any group has difficulty in comprehending the problem it can be addressed. The learner groups made visits to school premises and noting down what they observe and during Group work where learners discussed (Figure 5.23) what they observed and made drawings of school premises then groups made a plan of expenditure. The Student teacher interacted with learner groups to facilitate the discussion and observed group progress. The student teacher could able to see interesting episodes (misconceptions, interesting views etc.) which become part of group work and generally the interaction began with what the group observed and their plan of expenditure and related discussions.

Figure 5.23: Learner groups (Grade VII) were seriously contemplating on school environmental problem at Puthagaram

Each group worked with their own pace. Hence, the content of student teachers' interaction with each group varied depending on the group's progress.

During this PBL problem learners' group discussions mainly relied on textbook information and their own observation and experiences.

Group Work & Student teacher interaction with learner groups:

The learner groups made a plan of expenditure and the visualized the school premises through drawings. During the discussion they discussed many other general problems beginning of the school context. One of the group's drawings about what they observed in school premises and after spending their visualization of how the school premises look like is presented below.

Learners' observation of school premises

Learners' visualization of the school after renovation

The student teacher's interaction with student groups during group works most of their misconceptions, were clarified through peer disagreement on each other's ideas, student teachers 'questions and some of their conceptual understanding widened through explanation and discussion.

The novice / tenacious / misconceptions expressed by learners were:

"Those who inhale it (smoke) gets affected by malaria"

"That's only (to avoid mosquito breeding) sir, by constructing tank and leaving the water (industrial effluent) into it and close that tank"

"Trees and rains have no relation"

"Plants and trees evaporates won't perspire"

"Insects eat plants, it eats plants and moves to root and it reaches the soil, then it eats soil so, soil gets polluted"

"Earthworm eats soil… due to that soil gets polluted"

"The bacteria's in the soap mixed with water while washing. This water we use it for land. Due to those bacteria affects land (land gets affected)"

"Due to mosquito biting it (Cholera) spreads"

"Due to the burning of tyre, from that so much toxic gases comes out due to that many diseases (malaria) happens to us"

"If non-degradable things are not in the soil, then soil fertility increases …… because it doesn't stop water going into the soil (water percolation). So soil fertility increases"

"Making pit in the earth, and we should leave (industrial effluents) their"

"Due to that smoke…..AIDS comes"

One alternate conception was observed during the student teacher interaction with learners group *"Papers are produced through palm leaves"*.

The concepts widened through interactions were:

"Making Bore wells don't have any adverse effects"

"for avoiding this scarcity we need make more bore-wells"

The student teacher facilitated the situation where learners could understand that making more bore-wells leads to lowering down the ground water level.

One of the group suggested making tar (used for road making) from plastic could be one of the solution to address plastic pollution. Learner group suggested this because they read this idea from a newspaper item. The student teacher's interaction with learners during their group work and learners groups' group work (translated) is given in **appendix F.**

Topic / Activity 2: Human – Elephant Conflict

Approach / Method: PBL, Cooperative Learning

School: Panchayat Union Middle School, Puthagaram

Teacher: II Year Student Teacher (S.T)

Participants: Grade VII learners

Context:

Student teacher brought a newspaper item on elephants coming to agricultural farms and the problem faced by the farmers. The student teachers were interested in engaging Grade VII learners in PBL problem related to Human Elephant Conflict. The researcher also shared a resource material on elephant in local language and had few more newspaper items for the student teacher to formulate the problem. With this background the student teacher framed this problem and provided all the learning materials to the learners in their PBL work.

PBL Problem:

You have two newspaper items and an article on the difficulties faced by farmers by elephants' intrusion to their farm. Your group is expected to provide suggestions and solutions to reduce this human-elephant conflict through the report.

Description of Classroom process:

The PBL problem was introduced in the classroom by providing photocopies of problem for all the groups. From few groups learners were asked to read the problem aloud and the student teacher asked if any group has difficulty in comprehending the problem it can be addressed. During the group work the student teacher visited each group and interacted with learners about the progress of group work. Each group worked with their own pace. Hence, the content of student teachers' interaction with each group varied depending on the group's progress. During this PBL problem learners' group discussions relied on newspaper articles, a resource book on elephant and their own experiences (what they heard, read etc.).

Group Work

Most of the learner groups' work indicated that due to human encroachment in forest areas and cutting of trees from the forest were important reasons for elephants coming to cultivated areas. Elephants face food and water scarcity due to cutting of trees in the forest and low rainfall. Preparation of KallaCharayam (illicit liquor / DesiSharab) in the forest areas and by accidentally drinking of these by elephants has also becomea major cause for elephants coming in border areas of forest and human settlement.

The learners groups' suggested that planting more trees could be one of the solution. Enabling the water and food security in the forest for elephants was another suggestion. Some learners groups suggested by making a fence around the forests the conflict can be avoided. Avoiding farm related activities closer to forest areas also was suggested. It also suggested that elephants should to be protected from poachers. The learner groups work also indicates various things elephants eat, and other information like its average weight, its uses, different ways it was harmed by humans and their social group etc. Some of the learner groups also made elephants drawing. One such drawing is presented in appendix F2.

Student teacher interaction with learner groups:

The student teacher's interaction with the learner-groups during the group work some of their misconceptions were identified and clarified through discussion. The misconceptions / novice conceptions and imaginations expressed by learners during student teachers' interaction with them were:

"Elephants are, … human beings are putting baby elephants in inside cage. So it gets disturbed (feels bad) and enter into the village and attacks everybody".

"If it's inside the forest, nobody puts food in it, so it comes out of the forest and eats humans"

"If we jail all the animals in sanctuaries, they will give food for them. For all animals they will give food"

"Yes sir. Even if it (elephants) present in the forest, it pollutes the nearby lands"

To a question on what are the advantages of having animals in the forests? The learners responded that the presence of animals makes people fear to go to the forest and cut the trees. This will help in getting more rain, pure air etc. The student teacher's interaction with learners during their group work and learners groups' group work (translated) is given in **appendix F1.**

Topic / Activity 3: Agricultural Problem

Approach / Method: PBL, Cooperative Learning

School: Panchayat Union Middle School, Puthagaram

Teacher: II Year Student Teachers (S.T)

Participants: Grade VII learners

Context:

The people around the village were engaged in agricultural farming, agricultural labourers, agro-business, agarbathi making etc. As most of the learners' family background is farming or related activity, the student teacher was very much interested in agriculture related problem. With this background this problem was framed. The student teachers were interested in engaging Grade VII learners in PBL problem related to Agricultural problems of the locality.

PBL Problem:

In our area, crop productivity is reducing over the years. The government has planned to avoid this situation and increase the productivity. Assuming you are a team of agriculture related experts to give suggestions to the government through your report.

Description of Classroom process:

The PBL problem was introduced in the classroom by providing photocopies of problem for all the groups. From few groups learners were asked to read the problem aloud and the student teacher asked if any group has difficulty in comprehending the problem it can be addressed. During the group work the student teacher visited each group and interacted with learners about the progress of group work. Each group worked with their own pace. Hence, the content of student teachers' interaction with each group varied depending on the group's progress. During this PBL problem learners' group discussions relied on textbooks and their own experiences.

Group Work

Most of the learner groups' works indicate that due to water scarcity, constructing houses in agricultural land, cutting trees and its impact on soil erosion, land pollution from industrial effluents, plastic materials, insecticides, rotten, floods, reduction in cultivation area were major reasons for reduction of crop productivity. Most of the learners groups' suggested rain water harvesting (some learners groups were made drawing of rain water harvesting) and water conservation, non polluting water bodies, not burning wastes, use of bio-fertilizers and vermincompost as solution. Most of the learners groups' work also indicates water cycle (Appendix F3).

Student teacher interaction with learner groups:

The student teacher's interaction with the learner-groups during the group work few misconceptions were identified through discussion.

"Insecticides,…DD powder like insecticides (or artificial fertilizers)"

"Due to using artificial fertilizers….. Yielding getting reduced"

Alternate conception:

"For getting more yield, natural fertilizer should be use it"

However, the student teacher did not make an effort to address these misconceptions.

The student teacher's interaction with learners during their group work and learners groups' group work (translated) is given in **appendix F2.**

Topic / Activity 4: Wastes

Approach / Method: Cooperative Learning

School: Panchayat Union Middle School, Kurumbar Colony

Teacher: II Year Student Teacher (S.T)

Participants: Grade VIII learners

Context:

The student teacher was interested in knowing learners understanding on wastes. The student teacher began the topic by asking learners to observe what are the things they are throwing as a waste in their house and nearby places as a homework. The next day through initial discussion following questions / ideas emerged and the learners groups' were asked to work in group to address the questions and ideas. They were:

What are wastes?

What are sewage wastes?

What are the things at your home throw as a waste?

Other than home, what are the other activities and places were wastes generated?

Classification of wastes

Adverse effects of wastes

Waste management.

Groups Works:

Most of the learners groups' work indicated that paper, plastic, grass, water can, and cardboard, rotten fruits, broken bulbs, pen, glass tumbler, onion, garlic skins etc are wastes. Most of the learners groups' work indicated that waste water of various

household works, drainage water, and sewage water is of waste water. Learner groups also indicated that, Coconut cover, worn clothes, bags, slippers, cement bags, balls, papers, remaining food, rotten fruits, fire wood ashes are of household wastes. Plastic papers, chocolate papers, dried leaves, waste pipe were thrown at roads, school rooms, industrial areas, market, bus, lake, hospital and other areas. Most of the groups classified waste into two groups. They were degradable and non-degradable. Most of the group indicated that due to wastes there may be a possibility of getting a chickengunya Plague, Cholera, smoke, cancer, malaria, dysentery, typhoid, tomotogunia, throat infection, headache, eye pain, dengue, lung diseases, cough and cold. However some of the learners group also had a misconception that due to wastes there is a possibility of getting HIV, rabies, hepatitis, bird flu, leprosy, mumps, chicken pox, fever, leg pain etc.

Description of Classroom process:

Student teacher interaction with learner groups:

The student teacher's interaction with learners groups' during their group work and their misconceptions/tenacious conception were identified and clarified through discussion. They were:

"*Breathing of waste water….. (Leads to) Cancer, vomiting and headache"*

"Burning (of) wastes is good…..Otherwise it accumulates in front of the house as dirt"

"It (leather) won't degrade"

One such interaction is presented below.

S.T: *Is burning wastes good/bad?*

L1: *It is good.*

S.T: *How?*

L1: *Otherwise it accumulates in front of the house as dirt.*

S.T: Ok. If we burn it, what will happen?

L1: Burning?

L2: It gets empty.

S.T: *When it burns, what are all come out? (No response)*

S.T: When we see burning, what are the things happening?

L1: *Bad smell comes.*

S.T: Then

L1*: Gas is mixed with air.*

S.T: Which gas?....Does smoke come?

L1: *Yes smoke comes.*

S.T: *What happen, when smoke comes and mixes with air?*

L1: Ozone layer will get affected.

