CHAPTER 1
INTRODUCTION

In our everyday lives outside the school, we enjoy the curiosity, inventiveness
and constant querying of children. They actively engaged with world around them,
exploring, responding, inventing and working things out. Childhood is the period of
growth and change, involving one’s physical and mental capacities to the fullest. It
involves being socialized into adult society, into acquiring and creating knowledge of
the world and oneself in relation to others in order to understand, to act, and to
transform. Each new generation inherits the storehouse of culture and knowledge in
society by integrating it into one’s own web of activities and understanding, and
realizing its fruitfulness in creating afresh. ‘Child centered pedagogy’ means giving
primacy to children’s experiences, their voices, and their active participation. This
kind of pedagogy requires us to plan learning in keeping with children’s
psychological development and interests. The learning plans therefore must respond
to physical, cultural and social preferences within wide diversity of characteristics and
needs. Learning must take place through interactions with the environment around,
nature, things and people, both through actions and through language. Further,
interaction with teachers and with peers opens up many more rich possibilities. The
physical activity of moving, exploring and doing things on one’s own, with peers or in
company of adults, and using language – to read, to express or ask, to listen and to
interact – are the key process through which learning occurs. Much of our school
learning is still individual based (although not individualized). The teacher is seen as
transmitting ‘knowledge’, which is usually confused with information, to children,
and organizing experiences in order to help children learn. Teachings approaches
should be such that tend to focus on the socialization of children and on the ‘receptive
features’ of children learning. Instead, we need to nurture and build on their
constructive and creative capabilities their inherent interacts in making meanings, in
relation to the world in ‘real’ ways thro
ugh acting on it and creating ideas, and in relation to human. The field of
education has undergone a significant shift in thinking about the nature of human
learning and the conditions that best promote the varied dimensions of human
designed instruction; from behaviorism to cognitivism and now to constructivism (Cooper, 1993). Certainly one of the most influential views of learning during the last two decades of the 20th century is the perspective known as constructivism. Although by no means an entirely new conceptualization of learner and the process of learner (roots can be traced to John Dewey and progressive educators, to Piaget and Vygotsky and to Jerome Bruner and discovery learning), constructivist perspectives on learning have become increasingly influential in the past twenty years and can be said to represent a paradigm shift in the epistemology of knowledge and theory of learning. The curriculum and evaluation standard for school education. National Curriculum Framework (NCF), prepared by working group of NCERT (2008), does also highlight the importance of introducing constructivist approach in education system.

Traditional teaching and learning is the process of the transmission of knowledge from teacher to student. It is essentially a one-way process. This teaching method can hinder the development of individual student’s active and creative abilities, and students who experience only this method of education may no longer be considered sufficient for the needs of a future educated citizenry. Socio-Constructivism is basically a theory about how students learn by fitting new information together with what they already know. Because everyone lives in the natural and built environment, everyone has some knowledge of these environments. Based on the constructivist theory, everyone therefore has the background and the potential ability to learn about and acquire knowledge of environmental science. Socio-Constructivist teaching models can therefore be a very useful approach to teaching environmental science.

1.1.1 Theory of Constructivist Approach

Formalization of the theory of constructivist approach is generally attributed to Piaget (1954, 1970 & 1980), who articulated mechanisms by which knowledge is internalized by learners. He suggested that through processes of accommodation and assimilation, individuals construct new knowledge from their experiences. When individuals assimilate, they incorporate the new experience into an already existing framework without changing that framework. This may occur when individuals' experiences are aligned with their internal representations of the world, but may also occur as a failure to change a faulty understanding; for example, they may not notice
occur as a failure to change a faulty understanding; for example, they may not notice events, may misunderstand input from others, or may decide that an event is a fluke and is therefore unimportant as information about the world. In contrast, when individuals' experiences contradict their internal representations, they may change their perceptions of the experiences to fit their internal representations. According to the theory, accommodation is the process of reframing one's mental representation of the external world to fit new experiences. Accommodation can be understood as the mechanism by which failure leads to learning: when we act on the expectation that the world operates in one way and it violates our expectations, we often fail, but by accommodating this new experience and reframing our model of the way the world works, we learn from the experience of failure, or others' failure.

1.1 2 Constructivism

The term constructivism most probably is derived from Piaget's reference to his views as “constructivist” (Gruber & Voneche, 1977), as well as from Bruner’s description of discovery learning as “constuctionist” (1966). It is an approach to teaching and learning based on the premise that cognition (learning) is the result of ‘mental construction’. In other words, students learn by fitting new information together with what they already know. Constructivist believes that learning is affected by the context in which an idea is taught as well as by student’s beliefs and attitudes. Constructivism term refers to the idea that learner construct knowledge for themselves—each learner individually (and socially) construct meaning—-as he or she learns (Hein, 2001). Constructivism is a philosophy of learning founded on the premise that, by reflecting on our experience, we construct our own understanding of the world we live in, each of us generate themselves our own ‘rules’ and ‘mental models’, which we use to make sense of our experiences (Jacqueline and Brook, 2008). Learning, therefore, is simply the process of adjusting our mental models to accommodate new experiences.

According to the constructivist method, people construct the knowledge in their minds when they have real life experience (Isman, 1999). Indeed, according to Durmus (2001), constructivism is concerned with the process of constructing the information. The information that we have created depends on what we know in advance, what kind of experiences we have had, how we organize these experiences
worldview is formed by our interpreting these experiences. Teachers cannot fully transfer their own perceptions to students, because students and teachers do not have the similar knowledge and experience. The purpose is to upbring individuals who make their questionings and who have developed critical thinking skills. The use of these tools which can achieve this objective is extremely important since it provides meaningful and lasting learning. Constructivism is a theory of learning where learners formulate or construct their own knowledge and understanding based on their experiences (Savery and Duffy, 2001). Through the theory of constructivism, individuals learn through exploration on their own, as well as through interactions with others (Carlson and Maxa, 1998). “Constructivism acknowledges the learner’s active role in the personal creation of knowledge, the importance of experience in this knowledge creation process, and the realization that the knowledge created will vary in its degree of validity as an accurate representation of reality” (Doolittle and Camp, 1999). Constructivism is used for teaching in vocational, agricultural, and career and technical education, as well as other disciplines.

Thus Constructivism is basically a theory -- based on observation and scientific study -- about how people learn. It says that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences. When we encounter something new, we have to reconcile it with our previous ideas and experience, maybe changing what we believe, or maybe discarding the new information as irrelevant. In any case, we are active creators of our own knowledge. To do this, we must ask questions, explore, and assess what we know.

1.1.3 Guiding Principles Of Constructivism

In the classroom, the constructivist view of learning can point towards a number of different teaching practices. In the most general sense, it usually means encouraging students to use active techniques (experiments, real-world problem solving) to create more knowledge and then to reflect on and talk about what they are doing and how their understanding is changing. The teacher makes sure she understands the students' preexisting conceptions, and guides the activity to address them and then build on them. There are several guiding principles of constructivism. The following principles are based on the work of various constructivist theorists.
them and then build on them. There are several guiding principles of constructivism. The following principles are based on the work of various constructivist theorists.

- Learning is a search for meaning. Therefore, learning must start with the issues around which students are actively trying to construct meaning. Information is sifted by the individual to create beliefs from interpretations of self-referent information and environmental contingencies. The construction of meaning relies on interpretation (Airasian & Walsh, 1997; Crowther, 1997; Ertl & Kraan, 1997; Glaserfeld & Steffe, 1991; Heylighen, 1997; Stewart, 1994; Yager, 1991).

- Meaning requires understanding wholes as well as parts and parts must be understood in the context of wholes. Therefore, the learning process focuses on primary concepts, not isolated facts (Can, 2006).

- In order to teach well, we must understand the mental models that students use to perceive the world and the assumptions they make to support those models. Motivation is a key component in learning. Beyond the use of rewards and punishments, constructivists contend that the motivations possessed by individuals will greatly affect their abilities and capacities to learn as well as what it is that they learn. The most basic motivation for learning is an individual's desire (need?) to make sense of the world (Bandura, 1986; Gruender, 1996; Hein, 1991; Piaget, 1926; Piaget & Inhelder, 1969; Vygotsky, 1978).

- The purpose of learning is for an individual to construct his or her own meaning, not just memorize the "right" answers and regurgitate someone else's meaning. Since education is inherently interdisciplinary, the only valuable way to measure learning is to make the assessment part of the learning process, ensuring it provides students with information on the quality of their learning (Can, 2006).

- Learning is internally controlled and mediated. Learners take in information, process it to fit their personal frameworks, and build new understanding. That knowledge construction occurs internally, in the private domain of each individual (Can, 2006).

- Knowledge is constructed in multiple ways, through a variety of tools, resources, experiences, and contexts. Constructivist learning theory tells us
have always used experience as a valuable instructional tool; that is why we arrange field trips and hands-on projects. It is why an internship or apprenticeship is essential to the completion of most vocations, including teaching. (Can, 2006).

Learning is a process of accommodation, assimilation, or rejection to construct new conceptual structures, meaningful representations, or new mental models. Every person is surrounded by an infinite variety of images, ideas, information, and other stimuli that provide raw material for thought and understanding. If new information matches the learner's existing understanding, it is easily assimilated. If it does not match, the learner must determine how to accommodate it, either by forming new understanding, or rejecting the information. (Can, 2006).

Learning is both an active and reflective process. Learners combine experience (action) and thought (reflection) to build meaning. Both parts must be present to support the creation of new knowledge. This is the constructivist concept of equilibration. Experiences or concepts that are encountered for the first time undergo one of two processes: assimilation, subsuming a new idea into an existing schema (organizational group), or accommodation, creating new schema to contain novel information. This organization and reorganization takes place constantly within the human mind (Airasian & Walsh, 1997; Piaget, 1926; Piaget & Inhelder, 1969; Glaserfeld & Steffe, 1991).

Social interaction introduces multiple perspectives through reflection, collaboration, negotiation, and shared meaning. In many situations, learning is enhanced by verbal representation of thoughts—it helps to speak about an idea, to clarify procedures, or float a theory to an audience. The exchange of different perceptions between learners enriches an individual's insight.

It takes time to learn: learning is not instantaneous. For significant learning we need to revisit ideas, ponder them try them out, play with them and use them. This cannot happen in 5-10 minutes (Can, 2006).

Learning involves language. The language we use influences learning. People talk to themselves as they learn, and language and learning are inextricably intertwined. For the constructivist, language is a synthetic tool that enables
Learning involves language. The language we use influences learning. People talk to themselves as they learn, and language and learning are inextricably intertwined. For the constructivist, language is a synthetic tool that enables individuals to make connections beyond what has been learned in the past because in the formulation of words, sentences, and paragraphs, learners must organize their thoughts into communicable ideas, a process that often results in knowledge (Hein, 1991; Piaget, 1965; Hirtle, 1996; Sexton & Griffin, 1997; Vygotsky, 1978).

Learning is both an individual and a social process. Constructivists believe that knowledge is developmentally organized into universal cognitive structures. Moreover, knowledge has a social component—individuals' interactions with their environment are critical and must not be discounted. Our learning is intimately associated with our connection with other human beings, our teachers, our peers, and our family. Conversations, interaction with others and collaborations are an integral aspect of learning (Airasian & Walsh, 1997; Bandura, 1986; Ertl & Kraan, 1997; Piaget, 1926; Piaget & Inhelder, 1969; von Glaserfeld & Steffe, 1991; Vygotsky, 1978).

Learning is not the passive acceptance of knowledge which exists "out there". Learning involves the learner engaging with the world and extracting meaning from his/her experiences. The process of learning takes place when individuals attempt to make sense of the world around them. In response to an environmentalist viewpoint, those who espouse a constructivist view would contend that learning takes effort on the part of the learner; there is no "osmosis" effect (Akyalcin, 1997; Crowther, 1997; Glaserfeld, 1995; Hein, 1991; Heylighen, 1997; Murphy, 1997; Piaget, 1926; Piaget & Inhelder, 1969; Sexton & Griffin, 1997; Vygotsky, 1978).

Learning is contextual. We do not learn isolated facts and theories in some abstract ethereal land of the mind separate from rest of our lives. We learn in relationship to what else we know, what we believe, our prejudices and our fears (Can, 2006).

1.1.4 Faces of Constructivism
**Trivial constructivism:** The simplest idea in constructivism, root of all the other shades of constructivism described below, is trivial constructivism (Glasersfeld, 1990), or personal constructivism or cognitive constructivism. In this the principle has been credited to Piaget (1954), a pioneer of constructivist thought, and can be summed up by the statement “Knowledge is actively constructed by the learner. not passively received from the environment”.

This reacts against other epistemologies promoting simplistic models of communication as simple transmission of meanings from one person to another. The prior knowledge of the learner is essential to be able to "actively" construct new knowledge. Learning is work - effective learning requires concentration. There are some things you have to learn before others. The education system has always been built on a progression of ideas from simple to complex.

Questions arise, however. What is "the environment"? What is "knowledge"? What is the relation of knowledge to "the environment"? What environments are better for learning? Trivial constructivism alone says nothing about these issues, and these are the shortcomings that the other faces of constructivism attempt to address.

**Radical constructivism:** Radical constructivism adds a second principle to trivial constructivism (Glasersfeld, 1990) which is expressed as “Coming to know is a process of dynamic adaptation towards viable interpretations of experience. The knower does not necessarily construct knowledge of a "real" world.” Knowledge is therefore is result of a self-organized cognitive process.

We do all create our own realities. Radical constructivism does not deny an objective reality, but simply states that we have no way of knowing what that reality might be. Mental constructs, constructed from past experience, help to impose order on one's flow of continuing experience. However, when they fail to work, because of external or internal constraints, thus causing a problem, the constructs change to try and accommodate the new experience.

From a radical constructivist perspective, communication need not involve identically shared meanings between participants. It is sufficient for their meanings to be compatible (Hardy and Taylor, 1997). If neither of the parties does anything
From a radical constructivist perspective, communication need not involve identically shared meanings between participants. It is sufficient for their meanings to be compatible (Hardy and Taylor, 1997). If neither of the parties does anything completely unexpected to the other, then their illusions of identically shared meaning are maintained (Glasersfeld, 1990).

The emphasis here is still clearly on the individual learner as a constructor. Neither trivial nor radical constructivism look closely at the extent to which the human environment affects learning: it is regarded as part of the total environment. These issues are focused on in more detail by social, cultural and critical.

**Socio-Constructivism or Social constructivism:** Incorporating influences traditionally associated with sociology and anthropology, socio-constructivism emphasizes the impact of collaboration, and negotiation on thinking and learning. Many of the authors that identify with social constructivism trace their ideas back to Vygotsky (1978), a pioneering theorist in psychology who focused on the roles that society played in the development of an individual. Socio-constructivism can be defined as an approach according to which individual knowledge relies on its social construction of it (Doise and Mugny, 1984). Especially relevant in this respect are the communication processes (learning dialogs) occurring in situations where at least two persons try to solve a problem. The social world of a learner includes the people that directly affect that person, including teachers, friends, students, administrators, and participants in all forms of activities. Accordingly, learning designs should enhance local collaboration and dialogue but also engage other actors (e.g. domain experts) to participate in certain ways. Research on collaborative learning is particularly interested in learning mechanisms that are triggered by specific collaborative activities.

Teaching strategies using social constructivism as a referent include teaching in contexts that might be personally meaningful to students, negotiating taken-as-shared meanings with students, class discussion, small-group collaboration, and valuing meaningful activity over correct answers (Wood, Cobb & Yackel, 1995). Cobb (1994) contrasts the approach of delivering mathematics as "content" against the technique of fostering the emergence of mathematical ideas from the collective practices of the classroom community. Emphasis is growing on the teacher's use of
often in science and mathematics classrooms, but perhaps not surprisingly, have been common for a longer time in humanities subjects like social studies and communication.

**Cultural constructivism**: Beyond the immediate social environment of a learning situation are the wider context of cultural influences, including custom, religion, biology, tools and language. For example, the format of books can affect learning, by promoting views about the organization, accessibility and status of the information they contain. "[What we need] is a new conception of the mind, not as an individual information processor, but as a biological, developing system that exists equally well within an individual brain and in the tools, artifacts, and symbolic systems used to facilitate social and cultural interaction" (Vosniadou, 1996).

The tools (including language and other symbolic systems as well as physical tools) that we use affect the way we think. Salomon and Perkins (1998) identify two effects of tools on the learning mind. (1) They redistribute the cognitive load of a task between people and the tool while being used. For example, a label can save long explanations, and using a telephone can change the nature of a conversation. (2) The use of a tool can affect the mind beyond actual use, by changing skills, perspectives and ways of representing the world. For example, computers carry an entire philosophy of knowledge construction, symbol manipulation, design and exploration, which, if used in schools, can subversively promote changes in curricula, assessment, and other changes in teaching and learning.

Higher mental functions are, by definition, culturally mediated. They involve not a direct action on the world but an indirect one, one that takes a bit of material matter used previously and incorporates it as an aspect of action. Insofar as that matter itself has been shaped by prior human practice (e.g. it is an artifact), current action incorporates the mental work that produced the particular form of that matter. (Cole and Wertsch, 1996)

Cobern (1993) writes of the world of subject matter and the internal mental world of the student as competing conceptual "ecologies", an image which invokes pictures of competing constructs, adaptation and survival-of-the-fittest. This is a somewhat more complex picture than radical constructivism. It highlights the need to
pictures of competing constructs, adaptation and survival-of-the-fittest. This is a somewhat more complex picture than radical constructivism. It highlights the need to consider both contexts fully, that of the student and that of the knowledge to be learned.

Critical constructivism: Critical constructivism looks at constructivism within a social and cultural environment, but adds a critical dimension aimed at reforming these environments in order to improve the success of constructivism applied as a referent. Taylor (1996) describes critical constructivism as a social epistemology that addresses the socio-cultural context of knowledge construction and serves as a referent for cultural reform. It confirms the relativism of radical constructivism, and also identifies the learner as being suspended in semiotic systems similar to those earlier identified in social and cultural constructivism. To these, critical constructivism adds a greater emphasis on the actions for change of a learning teacher.

An important part of the framework is the promotion of communicative ethics, that is, conditions for establishing dialogue oriented towards achieving mutual understanding (Taylor, 1998). The conditions include: a primary concern for maintaining empathetic, caring and trusting relationships; a commitment to dialogue that aims to achieve reciprocal understanding of goals, interests and standards; and concern for and critical awareness of the often-invisible rules of the classroom, including social and cultural myths. This allows rational examination of the often implicit “claims to rightness” of the participants, especially those derived from social institutions and history (Taylor, 1996).

Cultural myths that are prevalent in today’s education systems include (Taylor, 1996):

- The rationalist myth of cold reason - where knowledge is seen as discovery of an external truth. This can lead to the picture of the teacher in a central role as transmitter of objective truths to students. This philosophy does not promote clarifying relevance to the lives of students but instead promotes a curriculum to be delivered.

- The myth of hard control - which rends as the teacher's classroom role as controller, and "locks teachers and students into grossly asymmetrical power
Together these myths produce a culture that portrays classroom teaching and learning as "a journey through a pre-constructed landscape". Modification of such entrenched environments to reduce these myths and promote approaches based on constructivism is problematic, because of the self-reinforcing nature of administration, and the effects of wider culture. Taylor (1996) argues for an optimistic approach, and that teachers need to work collegially towards reconstructing education culture together rather than heroically on their own.

**Constructionism:** Constructionism is a constructivist learning theory and theory of instruction. It states that building knowledge occurs best through building things that are tangible and sharable (Ackermann, David & Cecilia, 2009). Constructionism asserts that constructivism occurs especially well when the learner is engaged in constructing something for others to see. According to Papert (1991) "Constructionism shares constructivism's connotation of learning as 'building knowledge structures' irrespective of the circumstances of the learning. It then adds that this happens especially felicitously in a context where the learner is consciously engaged in constructing a public entity, whether it's a sandcastle on the beach or a theory of the universe". Thus 'constructionism' is not just learning-by-doing, but engaging reflexively and socially in the task. Both the creation process and the produced artifacts ought to be socially shared. Important concepts are consciously engaged and public entity.

The cognitive structures are assumed to underlie such phenomena as problem solving and transfer ability. Virtually all cognitive science theories entail some form of constructivism to the extent that cognitive structures are typically viewed as individually constructed in the process of interpreting experiences in particular contexts. However, there are many versions of constructivism, suggesting a continuum anchored by trivial constructivism at one end, which stresses the individual as constructing knowledge but is concerned with whether or not the constructions are correct representations, to radical constructivism, which rejects the notion of objective knowledge and argues instead that knowledge develops as one engages in dialogue with others. In the study, researchers consider on teaching and learning that has been conducted from postmodern constructivist perspectives. The focus is on the social dimensions of constructivism where researchers have drawn distinction among
conducted from postmodern constructivist perspectives. The focus is on the social dimensions of constructivism where researchers have drawn distinction among different faces of constructivism. Interest in social constructivism has been motivated by a number of factors, many of which were actually informed by cognitive perspectives on teaching and learning

1.1.5 Conceptual Framework of Socio-Constructivism

The social world of a learner includes the people that directly affect that person, including teachers, friends, students, administrators, and participants in all forms of activity. This takes into account the social nature of both the local processes in collaborative learning and in the discussion of wider social collaboration in a given subject, such as science. Socio-constructivism provides an explanation for how learning can be fostered effectively through interactive pedagogical practices. It emphasizes that learning takes place in a social environment and views learners as “active constructors of their own learning environment” (Mitchell & Myles, 1998). We learn not as isolated individuals, but as active members of society. What we learn and how we make sense of knowledge depends on where and when, such as in what social context, we are learning.

Socio-constructivist theory advocates that students master new approaches of learning through interacting with others (Doise, 1990). This theory is an extension of Piaget's (Piaget, 1926) theory that focused on the reasons for cognitive developments in individuals. In socio-constructivist theory, emphasis is given to interactions rather than actions themselves. A given level of individual development allows participation in certain social interactions which produce new individual states which, in turn, make possible more sophisticated social interactions, and so on (Dillenbourg, 2005). The socio-constructivist approach focuses on the individual's development with respect to the social interaction, without really differentiating or identifying the underlying factors that enhance collaborative learning. Here the social interaction is assumed as a black box that boosts collaborative learning. The experimental setup for the socio-constructivist approach follows a three stage process of pre-test, individual or collaborative learning and post-test.

Vygotsky, the father of Socio-constructivism, claimed that learning occurs through dialogue (Vygotsky, 1978). This dialogue is initially *intermental*, meaning it
through internal or *intramental* dialogue (Vygotsky, 1978). Thus learning is both interactive in the sense that learners must interact with sources of ideas/knowledge in social settings, as well as in the sense that they must take an active part in reconstructing ideas/knowledge within their own minds. Further, Vygotsky points out that learning depends on the purpose or motivation for learning which Lantolf (2000) calls “activity theory”.

Another fundamental concept in social constructivism is the idea of *scaffolding*. In its literal sense, scaffolding is a support structure that is erected around a building under construction. When the building is strong enough, the scaffolding can be removed and the building will remain strong and stable. In the metaphorical sense used by Vygotsky (1978), scaffolding refers to the support provided by others—parents, peers, teachers or reference sources such as dictionaries which enables students to perform increasingly well. Hammond and Gibbons (2001) interpret scaffolding as high challenge, high support. In other words, teachers need to set up tasks which challenge students to perform beyond their current capacity. To enable students to achieve these tasks, teachers also need to provide support measures which make it possible for students to perform at this new level. If the task is not challenging enough, students will be bored and possibly become unmotivated; however, if there is not enough support, students will be frustrated and may give up. Thus, scaffolding enables students to achieve great leaps forward in their learning. Although teacher support is essential in scaffolding, it is also essential to unleash students from the teacher-fronted classroom setting.

The concept of scaffolding is also linked with what Vygotsky calls the learner’s Zone of Proximal Development (ZPD). By this he is referring to the range of tasks and activities which the student can achieve with scaffolding, but which may be beyond his current abilities if he is unassisted. Teachers need great skill in assessing and then exploiting their students’ ZPD. Mercer (1994) in his article entitled Neo-Vygotskian Theory and Classroom Education succinctly outlines the basic principles of constructivism and how they can be applied in the classroom. He states that Vygotsky viewed the child as a profoundly social being who only becomes aware of itself through social interaction with others. The cognitive development of a child is not just driven by internal processes rather it is by active adaptation to its social
itself through social interaction with others. The cognitive development of a child is not just driven by internal processes rather it is by active adaptation to its social world. Processes that occur between the child and others become the basis for processes that take place within the child. Dialogue, interaction and argument become internalized to form the basis for reflection, logical reasoning and the formation of new concepts.

As a result, Vygotsky saw a central and constructive role for adults in fostering childhood development, this he felt could be best achieved through extending the child’s zone of proximal development (ZPD). Mercer (1994) quotes Vygotsky himself as stating that the ZPD is "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more able peers.” In other words, a student’s learning or problem solving ability can be extended and enhanced by providing the appropriate kind of cognitive support and assistance.

Social constructivist theory emphasizes that we need to encourage students to create their own meaning, rather than to impose a teacher’s interpretation of the meaning upon them. Too often, however, teachers dominate the lesson by ‘telling’ students the meaning of the text rather than assisting them to create meaning themselves. The questions teachers ask need to show a genuine interest in the meanings the students construct rather than insisting on pre-conceived understandings. In fact, what we want students to learn is not the content of the reading text. So our questions need to focus on text awareness rather than text content. Perhaps the most effective text awareness questions are those which help students gain insight into the way texts are structured (Palincsar. 1998).

1.1.6 Assumptions of Social Constructivism

Social constructivism is based on specific assumptions about reality, knowledge and learning (Kim, 2001). To understand and apply models of instruction that are rooted in the perspectives of Socio-constructivists, it is important to know the premises that underlie them.
For the social constructivist, reality cannot be discovered: it does not exist prior to its social invention.

**Knowledge:** To social constructivists, knowledge is also a human product, and is socially and culturally constructed (Ernest, 1999; Gredler, 1997). Individuals create meaning through their interactions with each other and with the environment they live in.

**Learning:** Social constructivists view learning as a social process. It does not take place only within an individual, nor is it a passive development of behaviors that are shaped by external forces (McMahon, 1997). Meaningful learning occurs when individuals are engaged in social activities.

### 1.1.7 Intersubjectivity of Social Meanings

Intersubjectivity is a shared understanding among individuals whose interaction is based on common interests and assumptions that form the ground for their communication (Rogoff, 1990). Communications and interactions entail socially agreed-upon ideas of the world and the social patterns and rules of language use (Ernest, 1999). Vygotsky (1978; 1981) emphasized the social orientation of cognitive development, collaboration becoming a route to assimilation and independent action by re-structuring and re-patterning internal cognition. He drew attention to inherent links between emerging sociability and intellectual growth through the medium of language. Construction of social meanings, therefore, involves intersubjectivity among individuals. Social meanings and knowledge are shaped and evolve through negotiation within the communicating groups (Gredler, 1997; Prawat & Floden, 1994). Any personal meanings shaped through these experiences are affected by the intersubjectivity of the community to which the people belong.

Intersubjectivity not only provides the grounds for communication but also supports people to extend their understanding of new information and activities among the group members (Rogoff, 1990; Vygotsky, 1981). Knowledge is derived from interactions between people and their environments and resides within cultures (McMahon, 1997). The construction of knowledge is also influenced by the intersubjectivity formed by cultural and historical factors of the community (Gredler, 1997; Prawat & Floden, 1994). When the members of the community are aware of
their intersubjective meanings, it is easier for them to understand new information and activities that arise in the community.

**Figure 1.1: Intersubjectivity of social meanings**

Two people, interacting through communication, help to extend each other's understanding of what makes a rainbow. The flash graphic above illustrating the intersubjectivity of social meanings was created by Augustin and Huang (2002).

1.1.8 **General Perspectives of Social Constructivism on Learning**

Social constructivists see as crucial both the context in which learning occurs and the social contexts that learners bring to their learning environment. There are four general perspectives that inform how we could facilitate the learning within a framework of social constructivism (Gredler, 1997):

**Cognitive tools perspective:** Cognitive tools perspective focuses on the learning of cognitive skills and strategies. Students engage in those social learning activities that involve hands-on project-based methods and utilization of discipline-based cognitive tools (Gredler, 1997; Prawat & Folden, 1994). Together they produce a product and, as a group, impose meaning on it through the social learning process.

**Idea-based social constructivism:** Idea-based social constructivism sets education's priority on important concepts in the various disciplines e.g. part-whole relations in mathematics, photosynthesis in science, and point of view in literature (Gredler, 1997; Prawat, 1995; Prawat & Folden, 1994). These "big ideas" expand learner vision and become important foundations for learners' thinking and on construction of social meaning (Gredler, 1997).
**Pragmatic or emergent approach:** Social constructivists with this perspective assert that the implementation of social constructivism in class should be emergent as the need arises (Gredler, 1997). Its proponents hold that knowledge, meaning, and understanding of the world can be addressed in the classroom from both the view of individual learner and the collective view of the entire class (Cobb, 1995; Gredler, 1997).

**Transactional or situated cognitive perspectives:** This perspective focuses on the relationship between the people and their environment. Humans are a part of the constructed environment (including social relationships); the environment is in turn one of the characteristics that constitutes the individual (Bredo, 1994; Gredler, 1997). When a mind operates, its owner is interacting with the environment. Therefore, if the environment and social relationships among group members change, the tasks of each individual also change (Bredo, 1994; Gredler, 1997). Learning thus should not take place in isolation from the environment.

After reviewing the impetus for understanding the influence of social and cultural factors on cognition, Palincsar (1998) identified mechanisms for hypothesizing socio-constructive learning perspectives, drawing from Piagetian and Vygotskian accounts. The empirical research reviewed illustrates (a) the application of institutional analyses to investigate schooling as a cultural process, (b) the application of interpersonal analyses to examine how interactions promote cognition and learning, and (c) discursive analyses examining and manipulating the patterns and opportunities in instructional conversation. The review was concluded with a discussion that Social constructivist perspectives focus on the interdependence of social and individual processes in the co-construction of knowledge and the application of this perspective to selected contemporary issues, including: acquiring expertise across domains, assessment, educational equity, and educational reform. Zembylas (2005) published paper on ‘Three Perspectives on Linking the Cognitive and the Emotional in Science Learning: Conceptual Change, Socio-Constructivism and Poststructuralism’. The purpose of the paper was to organize and critique the theoretical work done so far on the relation between the cognitive and the emotions in science learning and suggested possible directions for research that takes into consideration this relation between the cognitive and the emotional. To do this, then,
science learning and suggested possible directions for research that takes into consideration this relation between the cognitive and the emotional. To do this, then, three perspectives were discussed and compared in terms of: how they theorized the relationship between emotion and cognition in science learning, and what implications they suggested for science pedagogy. The first perspective was embedded within a cognitivist framework and was drawn on conceptual change theory (CCT), a theory that still had an immense influence on research in science learning. The second perspective was informed by another influential theory in science education research: constructivism and in particular, the idea of social and cultural construction of learning. In this perspective, the situatedness of knowledge was highlighted and the interrelatedness of cognitive and emotional aspects of learning is recognized; however, the focus still remained on cognitive and metacognitive processes (situated knowledge, the zone of proximal development etc.). Finally, the third perspective was drawn on recent poststructural insights with an emphasis on the constitutive role played by language, the body and discursive practices in the construction and experience of learning: in this perspective, the interrelations of emotion and cognition were highlighted in ways that make artificial any separation between them. At last he concluded that in spite of the recognition of the interplay between emotional and cognitive processes, most research in science education favored socio-constructivism as primarily focused on cognitive and metacognitive processes.

1.1.9 Social Constructivism And Instructional Models

Instructional models based on the social constructivist perspective stress the need for collaboration among learners and with practitioners in the society (Lave & Wenger, 1991; McMahon, 1997). Lave and Wenger (1991) assert that a society’s practical knowledge is situated in relations among practitioners, their practice, and the social organization and political economy of communities of practice. For this reason, learning should involve such knowledge and practice (Lave & Wenger, 1991; Gredler, 1997). Social constructivist approaches can include reciprocal teaching, peer collaboration, cognitive apprenticeships, problem-based instruction, webquests, anchored instruction and other methods that involve learning with others. Buchanan and Smith (1997) suggested engagement, connection, application and culmination as a
four-phase model that could be used to infuse constructivist practice into higher education courses. Engagement was used to assess students’ own perceptions so they could connect course material with their personal knowledge and previous experiences. Then, they connected their gathered information and compared their assumptions with scholarly knowledge. Next, learners applied their reconstructed knowledge to important current issues or they constructed their own knowledge out of their understanding of personal experiences, and reflections by others and suggestions by different philosophies. Finally, the learners culminated or synthesized all the information and demonstrate their own understanding of the material. The authors strongly believed that most teacher educators were aware of the assets of constructivism and suggested the need to broaden teaching approaches to allow for multiple learning styles. Jonassen (1998) illustrated a model for designing constructivist learning environments, in which he revealed the process of constructing a constructivist learning environment. Briefly, the model began with, for instance, a problem accompanying various interpretative and intellectual support systems. The learner was expected to interpret and solve the problem. Related cases and information resources supported understanding of the problem and suggested possible solutions. Finally, the social/contextual support systems helped users to implement the constructivist learning environment.

1.1.10 Socio-Constructivist Perspectives on Teaching and Learning

- The Learner

The learner as a unique individual: Socio-constructivism views each learner as a unique individual with unique needs and backgrounds. The learner is also seen as complex and multidimensional. Social constructivism not only acknowledges the uniqueness and complexity of the learner, but actually encourages, utilizes and rewards it as an integral part of the learning process (Wertsch, 1997).

The importance of the background and culture of the learner: Socio-constructivism encourages the learner to arrive at his or her version of the truth, influenced by his or her background, culture or embedded worldview. Historical developments and symbol systems, such as language, logic, and mathematical systems, are inherited by the learner as a member of a particular culture and these are learned throughout the learner's life. This also stresses the importance of the nature of
the learner's social interaction with knowledgeable members of the society. Without the social interaction with other more knowledgeable people, it is impossible to acquire social meaning of important symbol systems and learn how to utilize them. Young children develop their thinking abilities by interacting with other children, adults and the physical world. From the socio-constructivist viewpoint, it is thus important to take into account the background and culture of the learner throughout the learning process, as this background also helps to shape the knowledge and truth that the learner creates, discovers and attains in the learning process (Wertsch 1997).

The responsibility for learning: Furthermore, it is argued that the responsibility of learning should reside increasingly with the learner (Glasersfeld, 1989). Socio-constructivism thus emphasizes the importance of the learner being actively involved in the learning process, unlike previous educational viewpoints where the responsibility rested with the instructor to teach and where the learner played a passive, receptive role. Glasersfeld (1989) emphasized that learners construct their own understanding and that they do not simply mirror and reflect what they read. Learners look for meaning and will try to find regularity and order in the events of the world even in the absence of full or complete information.

The Harkness Discussion Method: It is called the "Harkness" discussion method because it was developed at Phillips Exeter Academy with funds donated in the 1930s by Edward Harkness. It involves students seated in a circle, motivating and controlling their own discussion. The teacher acts as little as possible. Perhaps the teacher's only function is to observe, although he/she might begin or shift or even direct a discussion. The students get it rolling, direct it, and focus it. They act as a team, cooperatively, to make it work. They all participate, but not in a competitive way. Rather, they all share in the responsibility and the goals, much as any members share in any team sport. Although the goals of any discussion will change depending upon what's under discussion, some goals will always be the same: to illuminate the subject, to unravel its mysteries, to interpret and share and learn from other points of view, to piece together the puzzle using everyone's contribution. Discussion skills are important. Everyone must be aware of how to get this discussion rolling and keep it rolling and interesting. Just as in any sport, a number of skills are necessary to work
on and use at appropriate times. Everyone is expected to contribute by using these

**The motivation for learning**: Another crucial assumption regarding the nature of the learner concerns the level and source of motivation for learning. According to Glasersfeld (1989) sustaining motivation to learn is strongly dependent on the learner’s confidence in his or her potential for learning. These feelings of competence and belief in potential to solve new problems are derived from first-hand experience of mastery of problems in the past and are much more powerful than any external acknowledgment and motivation (Prawat and Floden 1994). This links up with Vygotsky’s “zone of proximal development” (Vygotsky, 1978) where learners are challenged within close proximity to, yet slightly above, their current level of development. By experiencing the successful completion of challenging tasks, learners gain confidence and motivation to embark on more complex challenges.

**Instructor**

According to the socio-constructivist approach, instructors have to adapt to the role of facilitators and not teachers (Cobb and Bauersfeld, 1995). Whereas a teacher gives a didactic lecture that covers the subject matter, a facilitator helps the learner to get to his or her own understanding of the content. In the former scenario the learner plays a passive role and in the latter scenario the learner plays an active role in the learning process. The emphasis thus turns away from the instructor and the content, and towards the learner (Gamoran, Secada, & Marrett, 1998). This dramatic change of role implies that a facilitator needs to display a totally different set of skills than a teacher. A teacher tells, a facilitator asks; a teacher lectures from the front, a facilitator supports from the back; a teacher gives answers according to a set curriculum, a facilitator provides guidelines and creates the environment for the learner to arrive at his or her own conclusions; a teacher mostly gives a monologue, a facilitator is in continuous dialogue with the learners. A facilitator should also be able to adapt the learning experience ‘in mid-air’ by taking the initiative to steer the learning experience to where the learners want to create value. Joia (2002) assessed a socio-constructivist model for training K-12 teachers in Brazil, in the use of Informatics in education from a summative perspective. A case study design included qualitative and quantitative data collection methods. The course provided the teachers
with two complementary modules: face-to-face and distance-based. The rationale of the study held an interactive and problem-solving methodology, and led to a central axis based on the development of interdisciplinary projects. Before the course, the teachers were measured as traditional or instructivist and teacher-centered. This study showed that after the socio-constructivist course, teachers raised consciousness of the need to change their pedagogical practices, but still needed time to change it. The author found that teachers complained about not being provided with the right answer and the lack of guidelines during class work. Consequently, more participative approach to teacher training was suggested to allow the schools to influence for a better organizational structure and strategy. Another implication was that the teachers hold dispositions about learning and teaching, and might expect the same approach from teacher trainers.