S.T: Ozone layer gets a hole?

L1: I don't know, but the air gets polluted.

S.T: *Ok, if we take non-degradable waste, burning or burying, which one is the best option?*

LI: *Burning*

S.T: *Why?*

L1*: It quickly gets over. Burying we need space for dumping and takes so much time.*

S.T: Ok. *After sometime what happen to that waste?*

L1: *People use it for their land.*

S.T: Is there any benefit of that?

L1: Yes. Crops yield will go up.

S.T: So, *Which is the best option?*

L1 & L2: *mm… mm… he he… Burying.*

The student teacher's interaction with learners during their group work and learners groups' group work (translated) is given in **appendix F3**.

Major observations:

During the group work in the student teacher visited the group and interacted with the group members. At occasions, the student teacher observed some of the misconceptions / novice conceptions. Sometime the student teacher addressed those misconceptions with the group interaction itself and at later stage during whole class discussion these were taken up to address if any other learners had similar misconceptions. However, often the misconception which is observed during discussion when already recorded in the group journal by the learners. But they kept the group journal without corrections.

5.1.3 To study the application of constructivist teaching methods and strategies with student teachers while teaching environmental concepts in their classroom during internship programme.

1. The student teachers use of constructivist teaching methods and strategies in their classroom for teaching environmental concepts fall on a continuum. Some student

teachers could use it well than the other. Similarly the same student teacher could use it well in a topic / activity than the other.

2. When more than one student teacher engaged the same topic, generally different student teachers engaged the learners in different methods. For example the topic, Which one absorbs/ releases heat first: soil / water?, the same activity three student teacher adopted different strategies (whole class discussion, cooperative learning, Inquiry Learning) to engage their learners in the activity. This variation indicates the student teacher's preference in learner autonomy in learning a topic. This was based on the student teachers' belief on constructivist approaches (see appendix D5).

3. Most of the student teachers allowed learners' responses to drive the topic when they were engaged in the dialogue with the learners. However, some student teachers could able to make use of the learners' responses to change their (learners) perspective on environmental concepts by raising critical questions.

4. Some student teachers provided more constructivists based learning experiences to their learner than the others. It was also observed that those who felt more comfortable with constructivist approaches or thinking that they were using an innovative approach in their teaching to make constructivist based lessons.

5. There were instances where student teachers left some stages fully or partially of inquiry or the PBL process. This was due to various reasons such as lack of adequate planning, school environment, organization of learning resources, activities etc. In some of the topic / activity the intended learning occurred even after missing some stage. For example the topic, what comprises the top soil? The student teacher did not raise a question "Is there any possibility of different layers formed when soil is put in with a bottle and shacked well?" before the activity. The stage of making a student hypothesis by the learners was missed. However, the student teacher in the post activity during the whole class discussion asked about various things observed in various layers.

6. School environment and student teacher interest played a critical role in deciding field visits as a part of learning experience.

7. Student teacher interaction with their peers in the same school as well as other school helped them to plan out their activities. For example, listening differences among trees, plants and creepers one student teacher facilitated the other student teacher to plan seed dispersal activity in the other school.

8. Some student teacher carried their experience of engaging themselves in learning environmental concepts at a teacher education institution in the school classroom to plan

out similar activities and PBL problem for learners. For example, water percolation capacity and energy resources.

9. It was observed that at occasions student teacher ignored learner misconceptions during their interaction with their learner. It was also observed that at occasions student teachers did not address the learner misconceptions expressed in their portfolio (group work).

In general, it was a mixed experience with some success and some failures. However, by applying constructivist principles and methods in their teaching learning process most of the teachers began their journey to become constructivist teachers.

5.2 Student teachers and Learner perceptions about constructivist approaches to Environmental Education

The data regarding student teachers and learners' perceptions about the use of constructivist approaches to Environmental Education presented in two subsections, 5.2.1 and 5.2.2

5.2.1 To study student teachers' perceptions about constructivist approaches to Environmental Education

5.2.2 To study Learner perceptions about constructivist approaches to Environmental Education

5.2.1 To study student teachers' perceptions about constructivist approaches to Environmental Education

The student teachers' were interviewed to know their perception about the use of a constructivist approach to environmental education. The student teachers' perception is seen in the following aspects.

(1)How did learners react on constructivist way of learning?

Most of the student teachers' said that learners were very actively participated with a lot of interest and enthusiasm. In fact, learners' participation in engaging the content through constructivist way was better than the student teacher themselves engaged.

The learners started to demand the student teachers to engage their lessons through constructivist approach. They started to raise new and those questions which they do not know. It was observed that, their participation was much better than the traditional classroom setup. It was also observed that their conceptual understanding was better when they were taught through constructivist approach.

However, some of the student teacher said, few learners find it difficult to participate, as they do not know how to participate.

(2) How student teacher did engage in their (practice teaching) classroom through constructivist approach?

The student teacher felt that the constructivist way of learning was very new to them. As they were new to this way of learning, they initially feared to adopt in their classrooms. However they observed that it helped them to see progress of individual student learning. They did not find it very difficult in adopting this in their classrooms. But student teachers felt that small size classrooms will be very suitable for this method. The student teacher observed that learners were very happy in learning through this approach as it allows them to ask questions to teacher which they do not know. The student teacher also felt that this keep them learning new things as they find it difficult to answer learners unexpected questions.

Some student teacher strongly advocated this approach in the classroom even though it takes more time than the traditional classes as they think "how much time we spent is not important but understanding was matters"

(3) What kind of school environment in which they adopted constructivist approach?

Most of the student teachers viewed that school environment was neither positive nor negative.

Most of the school teachers indifferent to the way student teacher engage themselves in their classroom. Neither they had any objection nor encouraged the student teacher. One school the student teachers said the school Head Master was encouraging the student teacher in engaging this approach.

(4) How did they view their engagement with content in a constructivist classroom and constructivist approach?

The student teacher alienated in their view on constructivism. Some of them felt they were very much interested in learning through this approach and make the learner to learn through this approach as a teacher. Some of them felt they were interested and actively participated but their peers did not do so. Some of the student teachers felt it was interested them for some time, but the interest could not sustain for a long time, because continuously having a particular type of approach (PBL) and working a long time for a problem became difficult and other curricular loads from the institution. Even though the approach appears to be very easy, but demands lots of thinking. Student teacher stated that they shared the responsibility, accepted each other's view when it is found to be

appropriate. They also stated it provided an opportunity to express their views in the classroom.

Very few stated that they had different views during their group work, but they said they could accommodate each other's ideas and accept appropriate answers. Few responded that their peers did not do well, and some of them said they themselves were not much involved.

(5) Student teachers view of change in environmental behaviour among themselves and their learner. The student teachers had a view that very little change occurred in terms of their environmental behaviour in their own as well as their learner. However, they agreed that a lot of change occurred in their understanding of environmental concepts and issues.

5.2.2 To study Learner perceptions about constructivist approaches to Environmental Education

The interview with the learners on their perception about the constructivist approach to environmental education revealed that, the learners liked to be taught by inquiry activities, Activity Based Learning (ABL), good handwriting and use of various learning resources (regular activities like padippum inikkum).

Most of the learners stated that they had a better conceptual understanding by learning environmental concepts through constructivist approaches.

Learners stated that they learn better if they can get access to many learning resources along with the textbook. While researcher specifically focused questions on their perceptions about inquiry learning they responded that they understand better by engaging themselves in inquiry learning. Their statements were:

"(We) like that Learning by doing activities",

"Through doing and seeing we understand better"

"We like learning through activities and understand. You cannot do activity on board"

However in most occasions learner explained the process of activity they engaged and stated that they like such learning.

Even though field visits made better conceptual understanding and many learners liked it, some learners from two schools did not like it. It is because one such visit the learner visited the place where path were muddy and sunny day. The other situation, the field visit was arranged in a post lunch session and learners need walk to one kilometer distance to see the lily pond. Since, some of the learners do not have their own sandal it

was very difficult for them to walk in a sunny time. One of the learners expressions on field visit was *"seeing and studying in a group is better"*

The learners were having a positive view of working in groups (cooperative groups) and addressing problems (PBL). Some of the learners' expressions were

"Sitting in a group and learning is happiest one"

"If I do not know something, they (group members) will answer. If they do not know we will ask to teachers"

"If teacher teaches, whatever he/she teaches we understand little, but if the same thing we discuss in our group and learn ourselves, we can understand little bit better"

"If we have doubts it is very difficult to understand, if we are working in group someone clarify our doubts"

Some learners stated that *"Teachers clarify only things in the books"*. But when they do it in groups, they discuss the process in detail.

Most of the learner stated that by discussing the problem in their peer group they understand the content well. However few learners felt that doing activities and engaging ill defined problems are somewhat confusing. They stated that learning by themselves (through interaction with peers, resources) they enjoy it. However, whatever they do not know they wish to learn from the teacher.

There were dissenting voices also. Some such expressions were

"These people (peers) fight each other. Instead of that studying alone is better"

"Is it right (for learning) to go and see things?"

There were very few voices from learner giving positive responses to changes in their environmental behavior. One such expression was "By learning in a group, we decided not to put wastes in the school". However, learners expressed they understood a lot of environmental concepts by learning those concepts through constructivist based learning.

FINDINGS AND DISCUSSION

6.0 Introduction

This chapter presents the discussion of findings of the present study. This is presented in two sections 6.1 and 6.2. The section 6.1 presents the findings in the form of assertions. Section 6.2 presents the discussion on those assertions.

6.1 Findings of the study

The findings of the study are expressed in the form of five assertions. The focus of these assertions is on the role of constructivist approaches on student teachers and learners learning.

♦ **Assertion One**

Constructivist classrooms facilitated student teachers and learners to develop better understanding on environmental concepts.

The student teachers and learners were expressing their understanding of environmental concepts during the classroom interactions. They did not have any difficulty in expressing their views. This climate facilitated others to know their misconceptions at occasions. Through the peer interaction or interacting with learning resources the student teacher and learners developed better understanding of environmental concepts. Some occasions it was replacing the misconception and some other occasions it was widening their conceptual understanding. One such situation in the teacher education classroom and at school classroom is presented below

Teacher Education Classroom:

Classroom Interaction on - acid rain … is artificially made

The second two student teachers' conceptions were based on the lack of conceptual understanding. The peer interaction in the whole class situation clarified the misconceptions.

S.T1: Rain also is sometime poured as acid rain, because chemical factories release H_2SO_4 (sulphuric acid) gas it mix with rain and becomes acid rain. When it fall on earth plants gets affected and if it rain at sea, living creatures in the sea also affected by this.

S.T2: She said about acid rain. It is artificially made. Naturally rain….

S.T1: (interrupts)

R: Wait, wait, wait… what do you think about acid rain?