- **The Learning Environment**
  
The learning environment should also be designed to support and challenge the learner's thinking (Di Vesta. 1987). While it is advocated to give the learner ownership of the problem and solution process, it is not the case that any activity or any solution is adequate. The critical goal is to support the learner in becoming an effective thinker. This can be achieved by assuming multiple roles, such as consultant and coach. A few strategies for cooperative learning model suggested by Woolfolk (2010) include
  
  - Reciprocal Questioning: students work together to ask and answer questions
  - Jigsaw Classroom: students become "experts" on one part of a group project and teach it to the others in their group
  - Structured Controversies: Students work together to research a particular controversy.

1.1.11 Collaboration among Learners

In a Vygotskian classroom, learning is promoted through collaboration -- collaboration among students, and between students and teacher. From a social constructionist perspective as students share background knowledge and participate in the give and take of collaborative and cooperative activities they are actually
negotiating meaning. They are building knowledge, not as individuals, but as a group. Learners with different skills and backgrounds collaborate in tasks and discussions to arrive at a shared understanding of the truth in a specific field (Duffy and Jonassen, 1992).

Most socio-constructivist models, such as that proposed by Duffy and Jonassen (1992), also stress the need for collaboration among learners, in direct contradiction to traditional competitive approaches. One Vygotskian notion that has significant implications for peer collaboration is that of the zone of proximal development. Defined as the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers, it differs from the fixed biological nature of Piaget's stages of development. Through a process of 'scaffolding' a learner can be extended beyond the limitations of physical maturation to the extent that the development process lags behind the learning process (Vygotsky 1978).

Participation in group activity allows students to generalize and transfer their knowledge of classroom learning and builds a strong foundation for communicating ideas orally (Reznitskaya, Anderson & Kuo, 2007). Large and small group activity also affords students opportunities to exercise self-regulation, self-determination, and a desire to persevere with tasks (Corden, 2001; Matsumara, Slater & Crosson, 2008). Group work increases student motivation, collaborative skills, and the ability to problem solve (Dyson, 2004; Matsumara, Slater & Crosson, 2008; Nystrand, 1996). Increasing student’s opportunity to work with one another and discuss their ideas increases their ability to support their thinking, develop reasoning skills, and to argue their opinions persuasively and respectfully (Reznitskaya, Anderson & Kuo, 2007).

Solid framework theories for collaborative social constructions

Science education research should produce sustainable and viable frameworks for teaching praxis so that teachers would be able to scaffold collaborative constructions process of viable knowledge through radical constructions among the learners. The slogan of constructivism in our scientific community started about twenty years ago. Later on this discussion extended to include collaborative social group processes. Still, there are quite few empirically tested models how teachers can
plan and realize learning environments within that paradigm. Even though there are numerous studies on collaboration and group development, the impact of knowledge structure, pedagogical philosophy and support for reflective communication has been neglected. With respect to our socio-constructivist framework, the famous pragmatic theory of truth emphasized by the famous philosopher Charles Peirce would give a solid basis, making the debate between radical and weak constructivism sound unnecessary and even naive. When an open problem is given, namely, the teams work in causal interaction with this problem under collaboration. After testing the viability of radical ideas among the teams and between the teams, only those ideas finally remain which are viable for the whole social group consisting of those teams. (see Figure 1.2).

Figure 1. Viable knowledge as a result of radical social constructions (Eskelinen & Haapasalo 2007).

Eskelinen and Haapasalo (2007) suggest that design of technology-based learning environments within an adequate constructivist theory linked to the knowledge structure might be a proper framework to respond to the main challenge of teacher education: to get students understand which are the basic components of...
modern constructivist theories on teaching and maintaining the learning through cognitive conflicts. Their studies reveal that working within socio-constructivist collaborative ICT-based design processes for the production of a hypermedia-based learning environment, even during a short period of time, changed student teachers’s conceptions of teaching and learning from an objectivist-behaviorist viewpoint to a constructivist view, and decreased students’ interest in having support for computer routines.

A qualitative case study was conducted by Curtis (2007) in a combined setting of a kindergarten classroom and music education classroom in a small mid-western community over a period of nine weeks. The study, framed in the socio-cultural theory of constructivism (Vygotsky, 1978) and Gardner’s Theory of Multiple Intelligence explored the way a kindergarten teacher and music educator provided literacy learning opportunities for young children. Data were collected through detailed observational field notes, interviews of the kindergarten teacher and music educator, and conversations with children. Data analysis revealed five characteristics that framed the literacy learning environment which included: (1) providing a caring community; (2) use of conversations; (3) connections to prior knowledge and community; (4) collaboration; and (5) consistency. Pedagogical commonalities were found to include: (1) a gradual release of responsibility; (2) use of metacognition; (3) a sharing of quality children’s literature; (4) purposeful oral language development; and (5) use of active engagement in learning, especially the use of gesturing. Data also revealed evidence of support of six components of early literacy learning: (1) phonemic awareness; (2) phonics; (3) fluency; (4) vocabulary; (5) comprehension; and (6) concepts about print. Data identified that the classroom teacher provided more incidences of instruction coded as phonemic awareness, phonics, and comprehension; with the classroom music educator providing more evidence of coded events for fluency and vocabulary learning. Analysis of combined events identified a balance of instructional methods, experiences, and techniques identifying the critical importance of the elementary music educator’s role in supporting early literacy learning of young children and the importance of collaboration in meeting needs of children.
Learning as an active and social process: Socio-constructivism, strongly influenced by Vygotsky's (1978) work, suggests that knowledge is first constructed in a social context and is then appropriated by individuals (Cole, 1996; Eggen & Kauchak, 2004). According to social constructivists, the process of sharing individual perspectives-called collaborative elaboration -results in learners constructing understanding together that wouldn't be possible alone (Greeno, Anderson, Reder & Simon, 1999).

Social constructivist scholars view learning as an active process where learners should learn to discover principles, concepts and facts for themselves, hence the importance of encouraging guesswork and intuitive thinking in learners (Brown, Collins & Duguid, 1989; Ackerman 1996). In fact, for the social constructivist, reality is not something that we can discover because it does not pre-exist prior to our social invention of it. Kukla (2000) argues that reality is constructed by our own activities and that people, together as members of a society, invent the properties of the world. Other constructivist scholars agree with this and emphasize that individuals make meanings through the interactions with each other and with the environment they live in. Knowledge is thus a product of humans and is socially and culturally constructed (Ernest 1998; Prawat and Floden 1994). McMahon (1997) agrees that learning is a social process. He further states that learning is not a process that only takes place inside our minds, nor is it a passive development of our behaviours that is shaped by external forces and that meaningful learning occurs when individuals are engaged in social activities.

Vygotsky (1978) also highlighted the convergence of the social and practical elements in learning by saying that the most significant moment in the course of intellectual development occurs when speech and practical activity, two previously completely independent lines of development, converge. Through practical activity a child constructs meaning on an intrapersonal level, while speech connects this meaning with the interpersonal world shared by the child and her/his culture.

The structuredness of the learning process: It is important to achieve the right balance between the degree of structure and flexibility that is built into the learning
process. Savory (1994) contends that the more structured the learning environment, the harder it is for the learners to construct meaning based on their conceptual understandings. A facilitator should structure the learning experience just enough to make sure that the students get clear guidance and parameters within which to achieve the learning objectives, yet the learning experience should be open and free enough to allow for the learners to discover, enjoy, interact and arrive at their own, socially verified version of truth.

**Dynamic interaction between task, instructor and learner:** A further characteristic of the learning process in the socio-constructivist viewpoint is that the instructor and the learners are equally involved in learning from each other as well (Holt & Willard-Holt 2000). Learners compare their version of the truth with that of the instructor and fellow learners to get to a new, socially tested version of truth (Kukla 2000). The task or problem is thus the interface between the instructor and the learner (McMahon 1997). This creates a dynamic interaction between task, instructor and learner. This entails that learners and instructors should develop an awareness of each other's viewpoints and then look to their own beliefs, standards and values, thus being both subjective and objective at the same time (Savory 1994).

Gergen (1994) in his paper ‘Toward transformation in social knowledge’ emphasized that knowledge is constructed through the interplay between an individual's knowledge, attitudes and values, on the one hand, and social interactions in a socio-cultural context, on the other. Henceforth, a socio-constructivist perspective in science learning does not only focus on the interplay between the individual and the social context, but also recognizes the close interaction between cognitive and emotional aspects. Some studies argue for the importance of mentoring in the process of learning (Archee and Duin 1995; Brown Collins & Duguid, 1989). The socio-constructivist model thus emphasizes the importance of the relationship between the student and the instructor in the learning process.

Some learning approaches that could harbor this interactive learning include reciprocal teaching, peer collaboration, cognitive apprenticeship, problem-based instruction, web quests, anchored instruction and other approaches that involve learning with others.

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1.1 The Importance of Context

The social constructivist paradigm views the context in which the learning occurs as central to the learning itself (McMahon 1997). Underlying the notion of the learner as an active processor is “the assumption that there is no one set of generalized learning laws with each law applying to all domains” (Di Vesta 1987). Decontextualised knowledge does not give us the skills to apply our understandings to authentic tasks because, as Duffy and Jonassen (1992) indicated, we are not working with the concept in the complex environment and experiencing the complex interrelationships in that environment that determine how and when the concept is used. One socio-constructivist notion is that of authentic or situated learning, where the student takes part in activities directly relevant to the application of learning and that take place within a culture similar to the applied setting (Brown Collins & Duguid, 1989).

Holt and Willard-Holt (2000) emphasize the concept of dynamic assessment, which is a way of assessing the true potential of learners that differs significantly from conventional tests. Here the essentially interactive nature of learning is extended to the process of assessment. Rather than viewing assessment as a process carried out by one person, such as an instructor, it is seen as a two-way process involving interaction between both instructor and learner. The role of the assessor becomes one of entering into dialogue with the persons being assessed to find out their current level of performance on any task and sharing with them possible ways in which that performance might be improved on a subsequent occasion. Thus, assessment and learning are seen as inextricably linked and not separate processes (Holt and Willard-Holt 2000).

According to this viewpoint instructors should see assessment as a continuous and interactive process that measures the achievement of the learner, the quality of the learning experience and courseware. The feedback created by the assessment process serves as a direct foundation for further development.

1.1.14 The Selection, Scope and Sequencing of The Subject Matter

Knowledge should be discovered as an integrated whole: Knowledge should not be divided into different subjects or compartments, but should be discovered as an
integrated whole (McMahon 1997; Di Vesta 1987). This also again underlines the importance of the context in which learning is presented (Brown, Collin & Duguid, 1989). The world, in which the learner needs to operate, does not approach one in the form of different subjects, but as a complex myriad of facts, problems, dimensions, and perceptions (Ackerman 1996).

**Engaging and challenging the learner:** Learners should constantly be challenged with tasks that refer to skills and knowledge just beyond their current level of mastery. This captures their motivation and builds on previous successes to enhance learner confidence (Brownstein 2001). This is in line with Vygotsky’s zone of proximal development, which can be described as the distance between the actual developmental level (as determined by independent problem-solving) and the level of potential development (as determined through problem-solving under adult guidance or in collaboration with more capable peers) (Vygotsky 1978).

Vygotsky (1978) further claimed that instruction is good only when it proceeds ahead of development. Then it awakens and rouses to life an entire set of functions in the stage of maturing, which lie in the zone of proximal development. It is in this way that instruction plays an extremely important role in development. To fully engage and challenge the learner, the task and learning environment should reflect the complexity of the environment that the learner should be able to function in at the end of learning. Learners must not only have ownership of the learning or problem-solving process, but of the problem itself.

Where the sequencing of subject matter is concerned, it is the constructivist viewpoint that the foundations of any subject may be taught to anybody at any stage in some form (Duffy and Jonassen 1992). This means that instructors should first introduce the basic ideas that give life and form to any topic or subject area, and then revisit and build upon these repeatedly. This notion has been extensively used in curricula.

It is also important for instructors to realize that although a curriculum may be set down for them, it inevitably becomes shaped by them into something personal that reflects their own belief systems, their thoughts and feelings about both the content of their instruction and their learners (Rhodes and Bellamy 1999). Thus, the learning experience becomes a shared enterprise. The emotions and life contexts of those
involved in the learning process must therefore be considered as an integral part of learning. The goal of the learner is central in considering what is learned (Brown, Collins & Duguid 1989; Ackerman, 1996).

1.1 Social Constructivism and Social Constructionism

Although both social constructionism and social constructivism deal with ways social phenomena develop, they are distinct. Social constructivism is closely related to social constructionism in the sense that people are working together to construct artifacts. However, there is an important difference: social constructionism focuses on the artifacts that are created through the social interactions of a group, while social constructivism focuses on an individual's learning that takes place because of their interactions in a group. Social constructionism refers to the development of phenomena relative to social contexts while social constructivism refers to an individual's making meaning of knowledge within a social context (Vygotsky 1978). For this reason, social constructionism is typically described as a sociological construct whereas social constructivism is typically described as a psychological construct.

Social constructivism has been studied by many educational psychologists, who are concerned with its implications for teaching and learning e.g. Glasersfeld (1990) and Palincsar (1998).

Constructionism became prominent in the U.S. with Berger and Luckmann's 1966 book, The Social Construction of Reality. Berger and Luckmann (1966) argue that all knowledge, including the most basic, taken-for-granted common sense knowledge of everyday reality, is derived from and maintained by social interactions. When people interact, they do so with the understanding that their respective perceptions of reality are related, and as they act upon this understanding their common knowledge of reality becomes reinforced. Since this common sense knowledge is negotiated by people, human typifications, significations and institutions come to be presented as part of an objective reality. It is in this sense that it can be said that reality is socially constructed. Berger and Luckmann's social constructionism has its roots in phenomenology.
1.1.16 General Implications of Social Constructivism

A constructivist teacher creates a context for learning in which students can become engaged in interesting activities that encourages and facilitates learning. The teacher does not simply stand by, however, and watch children explore and discover. Instead, the teacher may often guide students as they approach problems, may encourage them to work in groups to think about issues and questions, and support them with encouragement and advice as they tackle problems, adventures, and challenges that are rooted in real life situations that are both interesting to the students and satisfying in terms of the result of their work. Teachers thus facilitate cognitive growth and learning as do peers and other members of the child’s community. Jadallah (2000) worked on constructivist learning experiences for social studies education and suggested a planning process that integrates cognitive and social constructivism in conducting social studies so that the abstract constructivist ideas of knowledge and experience were more openly defined through curriculum making and instructional planning. Donlevey (2000) in their research indicated that Socio-constructivist practice was democratic and inclusive as it provided for student direction of the curriculum and encouraged personal responsibility for learning.

All classrooms in which instructional strategies compatible with Vygotsky’s social constructivist approach are used don’t necessarily look alike. The activities and the format can vary considerably. However, four principles are applied in any Vygotskian classroom.

1. Learning and development is a social, collaborative activity.
2. The Zone of Proximal Development can serve as a guide for curricular and lesson planning.
3. School learning should occur in a meaningful context and not be separated from learning and knowledge children develop in the "real world.”
4. Out-of-school experiences should be related to the child’s school experience.

1.1.17 Studies Related to Constructivism

In a research study by Gatlin (1992) he found that there was no significant difference in students’ scores at the posttest between students of the constructivist group and traditional (lecture) group. He reported that students’ scores of those who
received the constructivist approach showed a slight decrease on the delayed posttests, while students taught using the traditional (lecture) approach showed a greater decrease over time. Students who received the constructivist instructional approach have a higher relation over time. It can be said that students taught by traditional (lecture) means, who rely on memorization to pass tests, over time often do not remember much of the information learned.

Klein and Merritt (1994) worked on ‘Environmental Education as a Model for Constructivist Teaching’. They described four main components of a constructivist science lesson or unit. A review of commonly used environmental education materials from six environmental education projects was conducted to look for these components. Parallels between teaching strategies used in environmental education and constructivist methods were also discussed. In linking the goals and principles of environmental education to constructivists learning theories they found many similarities which suggested that students and teachers were actively engaged in constructing knowledge of the environment through their experiences rather than passively learning pre-determined knowledge.

Tippins, Tobin and Nichols (1995) in their study made a fictional account of an elementary science teacher and her use of constructivism as a referent for her various roles as a science teacher. They considered constructivism as a set of beliefs that could be used by teachers to think about learning and teaching and to plan and enact a science curriculum. They also described how the teacher came to teach in this manner, describing her involvement in staff development activities and an evolution in her thinking from an objectivist to a constructivist system of semantics. Implications were presented for the reform of science education.

Young, Nastasi and Braumhardt (1996) observed a conceptual change in classroom teaching regarding the nature of learning after implementing a constructivist design in a constructivist way. The research attempted to establish an environment that would foster problem-solving interactions and assess the nature of the interactions that occurred. The study lasted 3 months to engage students in anchored instruction, using the problem-solving videodisc series “Jasper.” Students were immersed into a complex, realistic problem-solving situation. Students had to solve three problems in three months. Each problem presented a realistic situation in
which middle school mathematics, planning, information-finding, and cooperative group solving could be used to solve an everyday kind of problems. The goal was to emphasize problem solving and other higher order thinking skills such as planning for complexity of information finding across distributed sources along with certain math topics. The authors sought ways to create authentic and meaningful learning environments, and managed to integrate experiences in life with that of schooling.

A study by Anderson and Piazza (1996) showed evidence of how the constructivist philosophies of the authors implemented in the mathematics classrooms changed the instruction of university mathematics education classrooms. The authors randomly selected 50 student journals from a group of 154. Based on the literature they examined aspects that indicated students’ commitment to a constructivist philosophy. The themes that emerged were strong constructivist commitment; valuing some elements of constructivism: lacking evidence of commitment to constructivism; and lack of evidence of constructivism. They underscore that beliefs about constructivism emerge from experience and reflection. Therefore, they suggested that preservice teachers should experience constructivist environments and should reflect upon them to promote teacher and learner autonomy.

Tynjala (1997) examined the changes in conceptions of the learning process of educational psychology students in a constructivist and a traditional learning environment. The researcher found that students’ conceptions changed similarly in both groups, except that the students in the constructive learning group emphasized more often the role of critical thinking and other student activity in learning.

Palmer (1998) in his article ‘Environmental education in the 21st Century’ believed that environmental science teachers should pay attention to the students’ communication and information that result from living and interacting in a particular locality and community. According to him it was obvious that Problem Based Learning and constructivist teaching played an important part in teaching environmental science. When teaching environmental science, we should present many complex real world problems, often as case studies of real events.

A comparative study was conducted by Tynjala (1998) at higher education level. The constructivist group who studied the given course book with the help of writing assignments; whereas, the control group just read the books on their own,
attended lectures and took an examination. In this study, the author’s aim was to measure learning outcomes as measured by a traditional examination in which students had to answer two questions. The constructivist group did take the exam, but were not graded for it, while the control group was graded. The author found that learners subjected to constructivist learning environment seemed to produce higher-level learning outcomes more efficiently than traditional teaching. This study included a traditional essay-type question in comparing learning outcomes. Although students subjected to constructivist learning showed greater levels of higher order thinking in their responses, learner outcomes were evaluated from a holistic perspective.

Shymansky, Yore Dunkhase, & Hand (1998) examined a major reform effort of an elementary science curriculum called the Science: Parents, Activities, and Literature (Science PALs) Project. The goal of the project was to move teachers towards an interactive-constructivist model of teaching and learning that assumes a middle-of-the-road interpretation of constructivism where hands-on activities were used selectively and purposefully to challenge students' ideas, promote deep processing, and achieve conceptual change. The program also enriches the cross-curricular connections of the science units and promotes meaningful parental involvement. A broad question was raised as to whether or not students really notice. This study explored elementary school students' perceptions of and attitudes toward interactive-constructivist science teaching and learning occurring in classrooms of teachers who were or were not participating in the Science PALs project. The sample consisted of 664 females and 651 males in Grades 1 through 6. Students' perceptions and attitudes were generally higher for science teaching and learning in classrooms of teachers with two or more years of Science PALs experience than in the classrooms of teachers with little to no experience with PALs. A survey of parent participants in the project revealed overwhelming support.

Lord (1999) measured critical thinking skills among students and found that the constructivist approach to learning (common in environmental education programming) develops deeper comprehensive thought and therefore critical thinking skills compared to students who learned similar lessons in a traditional lecture style. He also found that students who learned concepts of environmental science using a
constructivist approach were better able to recall information many months after the completion of a unit.

Windschitl (1999) referred to the increasing popularity of constructivist learning by emphasizing its effects on teachers, including increased demand on subject-matter understanding. He asserted that teachers must continually struggle to develop a new, well-articulated rationale for instruction decisions. Such shift, the author argued, could be realized by utilizing previous teaching or learning. Consequently, the teachers themselves should find ways to challenge the new classroom dynamics of diverse social and cultural contexts.

Nwagbo (1999) explained the guided discovery mode which was an example of constructivist learning for an approach to enquiry. The teacher provided illustrative materials for students to study on their own. Leading questions were then asked by the teacher to enable students think and provide conclusion through the adoption of the processes of sciences. Nwagbo believed that if the learner was allowed to discover relationships and methods of solution by him make his own generalizations and draw conclusions from them, he might then better prepared to make wider applications of the material learned.

Smerdon and Burkam (1999) argued that although many reformers advocate a move away from traditional, teacher-centered, direct instruction toward student-centered constructivist teaching that focuses on exploration and experimentation, the students of average social and academic status appear to be the forgotten majority with respect to constructivist instruction. The authors offered implications for educational policy and social equity in high school science. They found that constructivist teaching was more provided for less able students and lower-level science course and was especially submitted to males. The authors argue that the reality behind this founding is grounded in the fact that teachers do not employ instruction effectively.

An instrument to evaluate the effectiveness of constructivist teaching methods, the Constructivist Teaching Inventory (CTI), was developed and assessed by Margare, Lynne and William (1999). The assessment was focusing on the validity and reliability of the instrument. A pool of items measuring the presence of identified elements of constructivist teaching was developed; items were grouped into four
subscales representing teaching strategies, verbal interaction in the community of learners, learning activities, and curriculum. The classes of 10 primary school teachers in a large urban school district were studied. Results suggested that the CTI was able to identify the extent of constructivist teaching effectively and that the variability associated with teacher, content, and grade level, supports the validity of the instrument and the construct it measures. The reliability of a self-report form of the instrument was also investigated with the same teachers, and data suggested that the self-report form may be appropriate for use in professional development activities.

Tenenbaum, Naidu, Jegede & Austin (2001) attempted to identify characteristics of constructivism and their presence in face-to-face and open-distance learning environments. Findings indicated that constructivist teaching and learning components were not sufficiently present in any of the settings investigated despite the positive intentions that instructional designers had in their planning phase. Thus, teachers' conceptions about constructivist classroom environments may not be clear and overall need to be made explicit.

Balakrishnan (2001) investigated the use of constructivism and technology in project-based learning in elementary classrooms and found that teachers' planning and practice of project-based learning activities were focused more on multiple instructional activities and less on integration of constructivism and technology.

Yildirim, Ozden and Aksu (2001) made use of constructivism in hypermedia environments compared to traditional learning instruction in secondary biology education through an experimental design. The authors wanted to examine how hypermedia learning environments contributed to declarative, procedural, and conditional knowledge acquisition and retention in a specific area. They found that both experimental and control groups’ learning outcomes were similar in their post-test results; however, retention test results showed that the experimental group retained all three types of knowledge significantly better than did the control group.

Lord, Travis, Magill and King (2001) compared undergraduate non-majors biology lab section taught in a traditional teacher-centered style with a similar section taught as a constructivist class in the fall of 2000 semester at Indiana University of Pennsylvania. These two sections with the same lab instructor were used in an effort to reduce the variables between groups. Each lab section consisted of 23 students.
Weekly lab quiz scores, attendance, a science attitude test and analysis of videotapes were used to determine whether student interest and performance were affected by the teaching style used in the classroom. The results of this study did support the value of constructivist or student-centered learning. It was anticipated that the constructivist class would have a higher average on the weekly quiz grades, and this was supported by statistical analysis and showed better scores not only on occasion, but every single week in the constructivist group. Results of the Science Attitude Inventory also demonstrated that the constructivist group had a better outlook on science at the end of the semester than the students in the traditional group.

Cho (2002) examined the effects of a science-technology-society (STS) in-service programme, designed to change teachers' awareness and practice of STS/constructivist approaches, while also focusing on students' understandings and changes of perceptions of the constructivist learning environments. A total of 20 middle and high school science teachers participated in the in-service programme in 1998; and three of the middle school teachers were selected to gain information from their implementation of a Reactions of Acids and Bases unit in their respective classrooms. At the beginning and the end of the unit, they completed the Constructivist Learning Environment Survey. In order to assess student understanding, teachers administered the creativity test before and after the unit; and the concept acquisition test and the application test after the unit. Students made more relevant and creative responses on unfamiliar situations on the post-test than on the pre-test. Through several tasks including a short essay, students showed their abilities to apply various concepts related to acids and bases to daily life situation. It was found that the STS programme improved the teachers' awareness and practices of the science education reforms characterized by STS and constructivism. They could work together in developing units and reflecting on their teachings through video recordings of science classes. They were willing to assess various aspects of learning such as creativity, application and concept acquisition. Students perceived that the classroom environments improved in terms of personal relevance of contents, scientific uncertainty and student participation. The results showed that the STS in-service programme was effective and could be implemented successfully with Korean science teachers.
Zhao (2003) in his paper on ‘The use of a constructivist teaching model in environmental science at Beijing Normal University’ analyzed the characteristics of environmental science and the teaching methods of Beijing Normal University, and discussed how to use constructivist teaching models in environmental science teaching. His study showed that during teaching and learning in environmental science, both the concept map and mind map are useful tools to promote active learning and the students’ abilities to integrate knowledge; and that problem-based learning (PBL) and the use of case studies can effectively motivate students’ learning curiosity and develop creative abilities. It was argued that constructivist teaching models and perspectives can improve environmental education reform in Chinese universities. Further his paper reminded us that Constructivist theory has been one of the latest catchwords in higher education circles in recent years. It not only emphasizes active and collaborative learning, but also requires students and teachers to discover and construct knowledge together.

Kesal (2003) tried to explore the constructivist aspects used by teacher educators in Foreign Language Teaching Departments. She found that although the teacher educators held cognitivist or constructivist conceptions of learning, students were behaviorist in their conceptions of teaching. This finding can be a reason for having difficulty in translating their knowledge about constructivist approach to teaching and learning in their field practices.

Plourde and Alawiye (2003) examined the impact of the constructivist learning model on elementary preservice teachers’ beliefs in reference to their constructivist knowledge and the practical application of this knowledge. During the 2000-2001 academic year, 511 student teachers completed a "Student Attributes" questionnaire administered by their respective university supervisor. Ninety "Student Attributes" forms were randomly selected for data analysis. The Pearson product-moment correlation (Pearson r) was the relational measurement utilized to determine if there was a statistical correlation between constructivist knowledge and application beliefs. The correlation coefficient for the data between student teachers' beliefs towards constructivist knowledge and application was a high positive relationship of .76 (r = .76). As the student teachers' knowledge of constructivism increased, their belief that they would be "able to apply constructivist principles in the classroom..."
learning situation" tended to increase. This correlation coefficient, \( r = .76 \), was considered to be a relatively high positive measure of the strength of the relationship. The high correlation, then, assumed that the more knowledgeable student teachers were in regards to constructivism, the more likely they would be able to apply constructivist principles in the classroom.

Kurt and Somchai (2004) in their own research study on constructivism found that students used for their study participated more in the classroom activities and gained in content knowledge when a constructivist approach was used.

Guthrie (2004) compared three instructional methods for third-grade reading: a traditional approach, a strategies instruction only approach, and an approach with strategies instruction and constructivist motivation techniques including student choices, collaboration, and hands-on activities. The constructivist approach, called CORI (Concept-Oriented Reading Instruction), resulted in better student reading comprehension, cognitive strategies, and motivation.

Karaduman and Gultekin (2007) investigated whether the learning materials that based on constructivist learning principles had an effect on fifth grade Social Studies students’ attitudes, their academic success and their retention. The study was conducted on 5th grade students of Sehit Ali Gaffar Okkan Elementary School, Eskisehir. The data was collected in fall term in 2004-2005 academic years. Participants were divided into two groups: the control group (5-B) and the experimental group (5-C). For the data collection a questionnaire for demographic information, pre- and post-tests and open-ended essay-type tests that were used to measure learners’ academic success and retention level, lesson plans, various teaching materials for classroom activities, and a questionnaire to gather the learners’ perspectives were used. Social Studies Attitude Scale was used to determine students’ attitudes. The data obtained were analyzed using the SPSS program. The means and standard deviations were calculated for each group. The data were subjected to t-tests for inter- and between- group comparisons. The significance level was taken as \(.05\). Findings of research indicated that constructivist learning principles based learning materials increased students’ academic success and retention in Social Studies but didn’t increase attitudes.
Dogru and Kalender (2007) compared science classrooms using traditional teacher-centered approaches to those using student-centered, constructivist methods. In their initial test of student performance immediately following the lessons, they found no significant difference between traditional and constructivist methods. However, in the follow-up assessment 15 days later, students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods.

Paper presented by Zandvliet (2007) at the Australian Association for Research in Education (AARE) on ‘Learning Environments for Environmental Education’ yields some interesting insight into the different learning environments experienced by students in classroom and field-based settings which have lead towards a robust tool for the evaluation of learning environments in place-based and environmental education settings. In the reported case study, students noted a closer fit between their actual and preferred environments in the field-based settings (as compared to classroom based environments) and rated these settings more positively on all scales measured. Therefore, the study and ongoing instrument development offered a tentative step into a promising new field of inquiry, the learning environment in place based and constructivist oriented environmental education settings.

1.1.18 Studies Related to Socio-Constructivism and Socio-Constructivist Approach of Teaching

James and Prout (1990) studied constructing and deconstructing Childhood as Contemporary Issues in the Sociological Study of childhood. They demonstrated that early childhood itself was a social and cultural construction. Cultures not only vary but change over time, thus, notions of childhood change correspondingly. According to them these constructions were constituted through discourse and were highly productive of pedagogical theory and practice. In short, social constructivist perspectives assume that there are no immutable understandings of childhood, purposes for early childhood services, theories, policies or pedagogical practices. The very embeddedness of early childhood education within particular social contexts renders the critical examination of dominant assumptions, discourse practices and cultural activities the more difficult for those sharing the same cultural ‘lens’.

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The relationship between a constructivist approach to mathematics teaching and social and cultural norms in mathematics classrooms is explored by Cobb, Perlwitz, and Underwood (1991). Their paper offered a critique of Activity-Theory, both in its Russian and American manifestations, and in particular the related socio-cultural movement exciting educational interest in the United States. They addressed the work of Ilyenkov, in the Russian school, who suggested that 'objects as cultural tools serve as carriers of meaning' i.e. carrying meaning for their use in a practice. These objects included formal mathematical symbols, and so 'these symbols were for him (Ilyenkov) cultural tools that carry meaning'. A consequence of this was the view that 'children's development of abstract mathematical thought is supported by instruction designed to engage them in the social practice of using formal symbols'.

A research study by Galton and Williamson (1992) revealed that collaboration is sustained in primary classrooms if the environment is conducive and if educators are familiar with the purposes and benefits and see the associated activity as high status. In understanding the growth of sociability and the development of cooperation, they realized to draw closer parallels between psychologically-informed approaches linked to child development and opportunities available in socio-constructivist settings. This would suggest a need for observation-based studies in settings along with informed insights pertaining to a range of types of interventions or ‘scaffolding’ in enabling children to initiate and sustain sociable and cooperative encounters and to develop related knowledge and understanding in literacy, numeracy and other areas of learning. These types of interventions might be direct, such as adults playing and working alongside children, adults structuring play to achieve particular goals and adult design of tasks. They might be indirect such as allowing sufficient time for play themes to develop and providing open-ended resources that stimulate innovative responses from young learners.

O’loughlin (1992) presented an epistemological critique of forms of pedagogy founded on Piagetian constructivism. Despite the appeal of the notion that learners construct their understanding, he argued that constructivism was problematic because it ignored the subjectivity of the learner and the socially and historically situated nature of knowing; it denied the essentially collaborative and social nature of meaning making; and it privileged only one form of knowledge, namely, the technical rational.
He then presented a critique of active learning and student-centered forms of pedagogy. He argued that in the models of teaching we rely on too many unexamined assumptions from developmental psychology and we took for granted the problematic notion that children learn by doing. Constructivism was flawed because of its inability to come to grips with the essential issues of culture, power, and discourse in the classroom. In the concluding section of the article he presented a preliminary account of a socio-cultural constructivist approach to teaching and learning that takes seriously the notion that learning is situated in contexts, that students bring their own subjectivities and cultural perspectives to bear in constructing understanding, that issues of power exist in the classroom that need to be addressed, and that education into scientific ways of knowing requires understanding modes of classroom discourse and enabling students to negotiate these modes effectively so that they may master and critique scientific ways of knowing without, in the process, sacrificing their own personally and culturally constructed ways of knowing.

Munn and Schaffer (1993) identified a growing appreciation of how the development of literacy and numeracy are related to social settings and these form the contexts for children’s early cognitive achievements. They observed two- and three-year olds in day nursery settings and interviewed staff. Literacy events were greater in number than numeracy events. Whilst these environments were full of opportunities for literacy and numeracy events, one key issue was how effectively adults could communicate their potential to the children in naturalistic ways that correspond with children’s immediate and spontaneously articulated interests. The adult was a key figure in supporting young children’s emerging sociable and cooperative potential and in linking that potential with cognitive growth through the socio-constructivist provision of an appropriate learning environment and through their own interventions with interacting peers.

Swanepoel (1994) analyzed the reciprocal interaction between meaning making and cultural environment. The data that support the shaping of the theoretical framework was drawn from a program for underrepresented freshman engineering students. This program employed small-group, cooperative-learning that concentrates on problem solving. Classroom-cultural-shift was not a norm in this program, but it did occur when two teachers attempted to pursue problematic raised and owned by the
students. The data were collected by naturalistic enquiry methods. Classroom observations, and separate interviews with teachers and students served to 'triangulate' and 'member-check' the data recorded as field notes, video transcripts and audio transcripts. In the shaping of the socio-constructivist epistemological framework based mainly on the Piagetian and Vygotskian thought, attention was drawn to three issues that elaborate socio-constructivist and curricular thinking. These were: (1) The effectiveness of mixed power relations in the classroom in contrast with the purely egalitarian approach advocated by Piaget and the dominance of the 'more capable other' asserted by Vygotsky. (2) The influence of cultural values on the directions that members of the culture follow in pursuit of meaning making. (3) A "two-layered zone of proximal development" that links teacher and student development to common but student-initiated problematics. An operational curriculum, labeled the "emergent curriculum of classroom-cultural-shift," was spawned by classroom-cultural-shift. This curriculum was formed in the two-layered zone of proximal development initiated by student interests and supported by teacher colleagues.

Wood, Cobb and Yacke (1995) in their research indicated that teaching strategies using social constructivism as a referent included teaching in contexts that was personally meaningful to students, negotiating taken-as-shared meanings with students, class discussion, small-group collaboration, and valuing meaningful activity over correct answers.

Gergen (1995) in his article on 'Social construction and the educational process' focused on language as being the primary method by which knowledge was constructed. To emphasize this he posited three main points. First Gergen claimed that an understanding of language was a product of social interdependence. In this view methods of negotiation, cooperation, conflict, and other social settings were of primary interest. Next Gergen asserted, "Meaning in language is context dependent". He suggested that the language used in a social interaction was only relevant to that particular interaction. Finally, he mentioned language primarily serves a communal function. Language is used in community settings and serves the needs of that community. Out of this use of language, knowledge is constructed in the form of a social consensus.
In the article—‘The rhetoric and reality of play: teachers’ thinking and classroom practice’ Wood and Bennett (1997) reported a small scale qualitative study investigating teachers’ theories of play and learning, and showed how, during the study, initial Piagetian, non interventionist views had been transformed into more social constructivist, Vygotskian approaches.

Brody (1997) conducted an action research study investigating the application of metacognitive strategies; concept mapping and the Vee Diagram, to the design of new environmental curricula in Nizhnii Tagil, Russia. The research was conducted over the course of a year and emphasized socio-constructivist collaborative planning, execution and assessment of the project. Two teacher in-service workshops helped participants develop a new environmental science education course for teacher training at the Institute Pedagogica and new environmental education curricula at local schools in the city of Nizhnii Tagil, Russia. The conferences, meetings, workshops and curriculum development effort helped teachers, those who train teachers, and members of the community learn how they can help young people develop awareness, knowledge, and skills they need to understand their immediate situation, and to become lifelong environmental stewards. Curriculum materials emphasizing interdisciplinary approaches and inquiry oriented lessons were developed for pre-service and in-service teacher training as well as high school science students.

Alan (1998) in his paper discussed the relevance of social constructivism, based on the work of Vygotsky, to a constructivist, Piagetian theory-based primary years education program. After describing the constructivist and social constructivist theories of child development and offering several principles derived from these theories which should be borne in mind when organizing a primary classroom, he discussed some details of a specific primary program's pedagogy and how it incorporates a constructivist approach. The paper next described how social constructivism can be applied to encourage collaboration and cooperative work, which facilitates children's cognitive development. This discussion included a mention of how the larger social context now demands that children know how to work cooperatively, a description of research that supports the validity of cooperative learning, and how to engender cooperative learning in the classroom. The paper
concluded that well-planned cooperative learning can be a powerful organizing principle in constructivist education because it is based on interaction between the student and his or her social environment.