S.T2: *We are creating that. We can create rain. For that some chemical is there (he wanted to say chemical name but while uttering it sounds as reason) if we put that then we get rain. If we see in cinema there are rain situations; we can produce artificial rain. Natural rain does not contain any pollutants. We can keep it clean and drink that water. We cannot get any effect from that. But the artificial rains there are so many effects.*

S.T3: *Artificial rain is different and acid rain is different.*

S.T2: *Then, what is the difference?*

(**S.T**2 and **S.T**1 both wanted to say)

R: Wait a minute mam. (some student teachers laughing in the class)

S.T4: Say **S.T**3

S.T3: Artificial rain means on dry snow (ularpani when we spray) potassium iodide, we get it. Acid rain means…….

R: Wait a minute he wanted to say something.

S.T5: Sir, rain naturally pours. But when the poisonous gas in the air mixes with rain, the natural rain becomes acid rain.

R: Where from the poisonous gas comes?

S.T5: By burning gas

R: You wanted to say something. Say...

S.T1: *That type of poisonous gas is present. From chemical factories more chemicals; more CFC from* ***refrigerator*** *comes, because of those ozone layer become a hole. These are all because of chemical reactions. The same way the factories which produces* H_2SO_4 *(Sulphuric acid), the gas coming from the factory mixed with air and becomes* SO_2 *(sulphur dioxide) that becoming acid rain and pour into the earth and sea; plants and aquatic plants and animals gets affected by this. When we see, due to ozone hole the sunrays falls on to human, because of that many skin diseases it makes.*

R: What do you think?

ST2: *Initially I thought both are same (acid rain and artificial rain)*

School Classroom:

The student teacher interaction with the learners on earthworm is given below.

S.T: Ok, You wrote that, you have seen worm, which worm have you seen?

Chorus: Earth worm

S.T: Earth worm, what did it eat?

S5 & **S4**: It eats soil

S.T: *What else it eats?*

S3: *Fertilizer*

S.T: *mm??!! Does it (earthworm) eat fertilizer?*

S3: *Yes*

S1: *No miss. It will die*

Chorus: Yes miss, it will die.

S2: It will die miss.

S.T: What else do they eat?

S4: The things in the soil, *it will take small worms in the soil*

S.T: *Is it? Earth worm eats small worms in the soil?*

S1: *No miss. It eats soil, not worms*

S.T: Yes. Earthworms won't eat other worms but it eats maggana ilia (humus) and other minute things

S3 & **S4**: It keeps the land clean.

S2: Plastic paper.

S3: Those are all it eats.

S.T: *mm!! Does it eat plastic paper?*

S2 & **S3**: *Yes Miss*

S4: No miss. Plastic, it cannot. Even big animals die after eating plastics. In Newspaper I have seen

S.T: Ok. What do you think? (Looking at **S3** & **S4**)

S3: He he…..

S4: *If we put a plastic cover inland earthworm will die.*

S.T: What if we throw a plastic sheet on the ground?

S4: If we put it, when rain comes

S2: Water will stay (above), it won't be absorbed by plants

S5: For roots water won't go.

S.T: By putting plastic, the water won't go to the roots. Why?

Chorus: Plastic covers the root.

S.T: Speak one at a time.

S5: Above plastic cover water is there.

S.T: mm

S5: Due to that water won't go.

S.T: Ok. How does plastic go into the earth / soil?

S5: During ploughing?

S4: By carrying waste/manure (to put it on land)

S2: No teacher. We bring rice in plastic cover; later as a waste we dump that plastic cover in waste pit. I.e. due to air/wind it flies and go and fall on the land, when rain comes that water goes to earth and goes to the roots, at that time this plastic cover obstructs the roots of the plant; so water won't go to the roots that a plant becomes dry and die.

(All the students want to say)

Chorus: We should not put wastes in sort. Due to that pollution happening.

S.T: One at time, not all at a time.

S3: We are also, when we for purchase, we should purchase things yellow (cotton) bag only, if we bring it in plastic cover it won't be good.

S.T: So, what can we do with plastic bags and other things which already we are using it?

Chorus: We should not throw it on the ground.

S3: We should keep all this in a cover.

S5: We should burn it.

S3: Yes burn it.

Chorus: Yes

S.T: If we burn plastic, does air not get polluted?

S3: Pollution…

S.T: Does air get polluted or not?

S1 & **S4**: mhoom

Chorus: No. It gets polluted

S.T: For that, what can we do?

S5: How can we eliminate using plastic? We should not insert that anywhere. Whenever we bring plastic (intending plastic cover) we have to keep it in a bucket. We should not put in the waste bin. After closing it, we should not put it on land, but whenever we need we can reuse that (using many times).

♦ **Assertion Two**

Student teacher and learners proposed hypothesis based on certain concepts to explain the occurrence of events.

In the constructivist classroom set up the student teacher and learner proposed hypothesis in the form of question during the discussions. These hypotheses were tested / addressed through discussion and activities. One such situation in the teacher education classroom and at school classroom is as follows

Teacher Education Classroom:

Classroom discussion on – Do plant grow in rocky soil:

In this classroom discussion a student teacher countered the other student teachers view that rocks through natural process become small particle and become soil by raising a question that if we powder the rock and if a (tree) planted will it grow?

The other student teachers responded it stating

"The soil come from rock had to decompose (magganum)"

"The soil come from Rock, has that remained in the same place? No. it has not. During rain it floats from one place to other. When it mixes with soil in that new place it receives nutrients" etc.

The ideas expressed by other student teachers proposing hypotheses other than rock becoming soil over a period of time it also subjected to some other processes which makes it a nutrient soil.

The whole interaction among student teachers and researcher brought the understanding on nutrient presence need for rock to become soil.

This led further discussion and brought the understanding on nutrient present in the rocks.

S.T1: *Sir, They are saying that soil came from a rock. If we take a rock and grind it into small small minute pieces and make it as a soil,in that soil if we sow a plant, will it grow or not?*

(Few others talking with low voice)

R: Oh! Good question? Listen...

S.T2: Which question sir?

R: If we break rock into soil, will a plant grow or seed germinate in that soil?

S.T3: *No it won't grow.*

S.T2: It will grow.

(Some discussion)

S.T1: *They are saying that from rock, soil comes, and plants don't grow in that, then, how plants grow in that soil?*

R: That is a question!

S.T2: It will grow... From rock also sometimes plant grows.

S.T1: *(interrupts) we had an experience. When we put a bore, the soil (rock powder) came out. You know this soil came from a rock. We planted a plant in that soil, but the plant didn't grow.*

S.T3: *It won't grow sir.*

S.T4: It will grow sir.

S.T1: It didn't grow.

S.T4: It will grow.

S.T1: No.

S.T4: Because it is artificial.

S.T3: Whether soil comes from artificial or nature but it had come from the rock only.

(**S.T5** wanted to say something)

R: Just a minute, I think he asked a nice question. Very good. Say mam,

S.T5 & S.T6: *The soil come from rock had to decompose (magganum).*

(A big laugh in the class)

R: How it decomposes?

S.T7: With bacterial like living creature.

S.T2: The things from water.

S.T6: Plant, tree or creepers after drying, it gets decomposed.

R: Do you say plant came before soil?

S.T6: No sir.

(RS – Recording stopped)

R: The plant did not grow in the soil (rock powder) that came while drilling borewell?

S.T7: Soil has to break. (Here he intended to say decompose, but he used the word break)

R: For decomposition what we should need do?

S.T7: We don't need to do anything. It naturally happens through decomposition by a living creature.

S.T1: From (He begins, meanwhile Shali interrupts)

S.T6: *The soil comes from Rock, has that remained in the same place? No. it has not. During rain it floats from one place to other. When it mixes with the soil in that new place it receives nutrients. That is how plants grow.*

R: Yes mam. So you are saying that the soil is already present?

S.T6: No sir, Plants might have been destroyed. Those nutrients mixed with the soil. So that is how plants grow.

R: For soil formation, do you want to say, already at that place plant might be present in dry and decomposed form?

S.T6: No sir, (laughing)

S.T2: She says how plants decompose that she explained.

S.T8: Sister, how plant decomposes?

S.T1: (says something in a low voice)

R: (with a smile and little laugh), another person want to say, let us listen,

S.T9: Sir, it was said that soil had come from Rock. The soil which came from Rock, if we plant a seed immediately will it grow? or has it grown? Does anybody know that?

R: Look, here he had an experience of his own. It didn't grow.

S.T1: *After soil formation, several thousand years later only living creature come into existence. If we see that way, the soil which just formed from rock, if you take that soil and we plant the plant, in that case no plant grow.*

S.T1: We planted only after 10 months.

(There are a noise and discussion in the class)

S.T8: It requires several thousand years.

S.T2: (laughing loudly) ha ha ha…

S.T1: If rock breaks, whether plant grow or not?

(Again noise, everybody answering)

S.T2: Sir, you take land soil (Kollamannu) and rock soil (Paaraimannu). See which one has more salt (she intended to say nutrients).

R: Rise your hand, if you want to say something (towards student teachers)

S.T1: Do the soil that we get from rock have high / low water holding capacity? When you see it

(A word from class comes low – before he completes)

S.T5: Low

S.T2: Low.

S.T1: Why? You are saying that soil has more water holding capacity. Why did which came from rock soil have less water holding capacity?

S.T8: The decomposed soil has more water holding capacity (Padhapaduthapattamannuikkueerappathamaathigam)

S.T1: Why? What do you mean by decomposed soil?

S.T2: Yes. How many times it rains in the soil and how many living creatures (jeevarasigal) dies that become fertilizer.

(Continues)

S.T2: Due to that minerals are obtained in the soil and by that plant grows.

S.T1: (interrupts)

R: It is a very good discussion. Good.

School Classroom:

Here is a situation where student teacher and learner interaction shows how a learner makes some hypotheses to clarify one's own doubt. The learner itself could see the difficulty in explaining the hypothesis and changing his conception. The student teacher and learner interaction is given below.

S1: *Is cycle is living? Miss*

S.T: *How it looks like?*

S1: *It is big and circular in shape.*

S.T*: What do you think?*

S1: *In triangle is there, those are (not) living, (her voice very low*)

S.T: What is living?

S1: mm……..

S.T: Are we living?

S1: Yes, miss.

S.T: For us to live, which are the things necessary?

S1: Water, Sappadu (food), mat for sleeping, house

S.T: Then,

S1: Varanda (Vasal)

S.T: Without mat, house and veranda can't we live?

S1: We can, but little difficulty.

S.T: But we can live. *Does paper, cycle? And all required food for living?*

S1: No, miss

S.T: Then*, do you think it is living?*

S1: *No, miss.*

- **Assertion Three**

Student teachers and learners showed willingness to change ideas in the light of evidence

In the constructivist classroom set up the student teacher and learner changed their understanding of environmental concepts from their initial pre-existing ideas. Through the interactions with peers, teacher (researcher at a teacher education classroom and student teachers in school classroom) and through activities their change in ideas took place. Below which one such situation in the teacher education classroom and at school classroom is presented.