Samaras and Gismondi (1998) examined the Vygotskian theory of socio-constructivism in relation to pre-service teachers’ understanding of teaching. The program they studied was a reflective teacher education program that aimed at broadening and deepening pre-service teachers’ thinking about teaching and learning. A case study design was used and the primary data sources were learners’ final self-evaluation of their units; planning papers; field progress reports; self-evaluations, and interviews with pre-service and cooperating schools. Findings showed that situated learning may benefit pre-service teachers’ understanding of planning, perspective taking, social negotiation, and sense of ownership. The Vygotskian planned program enabled pre-service teachers to experience authentic teaching with task demands shared between and among peers and their cooperating teachers. However, placing pre-service teachers in cohorts did not necessarily imply a Vygotskian approach; they assert that it involves a process of joint activity. The authors also found that while there was much emphasis on the learning and support of pre-service teachers, there was less on the learning of cooperating teachers, and to examine the school environment more in depth. They concluded that practicum experiences need to provide formative assessment within pre-service teachers’ ZPD. The authors underscore that pre-service teacher education programs should prepare their learners’ collaboration and coping with difficult situations, and negotiation and reflection with colleagues who hold differing perspectives.

Simmons (1999) devised a teaching experiment on a unit of mathematics education as a part of a graduate program. It was designed on line with constructivist principles and it based on the assumptions that changes in the way teachers operated would come about more readily if teachers were exposed to a number of different experiences related to mathematics education that included problem-solving episodes mentioned both by radical and social constructionists, and whether primary teachers could identify aspects of practice to begin a process of restructuring. Teachers experienced their own construction of knowledge independently through collective work over a ten-week period. Their development was also realized through growing
awareness of some theoretical underpinning, a metacognition of scrutinizing their learning experiences and examining ways of relating their new learning into their classrooms. Simmons found some evidence in teachers’ beliefs about the nature of mathematics and the subsequent changes in classroom practice and expectations of children’s learning with respect to creating kinds of interactions that were fundamental to constructivist teaching.

Active learning was incorporated into large classes by Gerace, Dufresne and Leonard (1999), that made use of a new technology named Classtalk, which facilitated instructions. The technology allowed teachers to create a classroom environment that was based on socio-constructivist epistemology that was lively and rich, where co-operative learning, discussions and interactive classroom instruction was carried out without losing control of the class. Communication in terms of student and teacher interactions were greatly enhanced which affected both learning and instruction. Students realized that not only did their understanding and problem solving skills improve, their attitudes and motivation toward science also improved.

Bloom, Perlmutter and Burrell (1999) explored strategies for managing classroom behavior of children with special needs. They applied a constructivist approach by capitalizing on the social context and social activity in a classroom, and provided strategies for children how to manage their behavior and be responsible members of the community. They argued that traditional approaches could be demanding and might further isolate children. Whereas, the constructivist perspective on social context to classroom management was means to actively engage in problem solving, conflict resolution and learning to self-manage behavior, which in return provided the child with a sense of belonging.

Santmire, Giraud and Grosskopf (1999) in their research study reported that students in a middle school environment who were involved in a social-constructivist approach to education achieved higher gains in standardized test scores than those students who were involved in the more classroom-based ‘abstract’ instruction. The teachers who participated in the social-constructivist approach to education had designed service-learning projects in which the teachers and students were involved with the community. Student involvement in the projects during the school day enhanced their performance.
Brown (1999) in his published paper entitled ‘Middle school social studies in the cognitive revolution’ realized the importance of cooperative learning in socio-constructive environment of teaching learning. He suggested that in Cooperative learning students were required to collaborate and critically analyzed the issue at hand; this would cause them to develop higher-level thinking skills. Some cooperative learning activities like group problem solving, group inquiry, simulations, and debates encourage creativity, value, and foster higher-level thinking.

Teague (2000) realized the importance of socio-constructivist approach in teaching social studies to the students. He reminded us that Social constructivism is a theory on how people develop and acquire knowledge. Its main premise is that knowledge and reality are based upon social consensus. He considered socio-constructivism, a theory that challenges the “traditional” model that a majority of social studies programs institute. According to him “traditional” models were emphasizing on the memorization of facts and concepts. So there was need to a reform in the way social studies is delivered to the students. A social constructivist approach would call for a number of changes to occur in the social studies classroom. Classroom management and the role of the teacher would have to change from their traditional roles. A key aspect would be to start presenting material in a fashion that shows the complexity and multiple perspectives of real world situations. The teacher’s role would shift to that of a guide and facilitator. The classroom environment would begin to take the shape of a “learning community” where interaction is key factor. In order for changes of this nature to occur in the classroom, he suggested that the teachers should be well versed in theory and understands its implications.

Ferreira and Mueller (2000) purposed a conceptual model where experimentation was envisaged as a tool to achieve instructional objectives via socio-constructivist learning methods. Remote Experiments were embedded in an e-learning framework that supports the acquisition of theoretical concepts, communications via video-conferencing, equipment interface ponds, and the management tools to support architecture. Each remote experiment presented as broader activity (workshop activity) meant to achieve pre-defined learning goals, where collaborative actions and peer review activities are at me basis of the social constructivist learning models. The
outcome of these activities was itself a learning objects that provided evidence that
the learning goals were achieved.

Joia (2001) evaluated a socio-constructivist hybrid model for training K-12
teachers in Brazil in the use of Informatics in education. The method applied
combines both face-to-face exchanges and a WEB-based distance approach made
possible by Internet technology. The characteristics of such training and its main
objectives were analyzed according to the collected data presented. The main
conclusions reached by this research were presented, especially those addressing the
importance of care and coherence for knowledge creation in a socio-constructivist
training model developed with the help of the Internet. Comparisons between this
model and the traditional model were also presented. A cost-effectiveness analysis of
socio-constructivist training was carried out and conclusions regarding the outcome
derived from this adopted paradigm were developed. Finally, some recommendations
were made to enhance this highly innovative methodology for training K-12 teachers
in the use of Information and Communication.

Broadhead (2001) investigated sociability and cooperation in nursery and
reception Class Settings. The observational studies of three- to five-year-olds in
nursery and reception class settings had begun with chart the progression from
associative to cooperative play through four levels of development. The chart (or
continuum) described the characteristics of interactive play as language and action. It
demonstrates increasing reciprocity and complexity in both as children progress to
cooperative play. It illustrated high levels of intellectual demand and creativity as
children sustained cooperative endeavor, a key feature of socio-constructivism. Its use
with practitioners was illustrating some potential for enhancing their professional
understanding of the links between children’s social and cooperative play, intellectual
challenge and problem-solving.

A computer-mediated teaching system, called computer-aided personalized
system of instruction (CAPSI), was developed by Pear and Corne-Todd (2002) that
incorporated a social constructivist approach. In CAPSI, course material was divided
into study units, and the instructor prepared study questions on each unit. In addition,
the study questions in CAPSI did not specify any one correct answer; instead the
quality of the answer depended on how well it was argued as judged by the feedback
it evoked from others. The participants were 24 students enrolled in ‘‘Principles of Behavior Modification,’’ an undergraduate psychology course at the University of Manitoba. All students received feedback on their performance from more advanced students. In addition, the more advanced students learnt from the answers of the less advanced students. Data presented in this report showed that, consistent with social constructivism, students in a CAPSI-taught course received and gave a large amount of substantive feedback.

Akar (2003) examined the impact of constructivist learning process on pre-service teacher education students’ performance, retention, and attitudes in Classroom Management Course. In this study, an experimental design and a case study design were used together. The sample (n = 144) were third year pre-service teachers at the Foreign Languages Education program at Middle East Technical University, Turkey. The experimental group (n = 76) was subjected to social constructivist learning process, while the control group (n = 68) was subjected to traditional instruction for eleven weeks. Data were collected through qualitative and quantitative methods. Findings showed that posttest scores were not statistically different between the experimental and the control groups. However, a significant difference was found in the retention scores in favor of the experimental group.

Garrison and Anderson (2003) were also strong advocates of the usefulness of socio-constructivist approach for adult distance learners. Indeed, after extensive research Garrison and Anderson had developed the ‘community of inquiry’ model as a framework for facilitating online learning and also for identifying various indicators to show good practice in the three key areas of cognition, socialization and teaching. Bringing together online many of the influential concepts associated with adult learning and socio-constructivist views of learning was connectivism, which was portrayed as a learning theory for the digital age.

Doolittle and Hicks (2003) provided an excellent delineation of radical, social, and cognitive constructivism. Radical constructivism refers specifically to knowledge construction as a strictly internal process; social constructivism (also socio-constructivism) emphasizes social interaction as the source for knowledge construction; and cognitive constructivism engenders a positivistic slant (and might be dismissed from any categorization under constructivism by some scholars) that views
knowledge as externally existing, then re-structured internally by the learner. They further advocated the use of socio-constructivism in the social studies with particular focus on the use of technology as a mediating tool to support and foster student learning.

Dillon (2003) conducted study on learners and learning in environmental education: Missing theories ignored communities and noted that learner involvement was essential in the study of the environment and that Environmental science was most valuable when it embraced a more pragmatic social constructivist approach. He further suggested that environmental programs would be more effective if students actively participated in activities perceived to be useful and culturally acceptable.

Hart (2004) conducted a case study of a project that selected 15 African American students experiencing some type of academic difficulty. These students were selected not only because of their academic challenges, but also because they exhibited an intrinsic interest in computer technology. The students were placed in two single-sex groups for instruction in Web development. While the ostensible objective was to introduce the students to the cognitive tasks involved in Web development, the underlying objective was to teach students who appeared unmotivated in the mainstream school context to engage cognitively in a relatively sophisticated domain. The learning environment used to do this was “socio-cultural” in nature, in that not only were the students exposed to the factual material and vocabulary needed for the domain, and not only were the students allowed to work with this material in a way relevant to them as individuals (that is, from a constructivist perspective), but they were also allowed to help define the language of the classroom via peer learning and discussion. Such an environment was selected because of its potential to address the possibility of the learning environment being a “poor fit” for these students. Even though the contact hours were limited, it appeared that the girls quickly mastered the tasks and concepts required - and were able to articulate these concepts - while the boys mastered the tasks but did not appear to acquire the same mastery of the concepts as the girls. Much more work in this area was needed, but this case study indicated that the methodology used not only facilitate a wider pool of African American students entering technology and science fields, but also help students of various ethnicities that were struggling academically.
Kaufman (2004) developed a comprehensive framework for understanding constructivist issues in language learning and teaching on the basis of its major intellectual impact on the development of pedagogy, especially in mathematics and science. Rooted in the cognitive developmental theory of Piaget and in the socio-cultural theory of Vygotsky, constructivist notions had an impact on the development and application of technologically enhanced microworlds and on linguistic investigation into literacy and narrative development. According to her, to date, constructivism has had little impact on language pedagogy; however, the advent of content-based pedagogical paradigms as an anchor of language education has opened new opportunities for integration of interdisciplinary collaborative approaches for language teaching and learning. Furthermore, she emphasized on standards based accreditation and reconceptualization of teacher education programs would likely expand the horizons of language pedagogy, bringing socio-culture-constructivist approaches to the foreground in language teacher education and opening new avenues for linguistic and interdisciplinary classroom-based research.

Fosnot (2005) urged the transition of traditional classrooms into socio-constructivist learning environments—using socio-constructivist principles which were based on the fusion of what is known about how students learn and the nature of knowledge.

Lord, Travis, Magill and King (2005) compared the effects of traditional (teacher-centered) and socio-constructivist (student-centered) learning styles on students' interest and performance. They reported that students in the traditional style classrooms were taught in a lecture format and the concepts were explained before laboratory work. In the other class, students were asked to discuss relationships and concepts with team members and make a presentation on it before laboratory work began. Tests were carried out every week to determine any difference between the two groups. They found that student-centered learning not only helped students have a higher average grade on their weekly test but also showed more student participation, a high level of satisfaction, willingness to answer or ask questions, and a better interest towards science when compared to students in the traditional or teacher-centered environment.
Turgut (2006) in a qualitative study described the meaning making process of English language learners with different cultural backgrounds during reading and writing activities based on a social constructionism theoretical framework. The data were collected through participant observations, interviews, archival documents and a feedback session. Six participants were from Venezuela, Honduras, Poland, Switzerland, South Korea and Japan. As a researcher, he was a participant with a Turkish cultural background. Through James Gee's macro and micro discourse analysis, the findings indicated that reading and writing discussions unite participants despite cultural and linguistic differences. Due to the culture, Asian participants' perception of classroom talk was to teach knowledge they were sure of whereas European and Hispanic participants considered it as a brainstorming tool that they learn together. Gradually, participants had constructed a group identity and served to the group through different roles. Towards the end of the study Asian participants became more talkative even on a topic considered taboo in their culture. Through reading the writing of other participants, awareness of an audience developed in their writing. Also, peer corrections and suggestions had been considered more meaningful and easier to remember compared to the teacher's corrections. The implications of this study indicated that teachers should be aware of the importance of learning students' cultural backgrounds. Applying small-group activities might be used as a transition period for those learners to speak in class. Small-group activities help them to share their ideas with few members first and then to share and verbalize in front of the whole class.

Eynde, Corte and Verschaffel (2006) studied the socio-constructivist perspective on the role of emotions in the mathematics classroom. According to them a socio-constructivist account of learning and emotions stressed the situatedness of every learning activity and pointed to the close interactions between cognitive, conative and affective factors in students’ learning and problem solving. Understanding the role of emotions in the mathematics classroom they implied understanding the nature of these situated processes and the way these related to students’ problem-solving behaviour. They presented data from a multiple-case study of 16 students out of 4 different junior high classes that aimed to investigate students’ emotional processes when solving a mathematical problem in their classrooms. After identifying the different emotions and analyzing their relations to motivational and
cognitive processes, the relation with students’ mathematics-related beliefs were examined. They specifically used Frank’s case to illustrate how the use of a thoughtful combination of a variety of different research instruments enabled them to gather insightful data on the role of emotions in mathematical problem solving.

A qualitative case study by Sullivan (2007), conducted from an interpretive epistemological stance, focused on the understanding and implementation of socio-constructivist pedagogy by two middle school and two high school social studies pre-service teachers during their apprentice (student) teaching semester. The means by which the participants facilitated socio-constructivist instructional design, and within it, historical thinking, was of primary interest in this study in which the intricate circumstances of diverse classrooms and beginning teachers provided a rich context. The resulting successes and negotiations derived by data analysis include four themes. The first entailed the classroom context and resulting logistics of student teaching during the pre-service teachers’ apprentice teaching semester; the second explored the participants’ thinking as they adopted these new pedagogical approaches; the third involved the selection of course materials, navigation of the standardized curriculum as well as efforts with lesson planning; the fourth and final theme investigated the actual classroom praxis of socio-constructivist pedagogy and historical thinking by the study participants. Findings focused on three areas of interest. First, that epistemological stance played a significant role in the pre-service teachers’ adoption and development of socio-constructivist pedagogy; second, the classroom community was essential to the creation of a student-centered learning environment; and finally, that the pre-service teachers’ partial appropriation of both socio-constructivist pedagogy and historical thinking was an area needing improvement to achieve ultimate success with these pedagogical approaches. Implications indicated that first, pre-service teacher education programs should be built upon the examination of foundational epistemology. The second implication had direct impact on the university and practice teaching classroom in that pre-service teachers need more opportunities to participate and observe socio-constructivist lessons as exemplary models. The third and final implication demanded structural consideration of the comprehensive implementation of socio-constructivist pedagogy.
Eskelinen and Haapasalo (2007) studied socio-constructivist collaborative group processes in teacher education and suggested that design of technology-based learning environments within an adequate constructivist theory linked to the knowledge structure might be a proper framework to respond to the main challenge of teacher education: to get students understand which were the basic components of modern constructivist theories on teaching and maintaining the learning through cognitive conflicts. Their studies revealed that working within socio-constructivist collaborative ICT-based design processes for the production of a hypermedia-based learning environment, even during a short period of time, changed student teachers’ conceptions of teaching and learning from an objectivist-behaviorist viewpoint to a constructivist view, and decreased students’ interest in having support for computer routines.

Reznitskaya, Anderson and Kuo (2007) in their paper on ‘Teaching and learning argumentation’ found that increasing the use of student discussion in classroom both support and are grounded in theories of social constructivism. There are a full range of advantages that result from the implementation of discussion in the classroom. Participation in group discussion allows students to generalize and transfer their knowledge of classroom learning and builds a strong foundation for communicating ideas orally. Increasing students’ opportunity to talk with one another and discuss their ideas increases their ability to support their thinking, develop reasoning skills, and to argue their opinions persuasively and respectfully.

Haapasalo (2008) in the article ‘Applying minimalist instruction for socio-constructivist technology-based environments in mathematics teaching and teacher education’ presented examples of empirical studies focusing on solving the conflict, which causes from the need to apply minimalist instruction in teaching praxis but on the other hand to plan learning environments based on an appropriate pedagogical framework using also versatile technical tools. The study placed emphasis on the eight-fold framework of activities that, in the history of human thought, had proven to be sources of new ideas for mathematics: ordering, finding, playing, construction, applying, calculating, evaluating and arguing. The studies were integrated in teacher education, discussing also features of group dynamics when a collaborative socio-
constructivist approach was applied, stressing the impact of knowledge structure, pedagogical philosophy and support for reflective communication.

Mackenzie (2008) evaluated the use of a sixth generation model of distance learning that looked beyond the use of institutional virtual learning environments (VLE’s) to enhance adult distance learning. With the vast bulk of research in recent years concerned with the use of asynchronous interaction as the dominant component in distance learning strategies, the Synchronous Community Orientated Reflective and Experiential 2.0 (SCORE 2.0) socio-constructivist and connectivist models puts the online synchronous classroom and the teacher at the heart of the proposed model of distance learning. An action research strategy was used that included pre/post course surveys, anonymous end of course questionnaires and semi structured interviews. The key findings were that the online synchronous classroom when used in conjunction with socio-constructivist and connectivist learning activities could be a motivating and engaging environment in which to build a community of learners. Supporting ‘Web 2.0’ technologies played an important part in supporting the community of learners and in helping to develop learner autonomy. Vital to the successful implementation of the model was an appropriately trained and motivated teacher.

Panagiotis and Panagiotis (2008) developed a design of an in-service primary school teachers and advisors training curriculum which was based on History and Philosophy of Science (HPS), using concepts on electricity and electromagnetism. The design of the training curriculum was to made for the development of e-material on the context of the “STeT project”. The training curriculum was based on socio-constructivist and socio-cultural learning principles and embodies appropriate teaching strategies (e.g. debates, argumentation, group work, simulations) for exploiting authentic historical science events on the topic of electricity and electromagnetism. A basic characteristic of the training curriculum was collaborative inquiry nature in order to involve teachers and advisors, with the guidance of the trainers, in conversations about common experiences and in the development of their own educational instructional material (e.g. worksheets). They believed that when teachers had the opportunity to collaboratively research their own practices, they establish what works for them and their students.
Irvin (2008) in his study prepared a report on a Head of a Mathematics Department (the author) in a Brisbane suburban High School and her attempts, over a two year period, to implement a new teaching program involving innovative curriculum resources using socio-constructivism pedagogy. The goal of the Head of Department was to support staff to create learning environments that followed a social constructivist philosophy. The aim of the study reported on in this paper was to investigate a department of teachers in a high school setting as they implemented a new pedagogy and curriculum into their teaching practice. The participants in this study were the Head of Department Mathematics (the author) and the teachers of Year 8 Mathematics (four in 2005 and six in 2006 with three of these teachers involved in both years). The researcher collected primary data in various forms – firstly, researcher field notes of observations of teachers and students; secondly, teacher observations of themselves and the students; thirdly, journal writing by the researcher and the teachers; fourthly, minutes and field notes from weekly teacher meetings and regular teacher professional conversations; fifthly, teacher interview. The Head of Department (the author) found that the learning process for teachers seemed to be aligned with social constructivist theories of learning. The formalized weekly meetings of 2005 were more effective than the informal professional conversations of 2006 as staff had to be in the right place at the right time to be included. Some staff was left expressing a need for more support. As a result, the weekly meetings were re-established in 2007 and continue in 2008. What was found was that there was a parallel process that occurred for the teachers. The teachers were learners and they needed a community of learners for support within which to reflect, learn and grow.

Inbal and Kali (2009) in their research study examined the teachers as designers of online activities and the role of socio-constructivist pedagogies in sustaining implementation. The research characterized the range of schoolteachers’ practices as designers of online activities and the relation between their pedagogical perceptions and these practices. Data-sources included forty online activities designed and developed by novice and expert teachers, as well as interviews with these teachers. Findings indicated that although all teachers held positive perceptions about online instruction, novices perceived it rather as a burden, whereas experts appreciated it as an inseparable part of their practice. They further claimed that collaborative learning socio-constructivist strategies were the key to adoption of
online instruction by novices who would be willing to integrate online instruction into their practices when they would not need to become enslaved to it.

Alonso, Pampillon, Miguel and Pita (2009) presented a case study on the effectiveness of a Socio-constructivist learning design in a virtual learning environment. They believed that Learning is the basis for research and lifelong training. In the study they presented an experiment in positive learning from the virtual campus of the ‘Complutense University of Madrid (UCM)’. In order to carry it out they used E-Ling, an e-learning environment that was developed with an innovative didactic design based on a socio-constructivist learning approach. E-Ling was used since 2006 to train future teachers and researchers in “learning to research”. Some of the results of experiment were statistically analyzed in order to compare them with other learning models. From the obtained results they concluded that E-Ling is a more productive proposal for developing competences in learning to research.

Nguyen (2010) discussed the roles of computer mediated collaborative learning (CMCL) in English as a Foreign Language (EFL) classroom equipped with a communicative language teaching (CLT) approach. The discussion moved from an overview of the principal domains of socio-cultural constructivist theory (SCT) applicable to collaborative second/foreign language learning to the review of the current CLT approach, the main focus of which was the context of Vietnamese language education. CMCL was then analyzed in terms of how it was able to support and enhance language improvement in the given CLT context. The conclusion drawn from the discussion was that CMCL with its potential benefits was capable of helping resolve certain issues raised by the introduction of a CLT approach into the Vietnamese language classroom, including Confucian educational values, examination-oriented educational system, class management, and authentic communication. It was thereby argued that CMCL may possibly flow smoothly on a CLT foundation when the whole context was viewed through a SCT lens.

In master research thesis Kusumawati (2010) reported about a study in which he explored the influence of a specific approach in teaching variation on the progress and development of students’ statistical reasoning about variation. A socio-constructivist teaching and learning approach was designed and tried out in a pretest-
posttest experimental-control-group research design. There were 39 students in the experimental group and 39 students in the control group who did the pre- and posttest. This was done with students of a social science stream in a secondary school in a rural area of Indonesia. The teaching approach contained three new key elements, namely, the use of (1) real data within a context instead of the use of artificial data; (2) open-ended tasks; and (3) group work. The research results indicated that the experimental teaching approach provided students a more conducive learning environment for developing statistical reasoning. Although students from both experimental and control groups were mostly at a low level of reasoning, the quantitative and qualitative analysis of their response indicated that there were more students in the experimental group that improved regarding the level of statistical reasoning. Qualitatively, students in the experimental group began to use central measures in making their conclusions. Regarding the procedural knowledge, there was no statistically significant difference in the performance between the two groups. These results and the fact that the cooperating teacher was ready to adopt the teaching approach encouraged to conclude that the chosen teaching approach had potential to help students develop and progress with statistical reasoning about variation.

Xu (2011) in his article ‘Second Language Learners and Their Self-confidence in Using English: A Social Constructive Perspective’ examined how self-confidence was socially and discursively constructed through the qualitative analyses of the lived experiences of two Chinese advanced learners/users of English in Australia with data obtained from in-depth interviews. Built on socio-cultural views on L2 learning and self-confidence as being socially constructed, the learners’ senses of confidence were shown to be strongly influenced by external factors such as power relations in specific contexts of interaction. Besides, they appeared to be internally related to the learners’ previously established L2 identities shaped along the paths of investment in learning English in China. Through a micro-analysis at the sites of interaction and a description of the learners’ earlier language development, this paper shed light on the dynamic process of confidence construction. It also provided useful insights into the nature of the complex relationships the learners have developed with English and the significance of the interwoven relations between language, investment and identity.
1.2 Achievement

The modern scientific study of achievement began with Henry Murray’s seminal study of basic human needs, Explorations in Personality (1938). His definition of achievement, influential in all subsequent work on the subject, was “To accomplish something difficult. To master, manipulate or organize physical objects, human beings, or ideas. To do this as rapidly and independently as possible. To overcome obstacles and attain a high standard. To excel one’s self. To rival and surpass others. To increase self-regard by the successful exercise of talent” (Murray 1938). Achievement is essential aspect of human nature, and is influenced by learning, by expectations of the value and probability of success, by one’s own explanations for task performance, and by the beliefs and expectations of others.

We live in a society in which education is placed above all else in terms of importance, where success is measured by one’s ability to continue to achieve and where we are all driven by the constant search for satisfaction (Fagg, 2003). The concept of educational achievement believes you understand and see things the way they were meant to be from any teachings, the basics of every detail of every thesis. For the development of country, every student is an asset to the nation. In order to maximize the quality of human resources of the country, it is therefore necessary that every student should achieve maximum in the academic field. Therefore in order to make possible the proper utilization of our resources and also in view of rapid changes being witnessed in the curriculum, in teaching methods and techniques and also to improve the quality of education, it becomes pertinent to find systematic information on the significant correlates of academic achievement. Despite intensive researches in the field of academic achievement, researches in the field of academic achievement are still going on in order to seek more possible explanation to explore this important phenomenon.

Achievement is one of the most important goals of education. In the process of educating the young ones the stress and focus have come to the measurement and evaluation of the student’s achievement in school and college subjects. The outcomes of education are usually characterized as the achievement of those who have been educated. These may be expressed in terms of whether or not the aims of education were fulfilled in relation to those individuals and one requires some from assessment
(Winch and Gingell 1999). Ladson (1999) stated that at its best academic achievement represents intellectual growth and the ability to participate in the production of knowledge. All its worst, academic achievement represents inculcation and mindless indoctrination of the young into the cannons and orthodoxy of the old.

Academic achievement is, in general, referred to the degree or level of success or proficiency attained in specific area concerning scholastic or academic work. Good (1973), in the Dictionary of Education referred to academic achievement as “Knowledge attained or skill developed in the school subjects, usually designated by test scores or marks assigned by the teacher”.

“Achievement means the extent to which a learner is profiting from instruction in a given area of learning”. (Crow & Crow, 1956). In other words, achievement is reflected by the extent to which skill or knowledge has been acquired by a person from the training imparted to him. It is the outcome of general and specific learning experiences. Therefore, the special acknowledgement of a person’s skill, the range and depth of his knowledge or his proficiency in a designated area of learning or behaviour is indicative of the extent of his achievement. In the views of Biswas and Aggarwal (1971), achievement is the knowledge attained or skills developed in the academic subjects usually designated by test scores. Pressey, Robbinson and Horraock (1959) defined achievement as “The status or level of person’s learning and his ability to apply what he has learned”. According to them, achievement would not only include acquisition of knowledge and skills but also attitudes and values as aspects of achievement. Achievement as manifested by the application of acquired skills and knowledge is a product of learning attitudes and interests since these factors would implicitly influence the extent of achievement. Traw (1960) defined academic achievement as, “The attained ability of degree of competence in school tasks usually measured by standardized tests and expressed in age or grade units based on norms derived from a wide sampling of pupils performance.”

The importance of scholastic or academic achievement has raised several important questions for educational researches. What factors promote achievement in students? How far do the different factors contribute towards academic achievements? Many factors have been hypothesized and researched upon. Researches have come
out with varied results, at times complementing each other, but at time contradicting each other. A complete and comprehensive picture of academic achievement still seems to elude the researchers.

The need for measuring academic achievement is based on two fundamental assumptions of psychology. Firstly, there are differences within the individual from time to time known as behaviour oscillation i.e. academic achievement of the same individual differs from time to time, from one class to another and from one educational level to another. Secondly, there are individual differences. Individuals of the same age group, of same grade, usually differ in their potential abilities and academic proficiency whether these are measured by standardized measure of achievement or by the teacher grading by marks obtained in test and examination.

1.2.2 Achievement in Science

Achievement in different subjects at different stages is likely to be influenced by multiplicity of factors, such as intelligence, emotional intelligence, and attitude towards subject, interest, study habits and home environment. In addition to these, there are some other factors such as medium of instruction, quality and experience of teacher, method of teaching and evaluation, size of class and pupil teacher relation which influences the child’s interaction to the system of education at different levels.

Science is considered as an important subject in School curriculum because man’s future depends to a large extent on scientific advances and development of productive activity. Indian Education Commission (1964-66) suggested that great emphasis be laid on science education and that science be made a compulsory subject of school curriculum. Following lines from the commission’s report make the point clear:

“We lay great emphasis on making science an important element in the school curriculum. We therefore, recommend that science and mathematics should be taught on compulsory basis to all pupils as a part of general education during the first ten years of schooling. In addition, there should be provision of special courses in these subjects at the secondary stage for students of more than average ability”.

The construct of “science achievement,” although deceptively simple and elusive, represents a great challenge. Measuring educational achievement is difficult.
from both a conceptual and a practical perspective. What counts as “achievement” is not always easy to discern. Even when a concept of achievement has been clearly explicated, ways and means for assessing it are not easily devised. The construct of science achievement can be interpreted according to the conceptual framework of intended, implemented, and attained curriculum in TIMSS (Robitallie et al., 1993).

1.1. Assessment of Academic Achievement:

Perhaps no one would deny the importance of academic achievement in child life. The success of failure of a student is measured in terms academic achievement. It is common observation that success in the academic field serves as an emotional tonic and any damage done to a child in the home or neighborhood may be partially repaired by the success in the school. High achievement in school built self-esteem, self confidence and strengthens self-efficacy that leads to better adjustment with the groups. Good academic records to certain extent predict future of child. Today, at the time of admission for entrance in job, for scholarship, for future studies, good academic record is only yardstick. Whatever one’s interest, attitude or aptitude may be one can’t underestimate the importance of academic record. It also helps the teacher to know whether teaching methods/models are effective or not and helps both the students and teachers to know where they stand.

The assessment of academic achievement has long been a routine part of all educational processes. It has two purposes:

1. Specifying and verifying problems; and
2. Making decision about students

It aims to assist professionals in making decision about referral, screening, classification, instructional planning and student progress.

Psychological tests are among the most useful tools of testing achievement for they provide the data for most experimental and descriptive studies. Achievement as performance in school or college is done through tests, usually through teacher made tests. Teacher made tests area used to identify specific objectives that have previously been taught and to evaluate the degree to which students have mastered these objectives.
Several different procedures can be used for measuring or assessing achievement depending on the purposes of the selection: the standardized tests, the informal teacher made tests, interviews, observations, anecdotal records, student’s report and projects. Both standard tests and teacher made tests have their advantages and limitations towards effective evaluation of achievement. While standardized tests are available for much different purpose, the content of such tests may not conform closely enough to the local program of instruction. Teacher made tests have the advantage of being suit entirely in the context of the local teaching situations, but it is not so well defined as in the case of standardized tests. Method of assessing or measuring achievement can also be categorized into the following types:

**Norm Reference Tests:** is a type of test, assessment, or evaluation which yields an estimate of the position of the tested individual in a predefined population, with respect to the trait being measured (Assessment Guided Practices, 2008). This estimate is derived from the analysis of test scores and possibly other relevant data from a sample drawn from the population. That is, this type of test identifies whether the test taker performed better or worse than other test takers, but not whether the test taker knows either more or less material than is necessary for a given purpose. The term normative assessment refers to the process of comparing one test-taker to his or her peers (Glaser, 1963). A norm reference test compares student’s achievement. Such tests are used to compare a student’s performance to a norm or average of performances of similar grade/age peers. Thus a major feature of the norm reference tests is its ability to discriminate between students and their achievement.

**Criterion reference tests:** The criterion-referenced interpretation of a test score identifies the relationship to the subject matter. In the case of a mastery test, this does mean identifying whether the examinee has "mastered" a specified level of the subject matter by comparing their score to the cut score. According to Haertel (1985) Criterion referenced tests are designed to find out whether a child has a set of skills, rather than how a child compares to other children of the same age. The test designers analyze the component parts of specific academic skills, say number understanding, and then write test items that will measure whether the child has all the component parts of the skill. A test of reading skills would seek to discover whether a child can identify the specific sounds consonants make before it would evaluate
whether a student can answer comprehension questions. The questions in a criterion referenced test would seek to find if the student has all those skills, not whether the student does as well as other third grade children.

**Performance Based Tests:** A performance-based assessment is employed to measure students' academic achievement by evaluating their performance in a hands-on task. For example, students could be required to conduct and present independent research as part of a performance-based assessment (Glossary of Education, 2011)

**Curriculum Based Tests:** are criterion based tests, usually based on what the child is learning in the curriculum. Some are formal, such as the tests that are developed to evaluate chapters in mathematical text books. Spelling tests are Curriculum Based Assessments, as are multiple choice tests designed to evaluate a student's retention of social studies curricular information (Wright, 2008). According to Witt, Elliot, Daly, Gresham and Kramer (1998) the term curriculum-based assessment means simply measurement that uses "direct observation and recording of a student's performance in the local curriculum as a basis for gathering information to make instructional decisions."

More than mentioned above, there are many ways of assessing achievement one most commonly used is achievement test. Under ideal conditions, achievement or aptitude tests measure the test performance of which individual are capable (Best & Kahn, 1989). Achievement tests measures the current status of individuals with respect to proficiency in the given areas of knowledge for curriculum areas such as reading and also in the form of comprehensive batteries in several different areas.

Achievement Test is a test of knowledge or proficiency based on something learned or taught. The purpose of an achievement test is to determine student's knowledge in a particular subject area. Achievement tests are often administered by the state to measure specific areas of learning such as math, reading, writing, science, and social studies.

An achievement test is a test of developed skill or knowledge. The most common type of achievement test is a standardized test developed to measure skills and knowledge learned in a given grade level, usually through planned instruction, such as training or classroom instruction (Hawaii, 1999). Achievement tests measures
how well students have mastered the subject matter in a course of instruction (Meagargee, 2000). According to Psychology Glossary (2011), an achievement test is a standardized test that is designed to measure an individual's level of knowledge in a particular area. Unlike an aptitude test which measures a person’s ability to learn something, an achievement test focuses specifically on how much a person knows about a specific topic or area such as math, geography, or science. One of the most well known achievement tests is the SAT, which is often used by college admission boards to determine who gets accepted to college. Unfortunately, schools often use the SAT to predict how well students will learn (or perform) in college, which means they are using an achievement test as though it was an aptitude test.

Standardized achievement tests are carefully developed and are available for curriculum such as reading and in terms of comprehensive batteries in several different areas. A diagnostic test is also a type of achievement test yielding multiple scores for each area of achievement. In the school survey for the past several decades, achievement tests have been extensively in the appraisal of instruction (Best & Kahn, 1999).

Achievement test scores are often used in an educational system to determine what level of instruction for which a student is prepared. High achievement scores usually indicate a mastery of grade-level material, and the readiness for advanced instruction. Low achievement scores can indicate the need for remediation or repeating a course grade. According to Stout (2007) “When writing achievement test items, writers usually begin with a list of content standards (either written by content specialists or based on state-created content standards) which specify exactly what students are expected to learn in a given school year. The goal of item writers is to create test items that measure the most important skills and knowledge attained in a given grade-level. The number and type of test items written is determined by the grade-level content standards. Content validity is determined by the representativeness of the items included on the final test.”

1.2.3 Factors Affecting Achievement

Academic achievement is considered to be the unique responsibility of educational institutions. Knowledge of level of correction between different factors and academic achievement is, therefore, necessary for a teacher in ascertaining what
contributes to high and low achievement of students. This is also of great concern to the parents, institutions and society. Truly speaking the future of any institution depends on the academic achievement of its students.

Academic achievement is a multidimensional, multifaceted phenomenon. David (1975) reviewed 17 studies on factors affecting achievement. They vary from intelligence to physical health through socio-economic status of the family, sex, caste, distance of school from home and leisure time activities.

There are innumerable factors which affects academic achievement viz. intelligence, personality, motivation, school environment, heredity, home environment, learning experiences of school and class in particular etc. The factors like interest, aptitudes, family background and socio-economic status of the parent also influence of academic achievement. In a comprehensive study, Sinha (1970) asked high and low achievers to check factors that considered important in order of achievement significance. These were hard work, intelligence, memory and good health, interest in social and practical work.

There are several factors that are responsible for high and low achievement of the students and these factors can be grouped into two broad classes: subjective factors and objective factors.

**Subjective and Psychology Factors:**

These are related to individual himself while influencing one achievement e.g. intelligence, learning ability, motivation, self efficacy, learning style, study habits etc.

**Objective or & Environmental Factors**

These factors confirming to the environment of the individual include socio-economic status, educational system, family environment, evaluation system, value system, teacher’s efficiency, school situation and environments etc. Factors affecting achievement listed on the basis of different research findings have been classified into following categories:

**Cognitive Factors:** like intelligence, creative ability, learning rate, reasoning ability etc.

**Affective Factors:** like values, interests, self efficacy, preservance, stress etc.
Home related Factors: Socio-economic status, family size, both order, gender bias, parental involvement, and parental expectation, working status of parents.

Time Factors: Time spent, time allowed.

Misc. factors: culture, locate, age, gender etc.

1.2.4 Studies Related to Achievement

Whyte (1978) did a significant educational research studying locus of control as related to the academic achievement of students pursuing higher education coursework in science. Much of her educational research and publications focused upon the theories of Julian B. Rotter in regard to the importance of internal control and successful academic performance. Whyte reported that individuals who perceive and believe that their hard work may lead to more successful academic outcomes, instead of depending on luck or fate, persist and achieve academically at a higher level. Therefore, it is important to provide education and counseling in this regard.

The influence of active participation on student achievement in science was studied by Pratton & Hales (1986). Selected teachers were trained in using the techniques of active participation and identified active participation used by other teachers. They found that the mean achievement in science of the class taught with active participation was greater than the class taught without active participation. Active participation has made a difference in the degree of student learning and was said to be an efficient teaching method as the students spent more time in doing activities that required thinking, responding and verifying what they know.