Teacher Education Classroom:

Classroom Interaction on - geographically proximal places have similar nature of water

Here is a situation where researcher and student teacher interaction shows the student teacher raised a question. When it was countered by peers the student teacher stated the reason on which the idea was built. The further discussion clarification was made and student teacher shown willingness to change his earlier idea.

R: Yes **S.T**1, you want to say something.

S.T1*: Is Hokenekkal water is salty?*

S.T2*:No. No. There the water is in good condition.*

S.T1*: If the water is good and drinkable in Hokenkkal means it is also to be good in Dharmapuri*.

R: *Why?*

S.T1: *Because it is near to Dharmapuri.*

S.T2*: The water not yet brought to Dharmapuri. The people use the water which was already there. Hokenekkal water is well sir. Because it is river water and it comes from different places and it is 'Mooligai' (a water contains mooligai –* ***Ayurvedic content****) water, so it is good. If it is filtered and used, it will be good.*

R: Hmm, I see. Do you think (**S.T**1), the ground water in Dharmapuri and river water are of similar nature?

S.T1: *No sir. I got it.*

R: mm.

School Classroom:

The initial student teacher interaction with learners group indicated learners viewed that the leaves won't perspire (transpiration). The student teacher proposed the activity and asked learners' views in a whole class discussion.

(Whole-Class Discussion)

S.T: We have some transparent polythene cover and thread. Can you think of an activity where we are able to find out whether leaves give out water vapour or not?

S1: mm…

S.T: *What will happen if we cover a twig with this polythene bag and tie it with thread for two hours?*

S2: *Leaves will get a little bit dry*

S.T: Within two hours?

S3: No sir

S.T: Then

S3: *Nothing will happen*

S.T: Can we check it?

S3: Ok.

S.T: Ok. Each group takes a (transparent) polythene bag and a piece of thread. Each group will a covering twig with a polythene bag and tie using thread. We will meet once again after lunch.

Activity

The learner groups took polythene bag and inserted a twig inside it and tied it with the thread. The student-teacher assisted them in getting into different parts of the plants and cross checked whether they tied it well.

Post-activity Observation

During the lunch (after one and half hour) students' groups observed polythene bags on plants which they used to cover the twig.

Whole Class Discussion after the observation

S.T*: Did you observe anything in the cover?*

Chorus*: Yes. Water droplets are there on the cover.*

S.T*: Where did they come from?*

S1: It sweats sir, in that, water... water is there (in plastic cover water drops were formed)

S.T: Which one sweats?

S1: Plant

S.T: Which part of plant?

S2: Twig

S.T: Twig?!!

S3: *Leaves, sir*

S.T: Is it?

Chorus: Yes, sir

S.T: *Initially you all said that the leaves won't give out water vapour?*

S1: *We thought like that, sir.*

S.T: Ok. So, do you agree that all plants release water vapour through the leaves?

Chorus: Yes sir

S.T: We call this process it as 'transpiration'. So by this, can you see any relation between rain and trees?

S3: Yes sir. If we have more trees, we will get a good rain.

S.T: Good

- **Assertion Four**

Student teachers' belief on constructivist approach – a key factor to become a constructivist teacher

During the practice teaching session, it was observed that the student teachers who had positive view and belief on constructivist approach could facilitate the classroom better. They could appreciate the students' views and help the learner to construct their understanding of various environmental concepts. Those student teachers who adopted constructivist based classroom but did not completely believe in the constructivist approach struggled to facilitate or taken the role of responding students' doubts, questions or misconceptions immediately instead facilitating discussion or helping learners to engage some activity on which the learner can get an understanding. One such situation in the school class room is presented below:

The student teacher interaction with the learners group is presented below.

S.T: What do you mean by living things?

S2: Stone, soil

S.T: Living thing (stress)!!?

S3: Hey, plants, animals, birds, water, robot (doubtful – slow voice)

S.T: Ok. What are non-living things?

S4: Stone, soil, trees, plants.

S.T: Is it so? What is the difference between living and non-living things?

S4: Living things sir, move from one place to another place.

Chorus: Non – living things are in the same place sir.

S.T: Ok, What else?

S4: Plants….. (Thinking)

S.T: Ok, Which are all non-living things?

S4: Non – living things are plant, creepers, and trees

S.T: Hey, those are all living things, vengayathaleiya (abusing student – by saying one who having an onion kind head)

S4: mm

S.T: Ok, what are all living things?

S4: Living things…. (Thinking -avoiding answering)

S.T: Ok, which are non-living things?

S3: Deer, goat, cow

(Researcher calls the student teacher and interacts with him personally and informs him that the need for patience and about potential of wrong responses to understand learners misconception. The next ten minutes were spent on planning to carry out the task in whole-class discussion). Also see the appendix D5.

♦ **Assertion Five**

Organisation of learning resources is important for successful constructivist classrooms

The teacher education classroom as well as school classroom organisation of learning resources helped or hampered the constructivist classroom learning.

In the teacher education classroom during the 'Health and Hygiene" theme the student teachers had adequate learning resources which facilitated better learning. On the contrary, during the theme imaginary lines in the teacher education classroom the researcher struggled to get the learning resources which hampered the classroom discussion as well as facilitating learning **(refer imaginary lines theme, appendices A7).** Similar such situations were experienced by student teachers during their practice teaching session. For example PBL problem of energy resources at Puthagarm school the

learners work (portfolio) completely relied on the only textbook as a source which impacted the learners' understanding of the theme **(refer energy resources (appendices E, E1))**. Those student teacher who were using PBL experienced this difficulty.

6.2 Discussion:

The intent of this thesis was to understand (i) the student teachers change in perspective on environmental concepts during constructivist classroom experience at teacher education classroom (ii) the extent to which student teachers engage the school learners on environmental concepts through constructivist approach (iii) the learners change in perspective on environmental concepts during constructivist classroom experience and (iv) the student teacher and learners perception about constructivist approach to environmental education.

The findings of this study suggest that constructivist classroom experiences facilitated student teachers and learners to develop better understanding on environmental concepts. This was due to the student teacher and learners' interaction with the peers, teacher and learning resources. Similar such findings were observed by earlier researches (Ross(2008), Liang (1999), Jimarez (2006), Trundle (2000), Zinicola (2003), Marshall (2010), Ramkumar (2003),Muller Dahlberg (1999) and Ibrahim (2002)). Cognitive change often results from interactions with other learners who may hold different understandings (vonGlasersfeld, 1989). These social interactions may challenge our current views as well as allow us to test our currentunderstandings to see how well they help us make sense of and function in our world (Savery & Duffy, 1995).Student teacher and learners proposed hypothesis on concepts and process related to environment. The student selects and transforms information, constructs hypotheses, and makes decisions, relying on a cognitive structure to do so. Conceptual change was visualised when showed a tendency of proposing hypothesis based on their day-to-day experiences and what they come to know from other sources (Ramkumar, 2003).

The finding of the present study shows student teachers and learners showed willingness to change ideas in the light of evidence brought out through interaction among peers and learner and teacher in school and student teacher and researcher in the teacher education classroom. Similar such findings were observed by Soanes (2007) and Ramkumar (2003). Ramkumar study indicates that students expressed autonomy in learning through interactions with teachers and fellow peers; proposed hypothesis based

on certain concepts to explain the occurrence of events during the context of scientific investigation, and showed willingness to change ideas in the light of evidence.

Another finding of this study indicates that student teachers belief on constructivist approach – a key factor to become a constructivist teacher. Smith (2000) study also indicates that the participation in constructivist classroom does positively affect pre – service teachers' attitude toward mathematics teaching and learning as well as beliefs about the classroom environment. Eick (2000) study revealed that, one of the major factors consistently influencing use of constructivist practices is personal history informing beliefs and practices. Similar findings observed in Akcay (2007), Ji (2003) and McCaughan (2010).

However, Savasci (2007) study findings revealed that teachers generally reported that they held constructivist teaching and learning beliefs. However, they had difficulty in incorporating their beliefs into classroom practice. Only one teacher could implement his beliefs related to constructivist teaching and learning into classroom practice; as such, his expressed beliefs were consistent with his observed classroom practice. Personal Relevance and Student Negotiation were the most frequently preferred constructivist components and Critical Voice was the most perceived constructivist component in science classrooms. Shared control was one of the least preferred and was the least frequently perceived and implemented constructivist component in science classrooms. Whole- class activities were frequently observed in all science classrooms. A similar finding was observed by Lew (2001).

The other finding of the present study is that organisation of learning resources is important for successful constructivist classrooms. Hierlmeier (1999) study indicate that teachers made adjustments to their pedagogical thinking focusing more on several constructivist principles: personal relevance and learning styles, student initiative, daily discrepancy resolution, and appreciation for primary sources. MeGlynn (2002) study revealed that firstly, most faculty – educators teach as they were taught, developing constructivist pedagogy requires a process of activity reflection, and dialogue for authentic change to occur. Secondly, planned change is successful when outcomes are identified, and conditions and resources are in place, which support the phases of the change. Gejda (2006) study indicated that participants reported practicing the 5Es (engage, explore, explain, elaborate, and evaluate) in inquiry – based instruction in their

secondary science classrooms. Time, resources, the need to cover material for mandatory assessments, the science topics of concepts being taught, and professional development on inquiry – based instruction were reported to be important considerations in participants' decisions to practice inquiry – based instruction in their science classrooms.

6.3 Researcher's Reflection:

My journey as a researcher in engaging research work on constructivist approach to environmental education at primary pre- service teacher education institution and as an observer at various schools was mixed with joyful and difficult moments.

The joyful moments were the institutional administrations initial cooperation on allowing me to engage the student teacher with as much time I required. The principal of teacher education institution was very supportive throughout the research work. On occasions he requested the colleagues to provide required time for me to engage my research. This is after principal's observation on my engagement with student teacher on orientation of constructivist approaches and he liked it.

I also enjoyed the moments of interacting with student teachers who were very enthusiastic in engaging themselves in research work. Their ideas drove the research in many occasions. Similarly I enjoyed observing learners ideas when they were interacting with student teacher, among themselves and during field visits with curiosity.

I had to face so many challenges during my research work. To start with, in teacher education classes the student teachers took lot of time to complete groups work first problem. I was becoming restless due to the paucity of time as I had nearly three months before practice teaching and after orientation and first problem I had only one and half month and practice teaching was approaching. I started requesting student teacher to work hard to complete the tasks.

After the first problem some of the teacher educators in the college were not happy with the group process. The reasons cited were: (1) it makes lot of noise in the classroom (2) in group work both boys and girls were sit together and discuss as normally it was not allowed in the institute (3) (perceived) it will lead to indiscipline in the institute. So researcher changed individual group presentation into researcher facilitated discussion to avoid teacher educators' wrath as well as to complete each theme in a little shorter time. However, this had an implication in terms of potential misconceptions which were observed during the first presentation of first year.