Sherman (1989) conducted a comparative study on cooperative and competitive achievement in two secondary biology classrooms. Each was pretested and taught an identical unit of study, one in an individually competitive structure and the other using a cooperative group-investigation model. At the end of seven weeks both classes were post tested. A two-way within-subjects ANOVA was used to determine significant differences in pre- and post-test scores between the two treatment groups. The two groups were not significantly different from each other on the pretest. While both cooperative and competitive techniques obtained significantly ($p < 0.05$) higher posttest scores, neither treatment was superior over the other in producing academic achievement. Results were compared to previous studies which
had examined differences among cooperatively, competitively, and individually structured classrooms.

Lazarowitz, Lazarowitz and Baird (1994) conducted research on learning science in a cooperative setting and measured academic achievement and affective outcomes of high school students. A learning unit in earth science was taught to high school students, using a jigsaw-group mastery learning approach. The sample consisted of 73 students in the experimental group and 47 students who learned the topic in an individualized mastery learning approach. The study lasted 5 weeks. Pretests and posttests on academic achievement and affective outcomes were administered. Data were treated with an analysis of covariance. The results show that students of the experimental group achieved significantly higher on academic outcomes, both normative and objective scores. On the creative essay test, the differences in number of ideas and total essay score were not significant between the groups, although the mean scores for number of words were higher for the individualized mastery learning group. On the affective domain, jigsaw-group mastery learning students scored significantly higher on self-esteem, number of friends, and involvement in the classroom. No differences were found in cohesiveness, cooperation, competition, and attitudes toward the subject learned. The results were discussed through the evaluation and comparison of the two methods of instruction used in this study.

Banerjee and Vidyapati (1997) conducted a comparative study on the effect of lecture and cooperative learning strategies on achievements in general chemistry at the undergraduate level was undertaken with 68 first-semester students in a teacher preparation course. The overall achievement scores were similar in the two classes following different learning strategies. The achievement scores were not influenced significantly by subject background (mathematics or biology) and gender. The implications were discussed.

Ziegler (2000) examined characteristics of teachers’ perceptions, and factors influencing teachers’ perceptions of constructivist teaching, learning, and supervision; relationships of teachers’ perceptions of constructivist teaching, learning, and supervisory practice; and the influence of constructivist practices on student science and math achievement. He found that different dimensions of constructivist teaching.
learning, and supervisory practices have differing effects on student achievement. The results found confirm research that supports constructivist learning practices positively.

The impact of active learning on elementary school students’ achievement and attitudes in science education was measured by Korkmaz (2001). The active learning tasks were designed with regard to multiple intelligences. The findings indicated that the science achievement scores of the experimental group outperformed the control group. The author also found significant differences with respect to students’ attitudes toward science in favor of the experimental group. Korkmaz showed evidence that active learning impact positively on student achievement at elementary level in a Turkish context.

A major study on ‘Developing leadership and community to support an EiC program’ by Lieberman and Hoody (2000) reviewed academic scores of students in 40 schools that used environmental education to integrate their curricula. Using standardized measures of academic achievement they found better performance in reading, writing, math, science and social studies. These results supplemented other benefits associated with environmental education programming; students had increased enthusiasm for learning and pride in accomplishments.

Bahar (2003) measured the impact of group work on the achievement of sophomore students in pre-service science teacher education. Bahar conducted a comparative study and found that students in the experimental group showed significantly higher scores than the control group on the achievement test in science. Findings indicated that the discussion-based group work in the experimental group was favored both by field dependent and field independent students, while in the control group learning was benefited by field independent students more than did the field dependent students.

Zady, Portes and Ochs (2003) examined the cognitive supports that underlie achievement in science by using a cultural historical framework (Vygotsky, 1986), Thought and Language, and the activity setting (AS) construct (Tharp & Gallimore, 1988), Rousing minds to life: Teaching, learning and schooling in social context, with its five features: personnel, motivations, scripts, task demands, and beliefs. Observations were made of the classrooms of seventh-grade science students, 32 of
whom had participated in a prior achievement-related parent-child interaction or home study. The results of a quantitative analysis of classroom interaction showed two features of the AS: personnel and scripts. The qualitative field analysis generated four emergent phenomena related to the features of the AS that appeared to influence student opportunity for conceptual development. The emergent phenomena were science activities, the building of learning, meaning in lessons, and the conflict over control. Lastly, the results of the two-part classroom study were compared to those of the home science AS of high and low achievers. Mismatches in the AS features in the science classroom may constrain the opportunity to learn.

Frances (2003) examined the effects of weekly interactive science homework on family involvement in homework, student achievement, and homework attitudes. Sixth- and 8th-grade students (N = 253) participated in the 18-week study. Six classes of students completed TIPS (Teachers Involve Parents in Schoolwork) assignments with directions for family and parent involvement. Four classes completed non-interactive homework (no family involvement directions). Interactive students reported significantly higher levels of family involvement than did non-interactive students. Students in both groups who more regularly involved family members completed more assignments; TIPS students turned in more accurate assignments than did non-TIPS students. TIPS students also earned significantly higher science report card grades. The findings revealed that TIPS interactive homework affects family involvement in homework, science attitudes, and student achievement in the middle grades.

Sungur and Tekkaya (2003) investigate the effect of gender and reasoning ability on the human circulatory system concepts achievement and attitude toward biology. A total of 47 10th-grade students participated in the study. Group assessment of logical thinking, attitude toward biology scale, and the human circulatory system concepts test were administered to determine students' reasoning ability, attitude toward biology, and achievement, respectively. Two-way Multivariate Analysis of Variance (MANOVA) was used to analyze the data. The results revealed that although there was no statistically significant mean difference between boys and girls with respect to achievement and attitude toward biology, there was statistically
significant mean difference between concrete and formal students with respect to achievement and attitude toward biology.

Olubunmi (2003) examined the effect of a constructivist-based learning strategy - the Learning Cycle Approach (LCA) on male and female student's misconceptions on selected concepts in chemistry. Two instruments were developed along the guidelines set out by Piaget inspired studies and used for the study. The former was used to test the students' reasoning ability on how to solve giving problems in chemistry while the latter was used to test the students' practical skills in solving given scientific problems. Subjects for the study were 55 Nigerian Secondary Two (SSII) Students (30 males and 25 females) from a semi urban area of Ondo State, Nigeria were involved in the study, the findings showed that Female students performed significantly better than their male counterpart in the test of reasoning ability. The subjects possessed low understanding of manipulative skills. Female (57%) students responded better than males (43%) at formal operational levels while the greater proportion of males (62%) responded at the concrete levels as against 38% of females at concrete level respectively.

Akubuiro and Joshua (2004) investigated the influence of self-concept and attitude on academic achievement in science of secondary school students in Southern Cross River State of Nigeria. The study revealed that the students' academic achievement in science was significantly predicted by their attitude, academic self concept and science self-concept, with attitude contributing most to the prediction.

Naida, David and Gail (2005) investigated the relationship between self-perceptions of ability and achievement in math, science, and English from Grades 8 to 11 (N = 342). A state-trait model that included an association between stable (i.e., trait-like) components of self-perceptions and achievement as well as time-specific (i.e., state-like) effects during the transition to high school (i.e., Grade 8 to Grade 9) demonstrated superior fit to alternative models that did not incorporate these features. Stable components of self-perceptions of ability and achievement exhibited a substantial association in this model. In most instances, however, there also was evidence of a positive effect of self-perceptions in Grade 8 on achievement in Grade 9.
Young and Lee (2005) studied the effects of a kit-based science curriculum and intensive science professional development on elementary student science achievement. The science achievement of 226 5th graders from districts that had a kit-based inquiry science curriculum supported by intensive professional development (PD) was compared with data from a group of 173 5th graders from other districts that use non-kit science materials and did not have systematic science PD for teachers. Within the kit-based project, the sample of project teachers was stratified to select teachers with a high number of science PD hours versus those with few hours. While there were no significant differences in the mean total scores for kit-based students with low PD versus high PD teachers, the kit-based classrooms scored significantly higher than students in non-kit classrooms on both the pretest and posttest, though there were significantly more minutes of science instruction in the non-kit classrooms. Finally, non-kit teachers taught more units of shorter length and reported lower levels of preparedness to use reform pedagogical approaches.

Dhindsa and Emran (2006) compared the effects of constructivist-informed, technology-rich learning environments and traditional learning environments on students’ achievement. The subjects of the study were 115 Form V combined science students (16 to 19 years old) studying in a government school in Brunei. These students were from four intact classes. Two classes (23 boys and 34 girls) were taught using a constructivist-informed, technology-rich teaching methodology (involving interactive whiteboards and Active Studio software) and the other two (25 boys and 33 girls) were taught using traditional teaching methodologies. Student achievement was evaluated using a chemistry achievement test consisting of sections on multiple choice, short answers and essay type questions. The mean gain in achievement score in chemistry for the constructivist group compared to the traditional group was statistically significantly higher on the total test as well as on the sections of the test. Moreover, there were no gender-differences in the mean achievement score for the constructivist group, whereas such differences in the traditional group were statistically significant. These results suggested that a constructivist-informed, technology-rich teaching approach compared to a traditional teaching approach was more effective in improving the achievement of students as well as in minimizing the gender differences in academic achievement. It is therefore recommended that
teachers use this teaching technique to help their students learn chemistry better and achieve higher grades.

Yucel (2007) conducted a study on factors affecting student achievement in chemistry and the degree of their respective effects on achievement. The end-of-year grades in the report cards were emphasized so as not to compromise the average of written or oral exams only. In the assessment of achievement in chemistry classes, the necessity of some factors to be considered was expressed as a numeric formula at the end of the statistical calculations. Additionally, socio-economical factors were calculated with four operations together with the coefficients determined through regression analysis. The finding was that student achievement should not be assessed and evaluated with the average of written and oral exam grades throughout the year only, but that socio-economical factors, which were thought to have significant effects, should also be considered. This finding was also supported in the interviews with chemistry teachers.

Krishnasamy (2007) conducted a research study to examine the effects of a multimedia constructivist environment on Form Four students’ achievement and motivation in the learning of “Chemical Formulae and Equations”. This study was intended to design and develop a multimedia constructivist environment to solve the learning difficulties in chemistry. Multimedia Constructivist Instruction (MCI) and Multimedia Objectivist Instruction (MOI) courseware were developed. The MCI was assigned to 80 students whereas the MOI was assigned to 89 students. This quasi experimental study employed a 2 x 2 factorial design. The independent variables were the multimedia approaches, i.e. the MCI and the MOI, whereas the dependent variables were the students’ achievement and motivation. Students’ ability levels (high-ability, HA or low-ability, LA), cognitive styles (field-independent, FI or field-dependent, FD) and gender (male or female) were the moderator variables. This study found that (i) the MCI students performed significantly better and were significantly more motivated than the MOI students, (ii) the HA students performed significantly better and were significantly more motivated than the LA students, (iii) the FI students did not perform significantly better but were significantly more motivated than the FD students, (iv) the male students did not perform significantly better but were significantly more motivated than the female students, (v) the HA students
performed significantly better and were significantly more motivated than the LA students in MCI. (vi) the HA students using MCI performed significantly better but were not significantly more motivated than the HA students using MOI. (vii) the LA students using MCI did not perform significantly better but were significantly more motivated than the LA students using MOI. (viii) the FI students performed significantly better and were significantly more motivated than the FD students in MCI.

Folashade and Akinbobola (2009) investigated the effects of constructivist problem based learning technique on the academic achievement of physics students with low ability levels in Nigeria secondary schools. Pre-test-Post-test control group design was adopted for the study. A purposive sampling technique was used to select 2 schools out of 40-co-educational secondary schools in Taraba state. 105 senior secondary school II physics students were used for the study. Physics Achievement Test (PAT) and physics Ability Level Test (PALT) were used to collect data. The kuder-Richardson coefficient of internal consistency for PAT and PALT were 0.72 and 0.76 respectively. Three hypotheses were tested at p<0.05 level of significance using t- test analysis. The result of the findings showed that the physics students with low ability level taught with constructivist problem based learning technique performed significantly better than those taught with conventional learning method. Also, student taught with problem based learning technique performed significantly better than those taught with conventional method. There was no significant gender difference in the performance of students taught with problem based learning technique. It was recommended that problem-based learning technique should be used in schools to teach various concepts in physics.

Oludipe and Oludipe (2010) examined the effectiveness of constructivist-based teaching strategy on academic performance in integrated science by Junior Secondary School students in South-West Nigeria. Quasi-experimental research design was used to achieve the purpose of this study. Participants were 120 Junior Secondary School Students randomly selected from four out of the 25 co-educational Junior Secondary Schools in Ijebu-ode local government area of ogun state, South-west Nigeria. Findings revealed that the constructivist instructed students had higher
scores on the post test and the delayed post test, compared to those exposed to conventional (lecture) method of teaching. The researchers recommended that integrated science teachers should incorporate constructivist-based teaching strategy in their methods of teaching.

Akinbobola and Folashade (2010) investigated constructivist practices through guided discovery approach and the effect on students’ cognitive achievement in Nigerian senior secondary school Physics. The study adopted pretest-posttest control group design. A criterion sampling technique was used to select six schools out of nine schools that met the criteria. A total of 278 students took part in the study; this was made up of 141 male students and 137 female students in their respective intact classes. Physic Achievement Test (PAT) with the internal consistency of 0.77 using Kuder Richardson formula 21 was the instrument used in collecting data. The data were analyzed using Analysis of Covariance (ANCOVA) and t-test. The results showed that guided discovery approaches was the most effective in facilitating students’ achievement in physics after being taught using a pictorial organizer. It was recommended that physics teachers should endeavour to use constructivist practices through guided discovery approach in order to engage students in problem solving activities, independent learning, critical thinking and understanding, and creative learning, rather than in rote learning and memorization.

Chinwe and Chinyere (2010) investigated the effects of constructivist instructional approach on students’ achievement in basic ecology concept in biology. The study adopted a quasi-experimental design, specifically, the pre-test post-test non-equivalent control group design. Two research questions and two null hypotheses guided the study. The sample was made up of 154 students. The instrument was 38-item multiple-choice biology achievement test on ecological concepts (BATEC). Mean and standard deviation were used to answer the two research questions while ANCOVA was used to test the two null hypotheses at p<0.05. The result revealed that constructivist instructional approach was more effective in facilitating students’ achievement in ecological concepts. There was no significant difference between male and female students taught ecological concepts using constructivist instructional approach. Based on the findings, some recommendations were made which include...
the full incorporation of the 5Es (Engagement, Exploration, Explanation, Elaboration and Evaluation) constructivist model in teaching ecological concept.

Soltani and Nasr (2010) conducted a research to examine the relation between attitudes towards science in biology courses and students’ biology achievement. A total of 185 grade 12 (age 17-18 years) students in Isfahan answered to a 30 item questionnaire provided by authors based on STAQ-R inventory. The results showed that among attitude towards science dimensions, only “biology is fun for me”, had meaningful and positive relation with students’ achievement in biology. Also there was no significant difference between girls and boys in attitude towards biology, although girls had better achievement in biology in comparison with boys.

### 1.3 Scientific Creativity

Creativity is the ability to come up with ideas or artifacts that are new, surprising and valuable (Boden, 2004). It always involves some addition to our previous knowledge, either an improved theory, or new objects or procedure. According to Sternberg (2003) creativity is the ability to produce work that is both novel (original, unexpected), and appropriate (useful, meets task constraints). The concept applies to historic novelty, generating ideas and artifacts that arise for the first time in human history, and to individual novelty; ideas and artifacts new to the person who creates them (Boden, 1996). Creativity is the core of the processes in learning how to learn and in coping with changes and future new education (Torrance & Goff, 1989).

Thus creativity is a mental and social process involving the generation of new ideas or concepts, or new associations of the creative mind between existing ideas or concepts. Creativity is fueled by the process of either conscious or unconscious insight. An alternative conception of creativeness is that it is simply the act of making something new.

Bennell (1969) who researched the meaning of creativity remarked that creativity is multifaceted and does not mean same to all people. The meaning of creativity is fundamentally unclear, but the most accepted definitions of creativity are equally useful in all areas like mathematics, science, language, social studies,
psychology, music and physical education. The human being is creative in a special field. For instance, while an individual is creative in chemistry, he or she may not be creative in painting (Liang, 2002). Therefore it is generally necessary to separate scientific creativity from creativity (Lin, Hu, Adey and Shen, 2003).

From a scientific point of view, the products of creative thought (sometimes referred to as divergent thought) are usually considered to have both originality and appropriateness. In the area of scientific creativity various authors have conducted research and they emphasized that scientific creativity is creativity through the media of science. Scientists use their creativity in every stage of scientific research (Khalick, A. & Lederman, 2000). So, the creativity has a supplementary role in many scientific processes. It is used especially in introducing problem and hypothesis and designing experiments. That is why; science is a process containing the creativity components affecting each step of life in addition to being a product (Saxena, 1994). Individual need to think creatively and to be able to use their scientific process skills in order to develop a fundamental scientific understanding and creative scientists are required to find useful and new solutions for the problem existing in daily life. Creative scientists are much more sensitive to regarding problems. Every educated individual may not be scientist, but it is important for each person to begin his or her education life by applying creative thinking. All individuals who learned to think creatively while dealing with the scientific work can also apply these skills in other areas (Meador, 2003). Although creativity is accepted as a problem solving skill in research literature, it requires creative performance, recognizing the problem, thinking differently, and finding solutions. Recognizing the problem plays an extremely important role in the creative process (Erdener, 2003).

The best definition of creativity related to the science was done by Torrance; the definition is that, “The creativity is recognizing the gaps in the problem or the information, creating ideas or hypotheses, testing and developing these hypotheses, and transmitting the data” (Torrance, 1990 in Dass, 2004). Moravesik (1981) defined the Scientific Creativity by saying, "It can explain itself in comprehending the new ideas and concepts added to scientific knowledge, in formulating new theories in
Thus, scientific creativity (creativity in science can be considered to help achieve new and original steps in performing the targets of science. Rau and Schepige (2003) presents scientific creativity as relying upon the same aesthetic tools of thinking as arts; science involves not just the process of stepping back and analysis the world with 'cold logic' and rigorous methods, 'but also' stepping forward in an attempt to get inside of objects, events and ideas.

Creative thinking is necessary to search for solutions to all kinds of problems that are encountered in daily life and to make new products. According to scientific studies, creativity takes a complementary role in many scientific processes. The individuals who use creativity can make their science education functional, and therefore, the scientific information can be the basis for producing a valuable product instead of just amassing information. Therefore, for students to gain the creative thinking skills that they will need as adults, at each stage of their education, beginning in elementary school, must be one of the most important purposes of science education (Koray, 2003).

1.3.1 The Nature of Scientific Creativity

The concept of scientific creativity has proven over the years to be an elusive one to define. As early as 1960, Rapucci (quoted by Welsch 1981) counted between 50 and 60 definitions in the literature on scientific creativity. Twenty years later, an extensive review forced Welsch (1981) to conclude that the literature contains such a variance of definitional statements that the task of arriving at an integrated and agreed definition is virtually impossible. Different perceptions of the meaning of creativity have led to a correspondingly wide variety of techniques to assess it. Many researchers combine two or more aspects of the creative process, creative product, creative person and creative environment in defining creativity.