I took multiple roles as facilitating the classroom interaction, taking photographs, audio recording simultaneously. As a researcher I find it difficult in managing my responsibilities of multiple roles as facilitating the classroom interaction, taking photographs, audio recording, and interacting with each student teachers groups' simultaneously. Apart from this classroom task I need to create learning situation through PBL problem contextually so that student teacher feel learning context is relevant and understand the problem easily. Creating PBL problem required more time to contextually making it.

During the classroom interaction the student teachers tend to ask many questions to may due to lack of resources in the institution, which made drove me to locate information for the student teachers. At occasions the student teachers required some information which the researcher did not know it and they need to have it immediately. This created an additional work for me in locating some information everyday from internet sources and making it printed and sharing it with student teachers. In most occasions I need to explain the information in Tamil as they were available in English. So it became an everyday practice for mer. I tried to persuade student teacher to use internet for information access and took some student teachers to internet café to collect information few days. But it could not be continued for a long, because student teachers had to commute from their home to institute every day. So they did not have time spend time in the evening.

During the practice teaching student teachers experienced similar situation. The contextual questions raised by the learner may not be the textbook oriented. In such a situation, the student teachers needed additional resources. Most of the occasion the teacher left with text book as the only source. I moved from one school to other school every day and occasions two schools in a day I was not able to help everyone in a required time.

To enrich oneself and learning situation it is necessary to have a very good library and internet access / sources for any teacher to take constructivist spirit and practice into the classroom. So there is a lack of enthusiasm I could observe among some student teachers during the research.

The classroom interaction in the school were planned by the student teachers and discussed with me during the visit before the class begin in most occasions. At times it became difficult where the student teacher had class in the first period and most of the student teachers who participated in the research process were commuting from nearby

villages. In such situation even if they had to seek some clarification, it remained as doubt only.

I could see the progress of becoming constructivist teacher has some difficulty through this research work at school.

- Development of a constructivist teacher itself is a slow process. Those student teachers who actively engaged their teaching learning process through constructivist approach took lot of time in repeating answers during discussion on same content for longer time. The student teacher failed to avoid repeated talk of the same while interacting with the learner. Some of the student teachers could able to perceive this after few classes and some others were informed. Then they tried to avoid such situation to a certain extent. The second set of student teachers could not able to do this for a long because the late relation. So, it is observed that, developing oneself as a constructivist teacher itself need to be probed as a further research. It applies to me also.
- The other issue is utilizing the time more appropriately for learning. Even though constructivist classroom provided interactive classroom situation for better understanding of learning content it took much more time to discuss on an issue when one compare with traditional teaching. Thus time management is a bigger challenge and it can be actualised.
- The involvement of the student teacher is varied over a period of time. Generally those who just completed their schooling found to be more interested in participation as they were in touch with the system as well as found to be inclined to learn new things. Those who come after 5 to 10 years of gap found it difficult in overall classroom experience and felt it was a additional burden especially second year student teacher. On the contrary first year married women's were more inclined to participate and they show a kind of competition cum cooperation with the younger peers.

SUMMARY AND CONCLUSION

7.0 Introduction

The future of the world depends largely on the wisdom with which human use science and technology. This is, in turn, depends on the character, distribution, and effectiveness of the education that people receive (Kemal &Oguz, 2007). The problems of the world in different domains increase its complexity which requires collective action. Education being an influential subsystem of society needs to change its role from preparing a better individual to group of individuals who can work together to solve emerging and future problems. But when we look at Indian education system, the existing practices of education in school and universities, knowledge is presented as primordial and no more relevant to address new age requirement. This demands a paradigm shift in education system from knowledge transmission to knowledge construction. It requires the change in role on the part of the teacher and learner in teaching learning process. In this context constructivistic approach viewed as a suitable pedagogy for today's classroom setting.

Theoretical framework

7.0.1 Constructivism in Education

The new paradigm, "constructivism," is a psychological philosophical perspective contending that individuals form or construct much of what they learn and understand (Shunk, 1996). It is a descriptive theory that highlights the way people learn or develop rather than the way they should learn (Richardson, 1997).

7.1 Guiding principles for constructivist classrooms

In a constructivist classroom, the teacher searches for students' understandings of concepts, and then structures opportunities for students to refine or revise these understandings by posing contradictions, presenting new information, asking questions, encouraging research, and/or engaging students in inquiries designed to challenge current concepts. The following five overarching principles are evident in constructivist classrooms.

- Teachers pose problems of emerging relevance
- Teachers build lessons around primary concepts and "big" ideas
- Teachers seek and value their students' points of view

- Classroom activities challenge students' suppositions
- Teachers assess student learning in the context of daily teaching

7.2 Becoming constructivist teachers: descriptors

To become constructivist teacher one need to adopt certain set of teaching behaviour in his / her teaching. The descriptors are:

- Constructivist teachers encourage and accept student autonomy and initiative
- Constructivist teachers use raw data and primary sources, along with manipulative, interactive, and physical materials
- When framing tasks, constructivist teachers use cognitive terminology such as "classify," "analyze," "predict," and "create."
- Constructivist teachers allow student responses to drive lessons, shift instructional strategies, and alter content.
- Constructivist teachers inquire about students' understandings of concepts before sharing their own understandings of those concepts.
- Constructivist teachers encourage students to engage in dialogue, both with the teacher and with one another.
- Constructivist teachers encourage student inquiry by asking thoughtful, open-ended questions and encouraging students to ask questions of each other.
- Constructivist teachers seek elaboration of students' initial responses.
- Constructivist teachers engage students in experiences that might engender contradictions to their initial hypotheses and then encourage discussion.
- Constructivist teachers allow wait time after posing questions.
- Constructivist teachers provide time for students to construct relationships and create metaphors.
- Constructivist teachers nurture students' natural curiosity through frequent use of the learning cycle model.

These twelve descriptors highlight teacher practices that help students search for their own understandings rather than follow other people's logic. The descriptors can serve as guides to educators forge personal interpretations of what it means to become a constructivist teacher.

7.3 Constructivism: Implication to teacher education

The key implication of the constructivist paradigm for teacher education is that student teachers should have time and encouragement to reflect on what they are learning. Because of the short duration of pre-service programs there is a tendency to think we must "give them the theory" while we have the chance, leaving them to work out the implications as they teach. This is an unfortunate approach, however, not only because it models transmission pedagogy but because it gives the students inadequate opportunity to assess and adapt theory (Fosnot, 1989; Tom, 1997; Wideen& Lemma, 1999). Fosnot (1996) maintains that, to achieve a constructivist teacher education program, field experiences must take place in settings that are conducive to experimentation and in which curriculum is approached "in an integrated, learner-centered fashion with emphasis on learner investigation, reflection, and discourse".

7.4 Common methods and strategies used in ConstructivisticApproach

The common methods and strategies used in constructivistic approach are:

7.4.1 Cooperative Learning

Johnson, Johnson, and Holubec (1993) define CL as "the instructional use of small groups so that students work together to maximize their own and each other's learning".

7.4.2 Collaborative learning

Collaborative learning is an approach to teaching that is built on philosophical positions like Dewey's, Vygotsky's, and Habermas', which assert that knowledge is socially constructed within a community of learners. If knowledge is socially constructed in learning communities, an important feature of any method of teaching within this framework is to promote meaningful dialogue among students.

Cooperative learning's origins in a concern that competition can impede learning, collaborative learning began with a concern that the hierarchical authority structure of traditional classrooms can impede learning.

7.4.3 Problem based learning

Problem Based Learning (PBL) stresses the use of real - life problems as a stimulus for learning. In PBL, students work in small groups on these problems, and, in the course of discussing them, formulate goals for self-directed learning. The learning resulting from

these activities is constructive and contextually meaningful. Students using PBL build teamwork skills as they learn from each other and work together to solve the problem. The PBL process generally includes four main steps: (1) introducing the problem, (2) exploring what students do and do not know about the problem, (3) generating possible solutions to the problem, and (4) considering the consequences of each solution and selecting the most viable solution.

7.4.4 Inquiry learning

In Inquiry learning, the teacher poses question and then allows time for the students to consider possible solutions, plan an investigation, and go about solving the question posed to them. It helps students focus on the development of key skills such as hypothesis development, planning procedure for activities, data collection, data analysis, and drawing conclusions. In the classroom, inquiry-oriented learning can take many forms. As the teacher, one can help scaffold and build upon the inquiry process by assisting and encouraging students to ask questions related to the topic being investigated. Students then have the responsibility to identify and define their own individual procedures for answering these questions to make the content personal and meaningful to them.

7.4.5 Field Visits

A field visit enables the learners to experience materials and phenomena in their true and natural relationships. They can observe real conditions and gather actual data. Studies have shown that more education can be acquired in a pleasant outdoor environment than in the classroom. It provides an opportunity for learners to become keen observers, appreciating the beauty and order of the natural environment. It verifies classroom instruction and laboratory exercises.

The present study focuses on constructivistic approach to Environmental Education using all the above mentioned methods. Because there is growing concern about the state of the environment, and at the same time we are very often confused by the complexities of economic, ethical, political, and social issues related to it. Environmental problems become everyday news in our media.

7.5 Environmental Education: Meaning and Definitions

In general Environmental education is, forming desirable belief, attitude, value, interest and understanding about environment. While understanding the meaning of environmental education three of its connotations i.e. education about, education through and education for the environment are implicit in the meaning.

Education ABOUT environment means making environment a subject of investigation. It is based on a specific topic or a restricted area in which the main concern is to gain information and comprehension. It can be done in the classroom as well as in the field.

Education THROUGH environment usually connotes using environment as a medium for study, the use of real life situations as the basis for learning and enquiry. It is essentially an approach or method of enquiry usually conducted through field work.

Education FOR the environment means education for conserving and improving the environment, a study of environmental problems and working for their prevention and solution. Problem solving, decision making, development of an environmental ethics and critical judgment are called for here. Commonly accepted definition of environmental education is: Environmental education is aimed at producing a citizenry that is knowledgeable concerning the biophysical environment and its associated problems, aware of how to help solve these problems, and motivated to work toward their solution (Gigliotti, 1990).

7.6 Goals of Environmental Education

The overall goal of environmental education is to generate environmental action so as 'to improve all ecological relationships including the relationship of humanity with nature and people with one another' (Belgrade Charter, 1975). The Tbilisi Intergovernmental Conference on Environmental Education (1977) elaborated the goals of environmental education as the following: to foster clear awareness of, and concern about economic, social, political and ecological interdependence in urban and rural areas; to provide every person with opportunities to acquire the knowledge, values, attitudes, commitment and skills needed to protect and improve the environment; and to create new patterns of behaviour of individuals, groups and society as a whole towards the environment.

7.7 Objectives of Teaching Environmental Education

The Belgrade Charter has suggested the following six objectives for teaching environmental education.

Awareness: To help individuals and social groups acquire an awareness and sensitivity to the total environment and its associated problems.

Knowledge: To help individuals and social groups, acquire basic understanding of the total environment, its associated problems and humanity's critically responsible presence and role in it.

Attitude: To help individuals and social groups, acquire social values, strong feelings of concern for the environment and motivation to actively participate in its protection and improvement.

Skills: To help individuals and social groups, acquire the knowledge and skills of solving environmental problems.

Evaluation Ability: To help individuals and social groups, evaluate environmental measures and educational programmes in terms of ecological, political, economical, social, aesthetic and educational factors.

Participation: To help individuals and social groups, develop a sense of responsibility and urgency, regarding environmental problems to ensure appropriate action for solving the problems.

7.8 Guiding principles of Environmental Education

The Tbilisi Declaration, a document resulted from this conference, outlined the following guiding principles for environmental education.

Consider the environment in its totality – natural and built, technological and social (economic, political, technological, cultural historical, moral, aesthetic); Continuous, lifelong education process beginning at pre – school stage and spanning the entire stages through all formal and non – formal systems of education. Inter – disciplinary in its approach, drawing from various branches and integrating into a holistic and balancing perspective. Environmental issues are examined from local, regional, national and international perspectives and students receive insight into the environmental conditions and problems in global contexts. Promote proper values and attitudes and the need for cooperation of local, national and international bodies in the prevention and solution of environmental problems. Develop environmental sensibility, knowledge and problem solving skills among the students.

Assist learners to discover the symptoms and real causes of environmental problems and arrive at strategies for environmental protection and preservation.

Utilize environmental resources for teaching – learning processes and evolve educational approaches for teaching and learning with due emphasis on practical first hand empirical experiences. Emphasize the complexity of environmental problems and develop critical thinking and creative problem – solving ability in order to deal with complex environmental problems (NCERT, 1985).

7.9 Need of effective teacher training for Environmental Education

To Indian school system, Environmental Education (EE) is not altogether a new thrust. Educating children about, through and for the environment have always been stressed by earlier national commissions and committees. However, it was only during 1986, that a special focus was made in the country's New Policy on Education. The Policy States that "There is a paramount need to create a consciousness of the environment. It must permeate all ages and all sections of the society beginning with the child. Environmental consciousness should inform teaching in schools and colleges. This aspect will be integrated in the entire educational process". The National Curriculum Framework for School Education (NCFSE) 2000 (NCERT, 2000) also highlights the need for including environmental concerns at all the levels of schooling. It asserts the Fundamental Duties (Article 51 A of part IV A of the Indian Constitution): "…protect and improve the national environment including forests, lakes, rivers, wildlife and to have compassion for the living creatures… "(Common Core Components, p.36). As one of the General Objectives of Education, it mentions "understanding of the environment in its totality, both natural and social, and their interactive processes, the environmental problems and the ways and means to preserve the environment" (p.40).

In consonance with these documents, environmental studies was made an independent subject at the primary level and topics related to environment were suitably infused with different science and social science subjects at all school stages. As a sequel to this explicit policy statement, efforts have been made in the country to introduce EE in school education through reorganizing the content and methodologies of teaching. At the lower primary stage, i.e., up to class V, EE is introduced as integrated themes anchoring concepts of both natural and social phenomena. In Classes VI – X, Environmental Education has been integrated suitably in social sciences, languages and science and

technology. The objectives at this stage are to help the children appreciate the contributions of scientists and develop sensitivity to the uses and misuses of sciences, as well as concern for a clean environment and preservation of the ecosystem. Environmental Education is infused into the teaching of other schools subjects like mathematics, crafts and work experiences, and languages.

It is a reality that a high percentage of teaching force at the school level suffers from environmental illiteracy – illiteracy in terms of lack of understanding of the gripping environmental issues the country is facing, the methodologies of teaching – learning for infusing EE in to the school curriculum (Ravindranath, 1997). Teachers need to plan for projects and activities for students' participation in environmental problem – solving. This necessitates equipping teachers with necessary knowledge, attitudes and skills for the effective implementation of EE at the school level.

Realising the above need, the country has made several attempts in introducing EE as one of the thrust areas at teacher training level, and environmental education became a prominent component in in - service training programme. But, it is impossible to achieve all competencies within a single education programme. In this context, pre – service training of teachers is of paramount importance. Recommendation 17 of the Tbilisi Conference emphasizes the pre-service training of teachers. Competent teachers do not emerge out of the blue. They must acquire and practice the attributes of competency and skills during their education. Teachers education colleges should, therefore, review their teacher education programmes in the light of the philosophy of environmental education.

7.10 Importance of Constructivistic Approach in Environmental Education at pre service teacher educational level

Environmental Education requires less focus on training and more focus on developing wisdom and flexible applications of diverse problem solving strategies. The teachers in classroom not just supply information, but make the student to understand the role of the individual in environmental problems and what alternatives and / or actions are necessary to solve such problems. It is important that the problem / issues of environment in EE should engage students with real life issues and reinforce the notion

that scientific facts must be accumulated and analysed in social and cultural contexts in order to make valid value judgement.

The teaching methods and styles which environmental education requires is constructivist, student directed and experiential in orientation. Successful EE demands an in-depth environment related content knowledge and ownership (responsible environmental behaviour) (Hungerford & Volk, 1990). This can be achieved through constructivist based learning. Learning activities in constructivist settings are characterized by active engagement, inquiry, problem solving, and collaboration with others.

Constructivist approaches provides risk free environment for the learner in the classroom and teachers' role as a facilitator further helps learners own thinking which lead to the sense of ownership. This helps students interest, enthusiasm, and satisfaction towards learning. The training of environmental education and field experience helps teachers to have better environmental literacy and better conceptual understanding. Along with the environmentally literate teacher, if the schools have better infrastructural facilities further facilitate students' achievements in environmental education. Through constructivist based pedagogical approach student express their personal beliefs and multiple perspectives on environmental issues and perform well in their exams. From the review of related literature it is observed that there are very few studies conducted on constructivism and environmental education in teacher education. Further, pedagogical demands of environmental education go well with the constructivist methods. So it is necessary to conduct research on constructivist approach to environmental education at teacher education level in Indian context.

7.11 Research questions

1. What is the level of understanding about constructivistic approach among pre-service primary student teachers?
2. What is the level of understanding about Environmental Education among pre-service primary student teachers?
3. How well the primary pre – service student teachers and their learners change their perspectives on Environmental Concepts using Constructivistic approach based classroom process?

4. Do the student teachers and school learners appreciate developing environmental knowledge through constructivistic approach?

7.12 Statement of the Problem

A study on Constructivistic Approach to Environmental Education among Primary Pre – Service student teachers

7.13 Objectives

1. To study student teachers changing perspectives (conception) about environmental concepts in the constructivistic classroom.
2. To study the application of constructivist teaching methods and strategies by student teachers while teaching environmental concepts in their classroom during internship programme.
3. To study students changing perspectives (conception) about environmental concepts in the constructivistic classroom.
4. To study the student teachers perception about constructivistc approach to Environmental Education.
5. To study the school learners perception about constructivistc approach to Environmental Education.

7.14 Explanation of the terms

7.14.1 ConstructivisticApproach

In the literature on constructivism two terms viz., constructivistic and constructivist are frequently used interchangeably because of their unified meaning held by scholars (Sigrén, 2003; Simons, 2000; Terwindt, S.2000; Jonassen, D. H. 1992). In the present study also both the terms have been used at different places interchangeably. Constructivistic approach is a broader term which indicates that knowledge is constructed by the learner/individual by employing the means such as Problem Based Learning, Inquiry learning, concept mapping, cooperative and collaborative learning.

7.14.2 Environmental Education

Environmental Education is the education provided to the learners through different curricular content / concepts to equip them with better knowledge, understanding and developing action skills which will help to sustain better physical environment.

7.14.3 Changing perspective

Changing Perspective means the change that occurs in the student teachers and learners' or students' conceptual idea, viewpoint, and the way of thinking about any concept which he/she exhibits through their verbal or nonverbal expression.

Conceptual Change: Learners frequently enter learning situations with knowledge inconsistent with scientific views. This is termed as misconception / novice conception / tenacious ideas in different situations. The instruction is to enable students to construct scientifically accepted ideas while rejecting inaccurate constructs or larger cognitive structure. This process is called conceptual change.

7.14.4 Pre –service primary student teachers and Learners

The student teacher of first and second year primary teacher training institution, who are eligible to teach primary schools after completing the course. The school students are referred as learners.

7.15 Research Methods

In the present study the students/children were referred as learners. This research study is framed as a qualitative case study for several reasons. First, case study allowed me to examine closely student teachers' development of ideas of constructivism and changing perspectives about environmental concepts within a specific context, namely problem based learning (PBL), Inquiry learning methods in a collaborative learning setup. In the same way, second, it allowed me to examine closely the extent the student teachers use/adopt constructivist teaching in their classroom as a teacher and changing their own learners' perspectives about environmental concepts. Thirdly, it allowed me to use my own notes, plans, and reflections about the process as a participant observer at teacher education classroom and as an external observer at school classroom.

7.15.1 Location and Context of the Study

The present study was conducted at Tirupattur Teacher Training Institute, Tirupattur, Vellore District in Tamil Nadu. The name Tirupattur itself means a union of ten villages. Even though nearby towns like Vaniambadi, Ambur have many Tanneries and shoe making industries, Tirupattur don't have any big industrial climate except one sugar-cane factory and sandal wood oil factory (presently closed) in nearby villages. The economic activities of the town are mainly agricultural.

The main crops around the villages are sugar cane, banana, cotton, cereals, pulses, rice, coconut trees, mango farms, sapota (Tropical fruit with a rough brownish skin and very sweet brownish pulp, generally called cheeku in Northern India). In recent years, villagers mainly cultivate cotton and those who have water facility go for sugar cane, banana and rice. The cultivation of pulses and cereals has gradually decreased. Due to agricultural crisis villagers are gradually losing interest in their farming activities and going in for some manual jobs outside the village. In recent years Beedi (a country made cigarette by tobacco leaves) and 'agarbati' (incense sticks) making has become common jobs in some villages.

In Tirupattur town, there are people belong to different religions viz., Hindu, Muslim, Christian and Jains. But the majority of the people belong to Hindu community. With regard to the composition of people in the surrounding villages of Tirupattur town, a peculiarity can be observed. While in some villages people belonging to a particular caste living completely segregating themselves from other caste groups, where as a mixed composition of people living together in some other villages. With regard to educational facilities Tirupattur has one Engineering college, two Arts and Science Colleges, four B.Ed. colleges and 10 Primary Teacher Training Institutions. Moreover, it is also an education-district (not a revenue district). The Tirupattur Teacher Training Institution is the first co-education teacher training institute in the town. It is located in Pachal village which is at the extreme end of North West part of the town.

7.15.2 Selection of Schools

Out of 21 schools allotted by District Education Office for internship programme (practice teaching) of Tirupattur Teacher Training Institute (TTTI), 4 elementary (Grade I to Grade V) and 3 middle schools (Grade I to Grade VIII) in the surroundings of Tirupattur have participated. This was done based on the willingness of school head masters. The schools were:

1. Panchayat Union Elementary School, Kathirampatti
2. Panchayat Union Elementary School, Madavalam
3. Panchayat Union Elementary School, Mel Achamangalam
4. Panchayat Union Elementary School, Salai Nagar (Indicated as no. 17 in the map
5. Panchayat Union Middle School, Kalaroor
6. Panchayat Union Middle School, Puthagaram

7. Panchayat Union Middle School, Kurumbar Colony

7.15.3 Selection of Student Teachers

For the objective one, all the 49 (19 male and 30 female) student teachers of first year and 50 (20 male and 30 female) student teachers of second yearwere purposively selected. For objective two, 11 student teachers of first year and 6 student teachers of second year were selected based on their willingness from the selected schools.

7.15.4 Selection of Themes

The selection of the themes for the research was done based on three aspects: (1) content analysis of text books, (2) concept maps of identified themes from content analysis (3) Focus group discussion with student teachers.

Examining all the three aspects (content analysis, concept maps and FGD) the following themes were identified by the researcher.

(a) House
(b) Health and Hygiene
(c) Soil
(d) Water
(e) Energy Resources
(f) Environmental Pollution

7.15.5 Data Collection Methods

The main data collecting strategies employed in this study were Focus Group Discussion, Participant observation, Semi and Unstructured interviews and Document analysis.

7.15.5.1 Participant observation

The data for the present study was collected through participant observation. The participant observation focuses on "…human interaction and meaning viewed from the insiders view point in everyday life situations and settings" (Jorgensen, 1989 cited in Ramkumar, 2003). In this study the participant observation was done in two phases.

In the first phase the participant observation was centered on teacher education classrooms. The focus was on observing how student teachers engage themselves in constructivist based classroom activities. In order to conduct the participant observation I took the role of a teacher educator. This allowed me to access and reach student teachers

in terms of "access to the world of everyday life from the stand point of a member or insider" (Jorgensen, 1989 cited in Ramkumar, 2003).

In the second phase the participant observation was centered on various school classrooms which were chosen for the present study. The researcher took the role of a practice teaching supervisor in the schools. This allowed me to access the learner and student point of view as an observer. I observed the way student teacher engaged learners in a constructivist based classroom activities. In these phases I observed two aspects (i) the perspective change (conceptual change) among the student teachers and the learners on environmental concepts. (ii) how well the student teacher adopted the constructivist principles in their classroom engagement in schools as a teacher.

Recording observations

In order to record observation Tape recorder, still photography and field notes were used. Tape recorder and still photography were used to record the action / event, when it really occurred. Tape recorder was used occasionally to report on the action of an event as it was happening in front of the observer so that narrative of an event is stored as it happens. Field notes were used to report on the day-to-day observation after the event occurred. Although this approach is well suited for the study it had its own problems. At early stages of my fieldwork, I faced some difficulty in writing down all my observation notes. This was because a number of activities took place simultaneously and in a short period of time. In the later stage at occasions I started recording my field experiences in audio tape to avoid time constraint in preparing for the next day's work.

7.15.5.2Interviews

The interviews with student teachers in teacher education classroom were more of conversation between teacher educator and the student teachers (group), student teacher – student teacher, student teacher group – student teacher group. However, the questions were not focused on individual student teacher but more on the group. Similar pattern of conversation happened between student teachers and their learners in schools. The casual conversations done after the class with student teachers provided lot of insight into various things such as their aspirations, opinion on the education system, teacher preparation programme, their social background etc.

Tape recorder was used to record the interview. In the event of non availability of audio cassette the interview were recorded with a note book or note pad.

7.15.5.3Document Analysis

In this study document analysis consisted of the analysis of elementary level Environmental Studies (EVS) textbooks prescribed by Government of Tamil Nadu. This comprised of EVS text books of Grade I to Grade III, Environmental Science and Social Science text books of Grade IV and V, Environmental components from Science and Social Science text books of Grade VI to VIII. The content analysis was done to identify the general environmental themes which are dealt during the research work. Student teachers group work as well as learners' group works written either in note books and sheets were analysed to identify their understanding on environmental concept / themes. In order to analyse the contents of student teachers, learners note books or sheets translation procedure was adopted.This gave me an insight into the way school learners view an activity or set of activities or theme.

7.15.6 Process of data collection

The entire study was carried out in 2 phases.

7.15.6.1 Phase –I (with student teachers)

In the beginning certain general environmental concepts were identified from the textbooks of environmental science (Grade I – IV), Science and Social Science (Grade V – VIII). The identified concepts were divided into two groups. Those concepts derived from Grade I to V were placed in group I, and those derived from Grade VI to VIII were placed in group II. This was done primarily keeping in mind the nature of examination to be taken up by the student teachers. After initial rapport building with student teachers, I started orienting about making concept map in both the first year and second year classes. I explained about how to make concept maps, different kinds of concept maps, and things to be taken care while making concept maps. During this time, I made a concept map on the black board about crops, based on student teachers ideas. After this I gave a concept in each period (allotted for my research) in the classroom and student teachers' made the concept maps. This had taken one week time to complete. The first year student teachers made concept maps of health and hygiene, water and land. The

second year student teachers made concept maps on energy resources, environment and earth.

During this time I observed that, in afternoon of the day the second year students-teachers were going for physical education class, after the first period, regularly. The first year student teacher used to go after the second period. Here I found that there were good numbers of students chatting instead of playing games. So, with the permission of the Principal, I conducted focus group discussion in the afternoons. Through focus group discussion with student teachers I tried to know what do they think about the concept 'environment', and what are the issues they considered as related to environmental problem. There were quite a few issues the student teachers felt as very important environmental problem. One of them was traffic congestion in the town. But due to other reasons such as lack of time availability, subtle resistance from local faculty members, and student teachers' tight schedule with other academic works, this issue could not be taking up during the current research work.

Based on the Focus Group Discussion and concept maps, the environmental problems were framed by me considering institutional factors. Then, I gave orientation about cooperative/collaborative learning by explaining about group formation, kind of leadership, material resources, role of the teacher and the assessment procedure. I also explained about Problem Based Learning, Inquiry learning and steps to be followed to solve a given problem. I have administered Multiple Intelligence **(**MI) test through the scores of MI each student teachers' strength in various intelligence areas was identified.
I have tried to group those teachers who scored high in one particular intelligence test in one group. However other factors such as previous academic achievement, gender and their location were taken into consideration the group in a heterogeneous composition. I have tried to put the student teachers who have scored more in particular intelligence grouped together. Each class was divided into nine groups. Each group comprised of 5 student teachers; some group had six student teachers. Initially few student teachers wanted some changes in the formation of a group, because they wanted their close friends in their group. But I explained the reasons and convinced them. Here I faced some resistance from four teacher educators while making groups comprising both men and women. I was suggested to go for separate men and women groups. But the Principal stood by me and said that, ***"it is your research work, so you carry on the way you***

want". Initially these teacher-educators were really angry, but gradually they cooperated with me.

After making the groups, I introduced the theme in the classroom by providing a paper to each group where the theme was written on it and asking a student teacher from any group to read it out loudly. If the student teachers wanted to listen to it once again, I asked another student teacher to read it again. Then the student teachers identified and listed down whatever the content they know related to the theme and what are the contents they should know to solve the problem and corresponding learning issues (concepts) in their individual groups. During this time, I moved around each group and observed their work and interacted whenever need arised**.** Once they listed down what they wanted to know (mostly in the form of questions) and learning issues (mentioning concepts), they started looking for the sources of information. Usually school textbooks, library books (public library), newspapers, the researcher and occasionally internet were their sources of information. Through discussions based on the collected information the group members made a report which communicated solution for the theme based problem. During these discussions if they proposed hypothesis or they found some more questions to be answered they were free to carry out some activities or test the hypothesis through collaborative problem solving by making them think critically or again look for solution through different sources of information, and this is where inquiry learning become handy. Also at times the group members sourced the information from the researcher. Through such activities they experienced the PBL and Inquiry method.

For each problem the groups took 1 to 3 week time to complete. During these group works I always moved around each group and audio recorded the interaction. As nine groups were working simultaneously, I decided to audio-record the interaction between me and the members of the particular group. Initially it was difficult for the researcher on how to go about it. Gradually I tried to see their group work by their writings or asking them on what they discussed so far. Whenever I have seen any alternative conception in their explanation, I probed them to know their perspective, and demanded further information to support their ideas. At times the group members themselves had contradictory views leading to searching for further information. Sometime they would find difficulty in locating information for which I suggested some sources or provided the information. Once all the groups completed their task, they

presented it to the whole class. At this point, most of the alternative conception/misconception they expressed earlier during their own group work was in progress was absent here. This was because the student teachers not only interacted in their own groups but they interacted with other group members after college hours. Occasionally some alternative conceptions expressed during the presentation were discussed in the whole class. The student teacher presentation of the first problem took 4 periods, which brought the resistance from the teacher educators. Also there was repetition of similar ideas expressed by different groups which brought less participation of students in post presentation discussions. To avoid this, the researcher used whole class discussion at the end of group work of each theme on alternative / novice / tenacious / misconceptions of the student teachers which they expressed during the group work.

The student teachers were asked to assess themselves as well as their peers about their participation and performance at the end of each theme. For this assessment Ann Lambros (2004) Individual student assessment group rubrics was used. The rubric is of two parts. The first part focus on participation in group work, one's contribution, listening to others, asks and answering questions, stays on tasks, finding information, cooperating with other members, offering positive suggestions, exhibiting leadership and encouraging others. The second part focuses on generating effective learning issues, demonstrating hypothesis and testing, grasping of new concepts, applying new information for the group work, shows skill at teaching peers, demonstrating cooperation and consensus building, effective participation, identification and sharing appropriate resources, demonstrating growth of knowledge, exhibits functional decisive and focused qualities, exhibits leadership, encouraging others, assessing own strength and weakness appropriately. The rubric used four point scale where 4 indicate excellent, 3 indicates good, 2 indicates fair and 1 indicates poor. Student teacher group also submitted the learning logs (See in DVD) for each theme.

The student teachers' work (student teacher group journal) I got from them for analysis. I wrote my experience regularly on a separate note book (field notes). When I do not get time to write field note I audio recorded the particular day experiences which was later used along with field notes.

7.15.6.2 Phase – 2 (Student teacher teaching at school)

After almost three month exposure (From 20th November to 15th February) of constructivistic approach based methodologies in learning of content (along with learning about behavioristic methods) the student teachers went for a two month internship programme. In the first two week of internship, they were asked to observe the regular teachers' classes. During this time, I visited all the selected schools and interacted with the Head Masters, teachers and student teachers. During those interactions I looked for the willingness of the student teachers in implementing constructivist based lessons in the school class lesson transaction, willingness of the school head masters in giving permission to student teachers to teach through constructivist approach, interest of the regular teachers of the school, and the availability of the classrooms and space (Because in some of the schools two grade a schools were sharing a classroom and due to summer season viz., February to April, the learners could not be taken outside the classroom). Based on these factors, I identified 7 schools for the study. Because of these factors some of the active participative student teachers of phase I who were very much interested in using constructivist approach in their classroom could not participate in phase II, and were not included.

A total of 28 student teachers were allotted to teach in these 7 schools during their practice teaching session. Among these 18 student teachers were from first year and 10 student teachers were from second year of their programme. Out of this, 11 student teachers from first year and 6 student teachers from second year showed interest and agreed to teach lessons through constructivist methods, over and above their with regular lessons. The remaining student teachers did not agree. This was because; whatever the lessons they taught through constructivist method were not to be counted as their 'practice teaching' lessons. These student teachers felt it was burdensome to teach through constructivist method as they were supposed to prepare two lesson plans along with teaching learning material (TLM) every day for the regular lessons.

During the internship of student teachers, I used to go to one or two schools in a day and observed their lesson transaction. I was contacting the student teachers through telephonic talk and (or) evening meetings and (or) going early to the schools. The student teachers used Problem Based Learning and Inquiry Approach in their learners. The learners from the school divided into cooperative groups for this research. The criteria

followed for making student teachers groups is used for making student groups. For framing the context based problem the student teachers went around the village and the school surroundings, and came out with certain environmental issues to be dealt in class. At times, student teachers discussed with the researcher for framing the problem. They adopted the problem based learning procedure which they experienced in their own teacher-education class. I observed their lesson transaction and audio recorded their interaction with their learners. During those times, I could see learners' alternative conceptions and conceptual change through interaction with student teachers and their peers. The school learners used their textbook as a major source of information. Occasionally they referred to other sources. I got some books from Centre for Environmental Education, Bangalore for their reference. I collected learner work sheets for the analysis purpose. After six weeks of constructivist based teaching learning process, I interacted with school learners to know how they perceived the constructivist classroom. I audio recorded their views. I wrote my experience in field note. The student teachers found very difficult to write their experiences, because they were hard pressed with time, they had to prepare two lesson plans every day and Teaching Learning Materials for teaching. So virtually they had very little time to write their experiences. Instead, they shared their views with me during lunch time and during evening hours and these interactions have been recorded in my field notes.

Once they returned from internship, I again started interacting with student teachers on how they perceived teaching the environmental concepts through constructivist approach (with semi structured interview). I interacted with those who used constructivist approach in their lesson –transactions and those who did not. I also asked the student teachers to make concept maps on those concepts which were discussed in teacher education classroom. Once this process was over I thanked the student teachers for their cooperation.

7.16 Data Analysis

The data analysis was done during fieldwork and post field work. The data interpretation involved constructing the meaning on the student teachers, learners changing perspectives on environmental concepts through analysis of classroom interaction. The data analysis describes the units of analysis, procedure adopted for data analysis and the techniques adopted for establishing validity of qualitative data.

7.16.1 Units of Data Analysis

The data was collected from various sources such as student teachers and learners group work, researcher's field notes, audio tapes, still photographs, concept maps, rubrics for self and peer assessment and learning logson student teachers / learners working in groups or whole classroom situation. In order to assess the learning from these sources, it became apparent that individual is not the most useful unit of analysis. Thus, for the present study, the analysis of events and products that involved the negotiation between two or more participants in a group with different understanding of the situation became the necessary part of analysis (Vygotsky, Newman, Grifin& Cole cited in Ramkumar, 2003). The evidence presented is much more typical of all the participants than individuals. However, products of individual student teacher or learner were used in special circumstances to strengthen the evidence.

7.16.2 Procedure of Data Analysis

The data analysis was done in the following manner

1. Student teachers and learners participation in Constructivist classroom on environmental themes / concepts
2. Student teachers and learners perceptions about Constructivist Approach to Environmental Education

7.16.2.1 Student teachers and learners participation in Constructivist classroom on environmental themes / concepts

The data analysis consists of transcribing the recorded interviews. This was one of the most time consuming and frustrating activities during the post-field work. Each interview was clearly dated and labelled. Then I read the un-edited versions carefully, correcting the minor grammatical errors. During my second reading of un-edited versions of transcription I listened once again the tapes to identify the missing linkages. Then, I carefully selected the relevant information leaving the redundant information. The selected information from transcribed tapes, field notes along with the student teachers or learners group works (notebooks or sheets) were triangulated to view the occurrence of change in perspectives on environmental themes, recurring patterns of using the constructivist principles and methods by student teachers in their classroom engagement. These were analysed with respect to objectives one, two and three.

7.16.2.2 Student teachers and learners perceptions about Constructivist Approach to Environmental Education

Qualitative content analysis of audio transcription of semi – structured interviews of Student teachers and learners was done to find out the perception about constructivistic approach in environmental education as part of achieving objective 5 of the study.

7.16.3 Establishing validity of Qualitative Data

In the present study Triangulation was used as a validity procedure, where researchers search for convergence among multiple and different sources of information to form themes or categories in a study (Creswell & Miller, 2000). In the triangulation procedure, researcher provides corroborating evidence collected through multiple methods such as observation, interviews and documents to locate major or minor themes (Ramkumar, 2003).

7.17 Findings of the study

The findings of the study have been expressed in the form of five assertions. The focus of these assertions is on the role of constructivist approaches on student teachers and learners learning.

- **Assertion One**

Constructivist classrooms facilitated student teachers and learners to develop better understanding on environmental concepts.

- **Assertion Two**

Student teacher and learners proposed hypothesis based on certain concepts to explain the occurrence of events.

- **Assertion Three**

Student teachers and learners showed willingness to change ideas in the light of evidence

- **Assertion Four**

Student teachers' belief on constructivist approach – a key factor to become a constructivist teacher

- **Assertion Five**

Organisation of learning resources is important for successful constructivist classrooms

7.18 Discussion of findings :

The intent of this thesis was to understand (i) the student teachers change in perspective on environmental concepts during constructivist classroom experience at teacher education classroom (ii) the extentto which student teachers engaged the school learners on environmental concepts through constructivist approach (iii) the learners change in perspective on environmental concepts during constructivist classroom experience and (iv) the student teacher and learners perception about constructivist approach to environmental education.

The findings of this study suggest that constructivist classroom experiences facilitated student teachers and learners to develop better understanding on environmental concepts. This was due to the student teacher and learners' interaction with the peers, teacher and learning resources. Similar such findings were observed by earlier researches (Ross (2008), Liang (1999), Jimarez (2006), Trundle (2000), Zinicola (2003), Marshall (2010), Ramkumar (2003), Muller Dahlberg (1999) and Ibrahim (2002)). Cognitive change often results from interactions withother learners who may hold different understandings (vonGlasersfeld, 1989). These social interactions may challengeour current views as well as allow us to test our currentunderstandings to see how well they help us make sense of and function in our world (Savery& Duffy, 1995).Student teacher and learners proposed hypothesis on concepts and process related toenvironment. The student selects and transforms information, constructshypotheses, and makes decisions, relying on a cognitive structure to do so. Conceptual change was visualised when showed a tendency of proposing hypothesis based on their day-to-day experiences and what they come to know from other sources (Ramkumar, 2003).

The finding of the present study shows student teachers and learners showed willingness to change ideas in the light of evidence brought out through interaction among peers and learner and teacher in school and student teacher and researcher in the teacher education classroom. Similar such findings were observed by Soanes (2007) and Ramkumar (2003). Ramkumar study indicates that students expressed autonomy in learning through interactions with teachers and fellow peers, proposed hypothesis based on certain concepts to explain the occurrence of events during the context of scientific investigation, and showed willingness to change ideas in the light of evidence.

Another finding of this study indicates that student teachers belief on constructivist approach – a key factor to become a constructivist teacher. Smith (2000) study also indicates that the participation in constructivist classroom does positively affect pre – service teachers' attitude toward mathematics teaching and learning as well as beliefs about the classroom environment.Eick (2000) study revealed that, one of the major factor consistently influencing use of constructivist practices is personal history informing beliefs and practices. Similar findings observed in Akcay (2007), Ji (2003) and McCaughan (2010).

However, Savasci (2007) study findings revealed that teachers generally reported that they held constructivist teaching and learning beliefs. However, they had difficulty in incorporating their beliefs into classroom practice. Only one teacher could implement his beliefs related to constructivist teaching and learning into classroom practice; as such, his expressed beliefs were consistent with his observed classroom practice. Personal Relevance and Student Negotiation were the most frequently preferred constructivist components and Critical Voice was the most perceived constructivist component in science classrooms. Shared control was one of the least preferred and was the least frequently perceived and implemented constructivist component in science classrooms. Whole- class activities were frequently observed in all science classrooms. A similar finding was observed by Lew (2001).

The other finding of the present study is that organisation of learning resources is important for successful constructivist classrooms. Hierlmeier (1999) study indicate that teachers made adjustments to their pedagogical thinking focusing more on several constructivist principles: personal relevance and learning styles, student initiative, daily discrepancy resolution, and appreciation for primary sources. MeGlynn (2002) study revealed that firstly, most faculty – educators teach as they were taught, developing constructivist pedagogy requires a process of activity reflection, and dialogue for authentic change to occur. Secondly, planned change is successful when outcomes are identified, and conditions and resources are in place, which support the phases of the change.Gejda (2006) study indicated that participants reported practicing the 5Es (engage, explore, explain, elaborate, and evaluate) in inquiry – based instruction in their secondary science classrooms. Time, resources, the need to cover material for mandatory assessments, the science topics of concepts being taught, and professional development

on inquiry – based instruction were reported to be important considerations in participants' decisions to practice inquiry – based instruction in their science classrooms.

7.19 Conclusion

The findings of the present study indicate that through constructivist based classroom experience student teachers and learners understand the environmental concepts better. Their interaction with the various sources (peers, teachers, textbooks, newspapers, journals, TV, internet, libraries) in different point of time helped them to widen their understanding of environmental related concepts. It was observed that the social interaction with the group members and others play a key role in individual's understanding of various concepts. This Vygotskian view that reinforces the idea in student to resort to the process of interaction in order to understand how others process the ideas rather than trying to comprehend the content/concept is an isolated manner.

In this regard it is necessary to expose student teachers to constructivist classroom experiences in the teacher education programme itself. The constructivist based teacher education programme has to constantly deal with questions of practice as well as theory, linking teacher preparation programme closely with the school practices. This way the student teachers acquire a deep interest in theory and become reflective and critical practitioners.

7.20 Suggestions for the Further Research

The scope for further research can be seen in terms of understanding

- Impact of teacher beliefs of constructivist approach on their classroom practice
- Studies on student teachers and learners changing perspectives of various disciplinary concepts
- Information and Communication Technology enabled constructivist classrooms on student teachers and learners learning

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