Torrance (1990) considered fluency, flexibility, and original thinking as central features of scientific creativity. Fluency means the number of original ideas
produced, flexibility is the ability to 'change tack', not to be bound by an established approach after that approach is found no longer to work efficiently. Originality is interpreted statistically: an answer which is rare, which occurs only occasionally in a given population, is considered original. Hudson (1966) took a similar approach. In asking students how many uses they could think of for a brick, he collected all the answers and gave higher scores to the answers which were rare (which occurred only infrequently) than to common answers. Fluency, flexibility, and originality thus form one dimension of the model, one which can be described as being a personality trait, the characteristics of the scientific creative person. Although divergent thinking is no longer considered to be synonymous with creative ability, it is nevertheless an important component of creative potential (Runco 1991).

When we consider scientific products, we can distinguish between technical products, advances in science knowledge, understanding of scientific phenomena, and scientific problem solving. Cattell (1971) argued that problem solving does not mean solving routine problems using a recipe but finding the answers to new problems. Lubart (1994) pointed out that problem solving can lead to creativity because if a problem exists then there is the possibility of creative solution.

Sensitivity to science problems is also considered a component dimension of scientific creativity. Ochse (1990) argued that sensitivity to problems is an important feature of the creative process. Einstein and Infield (1938) suggested that the formulation of a problem is often more important than its solution, which may be a matter of mathematical or experimental skill. Products provide us with the second dimension of scientific creativity.

Einstein argued that language, as it is written or spoken, did not seem to play a significant role in his mechanism of thought. He referred rather to psychical signs and more or less clear images which seemed to be voluntarily reproduced and combined (Einstein, 1952). This role of imagination is also supported by psychologists (Gardner, 1983; Johnson-Laid, 1987). This suggests a distinction between creative imagination and creative thinking and this is built into the third, process, dimension of scientific creativity.
Hu and Adey (2002) suggested the three-dimensional Scientific Structure Creativity Model (SSCM). The proposed structure is designed as a theoretical foundation on which the measurement of scientific creativity, research into scientific creativity, and the cultivation of scientific creativity may be based.

Figure 1.3 The Scientific Structure Creativity Model (SSCM) Proposed by Hu & Adey (2002)

In summary, Scientific Creativity as a kind of intellectual trait or ability producing or potentially producing a certain product that is original and has social or personal value, designed with a certain purpose in mind, using given information. This definition may be elaborated with a set of hypotheses about the structure of scientific creativity:

1. Scientific creativity is different from other creativity since it is concerned with creative science experiments, creative scientific problem finding and solving, and creative science activity.

2. Scientific creativity is a kind of ability. The structure of scientific creativity itself does not include non-intellectual factors, although non-intellectual factors may influence scientific creativity.

3. Scientific creativity must depend on scientific knowledge and skills.
4 Scientific creativity should be a combination of static structure and developmental structure. The adolescent and the mature scientist have the same basic mental structure of scientific creativity but that of the latter is more developed.

5 Scientific Creativity and analytical intelligence are two different factors of a singular function originating from mental ability.

1.3.2 The Nature of Science and Scientific Creativity

Understanding Nature of Science has been seen as a key contribution to achieving scientific literacy, the drive for which has been significant in recent years. Hence, Nature of Science has achieved a degree of prominence (AAAS, 1989; De Boer, 2000; Driver, Leach, Millar, & Scott 1996; McComas & Olson, 1998; Schwartz, Lederman & Crawford, 2004). Student’s understandings in Science subjects is also linked to scientific problem solving abilities (Matthews, 1994) and their conceptual understanding of scientific knowledge (Leach 1999). Creativity is an aspect of the nature of science that normally features in school science research literature. McComas and Olson (1998), for example, studied aspects of Nature of Science in eight state and national standard documents from Anglo-American countries, finding creativity as a common thread. All documents mentioned science knowledge as 'tentative', implicitly suggesting that it comprised created ideas rather than being a 'true' description of the world.

Students should appreciate that science is an activity that involves creativity and imagination as much as many other human activities, and that some scientific ideas are enormous intellectual achievements. Scientists, as much as any other profession, are passionate and involved humans whose work relies on inspiration and imagination.

In addition, Schwartz, Lederman and Crawford (2004) indicate that in science creativity is always matched by rationality, with experiments playing a crucial role. Science knowledge is created from the human imaginations and logical reasoning. This creation is based on observation and inferences of the natural world. Osborne, Simon and Collins (2003) found that teachers were the sub-group of scientists who most strongly favoured the creativity aspect.
A theory for creativity is already established in the much referred-to picture offered by Reichenbach's (1938) two modes of science: the mode of discovery and the mode of justification. Popper (1959) implemented this in his science philosophy, but, like most science philosophers, he is not explicit about how 'discovery' actually happens. Another, more recent frame, might be that of Simonton (2004), who proposes a theoretical framework to explain scientific creativity based on the components chance, logic, genius and Zeitgeist. For Simonton, logic plays a crucial role in generating ideas, not just testing them. This is demonstrated through the development of many computer programs, so called ‘discovery programs’, which replicate great scientists' achievements by applying analyses to empirical data. Simonton further emphasizes the interplay between geniuses and the environment through the concept of Zeitgeist, the spirit of the time. When many people work on the same problem(s) new ideas will be 'in the air' waiting for anyone to pick them up. Numerous examples of the phenomenon of 'multiples' (Merton, 1961) exist in science, when scientists have simultaneously come up with the same original idea: the conflicts between Newton and Leibniz and Darwin and Wallace are well-known. There is no obvious compromise, but suggested statements for a reliable picture are:

* Scientific theories are creative products (ideas) made by scientists
* Many scientists work on the same problems and new ideas (theories, laws) emerge by common effort
* Most science theories develop over a long period in small steps
* Some scientists are highly creative and make substantial contributions in their fields, but they always build on other people's ideas
* All scientists must use their imagination when contributing to the development of science.
* Scientific theories are created in many different ways. The processes are sometimes highly creative and/or highly logic, rational and/or accidental.
* In science creativity and rationality always work together. Scientific creativity never works without rationality and strict empirical testing.

Whatever is agreed, an important issue is how to develop these understandings in school science among teachers and students. Gallagher (1991) has shown this task is more complicated than just helping teachers develop their understanding. Teachers
may have different perspectives on the nature of science, treating their classroom practice of science as an established body of knowledge and techniques requiring minimal justification. Improving teaching therefore requires teachers to reconsider their roles, use of discourse, conception of learning goals and the nature of classroom activities

1.3.3 Children Being Creative in Science

Science aims to describe order and explain the natural and physical world (Jardine, 2000). From a constructivist perspective, generating explanations and testing them are creative processes (Newton 2000). Klahr and Dunbar (1998) describe constructing explanations as working in ‘the hypothesis space’ and constructing tests of those ideas as working in ‘the experiment space’. In the elementary science classroom, children could be given a wooden meter rule and told to drop it so one end strikes the floor and bounces. The problem is: Why does it bounce? Thinking in the hypothesis space, these children construct various scientific explanations that are more or less new to them and, in the process, show psychological creativity. In practice, this kind of event can be used to build a ‘concept cartoon’, a pictorial representation with notes as an aide memoire to support thought in the experiment space (Keogh and Naylor 1999). In the experiment space, children could be asked to devise a practical investigation which tests one or more of their possible explanations. Such constructions involve imaginative thought, the bringing together of ideas and the generation of possible worlds. To the extent that their ideas are novel in their world, this is again an instance of psychological or small creative activity. Some science curricula (for instance, Rose 2009) include another mode of thought which could be called ‘the application space’. This is where scientific knowledge and understanding are used to solve practical problems. Here, children might be asked to apply their understanding of the ‘springiness’ of a wooden lath to invent a device to close a door. The generation of likely explanations of the world, however, is central to the scientific endeavor (Jardine, 2000) although it tends to receive little attention (Roberts, 2004).

Strongly constrained creative activity is often described as problem-solving and ‘imaginative problem-solving is at the root of all human inventiveness’ (Jardine 2000). That problem-solving in science is a creative process was not generally acknowledged until the twentieth century. Before that, creativity was commonly seen
as the domain of the poet and the artist, a view which still permeates popular notions of creativity (Tatarkiewicz 1980; Euster 1987; Treffinger, Young, Selby, & Shepardson, 2002)

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1.3.4 The psychometric approach to measuring scientific creativity

Guilford (1950), during the peak era for psychometric research, introduced 'divergent thinking' as a key concept to describe the creative process, and suggested this could be measured with paper- and pencil tests. In so doing, he laid the foundation for a major change in creativity research (O'Hara & Sternberg, 1999). The change was two-fold. First, his test enabled creativity to be understood as an intellectual ability, and second, test instruments became available so that researchers could study this ability in a variety of situations and contexts. Today, psychometrics has lost dominance and cognitive processes are studied in new and more varied ways, but Guilford's concept of divergent thinking and his creativity tests remain. We explore the influence this has had on creativity research in science education: first by reviewing direct uses of Guilford's theory and, in the subsequent section, by reflecting more widely on the cognitive approach to scientific creativity.

Guilford (1967) describes divergent thinking as thinking in various directions in order to arrive at alternative solutions to a problem. He contrasted it to convergent thinking; thinking logically to arrive at one correct solution. Both types are cognitive operators in Guilford's Structure of the Intellect (SI) model, presented as a three-dimensional cube-like 'space' in which operators form one dimension, with contents and products being the other two. Combining the numbers of operators (5), contents (4) and products (6) allows the model to identify a total of 120 (= 5 x 4 x 6) intellectual abilities, each making a cell in the three-dimensional space. Among the abilities relating to divergent thinking are fluency, the ability to produce many solutions/ideas to a problem; flexibility, the ability to generate different types of solutions/ideas; and originality, the ability to generate rare and uncommon solution/ideas. Guilford devised tests to measure creativity and used statistical factor analysis to investigate his model. An example of a 'classic' task testing divergent thinking is the 'brick problem': 'List all sensible ways you may make use of a brick'
(Guilford, 1967). Many creativity tests have been developed from Guilford's theories (Sternberg & Lubart, 1999; O'Hara & Sternberg, 1999) with Torrance's Tests of Creative Thinking (Torrance, 1990) being perhaps the most well-known.

Guilford's theory has been adopted for science education by several workers (e.g. Diakidoy & Constantinou, 2000-2001; Felder, 1988; Schlichter, 1983). Diakidoy and Constantinou (2000-2001) explored the context-dependency of creativity among university physics students who were asked to generate as many responses as possible to three physics tasks each designed to be 'open-ended', that is, having more than one solution. The tasks were scored according to Guilford's divergent thinking abilities: 'fluency' was a count of the number of solutions and 'flexibility' was the number of different types of solutions. 'Originality' was calculated on a sliding scale: responses given by fewer than 5% of the students scored 3, fewer than 15% scored 2 and fewer than 50% scored 1. In addition, the authors measured students' domain-specific knowledge and gathered information about their grades. They found that creativity varied with the tasks; it was context-dependent, but did not correlate strongly with subject matter knowledge.

Hu and Adey's (2002) work has generated great interest due to their attempt to address the specific issue of scientific creativity. In developing a test for scientific creativity for secondary science, they copied Guilford by constructing the Scientific Structure Creativity Model (SSCM) as a definition for creativity. Similar to Guilford's SI-model, the SSCM model comprises three dimensions in a 'space' of factors. These are: process, comprising imagination and thinking; trait, comprising fluency, flexibility and originality; and product, having the components technical product, scientific knowledge, science phenomena and science problem. In total the model offers 24 cells or 'factors'. Hu and Adey initially designed two items for each cell. These were reduced later to seven in total, each measuring a core element of scientific creativity, namely; unusual use, problem finding, product improvement, creative imagination, problem solving, science experiment and product design. The items are clearly recognizable as the Guilford/Torrance-type, but comprise problems set in scientific contexts. For example, the 'unusual use' item is the 'brick problem', cited above, set in a science context: 'Please write down as many as possible scientific uses as you can for a piece of glass.'
Guilford's and Torrance's work on creativity has received criticism. Mansfield and Busse (1981) find fault with the strong overlap with intelligence and dislike paper-and-pencil tests measuring 'creativity on request'. O'Hara and Sternberg (1999) claim the psychometric approach to creativity has lost its appeal, because tests seem only weakly to relate to other ratings of creativity and measure trivial aspects of the phenomenon. These critiques may apply to Hu and Adey's approach, but their test does seem to correspond to science educators' understanding of scientific creativity. They subjected their items to validity testing by an 'expert-panel' including thirty-five teachers and science educators from the UK and China. Two of the seven items had less than 50% support for measuring scientific creativity, but overall, support was strong. The 'product design' item 'Please design an apple picking machine. Draw a picture, point out the name and function of each part' received strongest support and was the task most students found interesting.

1.3.5 The cognitive approach to scientific creativity

Cognitive approaches seek to understand the mental processes underlying creative reasoning rather than just identifying particular intellectual skills (Sternberg & Lubart, 1999). These are gradually replacing psychometrics in creativity research. Research methods utilize human subjects and computer simulations (Boden, 1996; Simon, 1995). The general emphasis of the research is that creative thinking is normal, and not a distinct domain of activity (Finke, Smith, & Ward, 1999), meaning that the mind continually uses creative processes in everyday thought. An example is language use, where we apply a limited set of rules in flexible ways to create meaning. Creative reasoning, in all forms, may therefore be traced back to a fundamental set of common generative processes. These include recalling structures from memory; the formation of associations among structures; mental synthesis of new structures; mental transformation of existing structures into new forms; and analogical transfer of information from one domain to another. These processes also account for thinking in extremely creative people, who exhibit enhanced intensity of application of the processes; greater richness or flexibility of stored cognitive structures to which the processes are applied, and higher memory capacity. Several models and theories attempt to explain how such 'ordinary' cognitive processes can work together in creative reasoning (Sternberg & Lubart, 1999).
The cognitive approach suggests that teaching may be adapted to develop creative reasoning patterns, but focusing on such general skills may at first sight suggest we are taking a wrong path in terms of teaching scientific creativity. The situation is akin to the 'science skills' and 'science process' trends of the 1960s-1980s, when a series of reasoning skills, like 'classifying', 'hypothesizing' and 'interpreting', were presented as representing scientific thinking, being useful in people's ordinary life and teachable through science courses (Gagne, 1965). This approach received strong criticism on the grounds that such skills, even if used by scientists, are not science-specific and develop regardless of science teaching. The characteristics of scientific reasoning, and therefore what teaching should focus on, were instead thought to be the type of problem, knowledge and contexts in which these skills are used.

In spite of this critique, reasoning patterns still exist that most science educators agree should be taught; for example, learning to 'control variables' and 'coordinate theory and evidence' (Newton & Newton, 2000). These are generally agreed upon as important aspects of 'science', but also recognized as general cognitive abilities with importance (Piaget, 1954). Learning science obviously includes cognitive development beyond factual and procedural knowledge. The problem might therefore be what reasoning skills should be taught and how, rather than if we should develop them or not.

An answer may be found in the long list of reasoning patterns identified by studies in the field of psychology of science (Feist & Gorman, 1998). For example, scientists typically form abstract representations; work on problems in a forward, abstract manner rather than backward and concretely (as novices often do) (Larkin, 1983); use 'confirm early-disconfirm late' heuristics (Mynatt, Doherty & Tweney, 1977) and are able to think simultaneously in two problem spaces (that is, reflect on possible alternatives) (Klahr, Dunbar & Fay, 1990). Worth noticing though, is that the most general attribute of scientists' thinking seems to be the complexity (Feist & Gorman, 1998). Expert scientists are characterized by complex cognitive networks of knowledge (Gruber, 1989) and by being complex thinkers:

The simple thinker makes relatively few qualifications and sees things in black and white terms. In contrast, the complex thinker not only makes distinctions and
qualifications, but integrates into a synthetic whole the opposing points of view (Feist & Gorman, 1998). Parr (1990) investigated the meaning of ‘to be creative in science’ by looking at the activities of four nineteenth-century scientific practitioners who had been universally recognized as being creative. They included: Ignaz Semmelweis, Joseph Lister, Louis Pasteur and Robert Koch. It was argued that the creative achievements of these individuals were mainly concerned with a process called creative thinking—a process which can be defined or explained in terms of certain criteria or principles that, if followed, also promote creative outcomes. He suggested that the theory formation lies at the heart of scientific creativity and those who develop new theories change the operative paradigm of science. In doing so, these individuals changed the way science operates. He believed that a paradigm shift occurred when creative practitioners elaborated broad explanatory theories—theories which could subsequently be applied to the problems of nature. Thus, in science, theory formation was creative achievement, and the manner by which this was accomplished revealed the creative process in action.

Compulsory science students in school are 'simple thinkers', so may tend to use any of the above processes differently from scientists. The initial conclusion to the issue of finding creative reasoning skills associated with science is that we should respect, not simplify differences between real science and school science, and between scientists and student. This raises the fascinating possibility that students could become better creative thinkers by teaching them to think the same way as scientists, but in saying this we underestimate strongly science's complexity. Hence, when identifying any skill as useful or important we need arguments and evidence from school science and real science. The two rational skills mentioned above, controlling variables and coordinating theory and evidence, for example, have achieved status in science education not just because they are scientific processes, but because of their intrinsic value for science education.

1.3.6 Imagination and Scientific Creativity

Imagination is often described as 'seeing with the mind's eye'. As a concept, the term has general and narrow meanings. The general meaning refers to making up or thinking about fictional situations or worlds, such as fairy tales and fiction novels. These emerge from fantasy, but are based on real world knowledge and experiences.
This makes imagination a general tool humans use to reflect on situations that are beyond their experience. Rugg (1963) and Holton (1978, 1998), for example, study scientists' imaginations when developing new ideas and theories, while Harries (2000) and Vygotsky (1930, 2004) study children's use of imagination in role-play and pretend play.

The narrow meaning of imagination operates in the same context but more specifically means the mind's ability to create and explore mental images of situations that are not physically present (Block, 1981). In this context, psychologists often refer to more specific concepts such as imaging, imagery and visual-spatial thinking. Other terms such as 'auditory imagery' (Reisberg, 1997) and 'kinaesthetic (or motor) imagery' (Jeannerod, 1994) have been coined to demonstrate that 'image' is not necessarily a 'picture' but all types of 'quasi-sensory experiences' (Richardson, 1969).

Obviously, imagery and imagination are important skills for scientists. When developing new theories they use the ability to imagine and visualise physical phenomena and 'play' with possible outcomes. Examples include simple analogies, as when Einstein, while working out the general theory of relativity, imagined what it would be like to ride on a ray of light and Faraday visualised electro-magnetic field lines. The common feature seems to be an ability to operate in an imaginative visual-spatial mode of thinking. Shea, Lubinski and Benbow (2001) indicate that this is characteristic of scientists in general, not just scientific 'geniuses'.

Work on 'thought experiments' (Ireson and Hallam, 2005; Reiner & Burko, 2003; Reiner & Gilbert, 2000) is an example. This concept originates in studies of how scientists use their imaginations to run 'experiments' including problems, hypotheses, 'results', discussions and conclusions. Reiner and Gilbert (2000) show this phenomenon is common practice in science education, even if the 'experiments' are often turned into 'simulations' because students are given insufficient time to reflect on problems themselves. Students are often expected to reason within an imagined world of invisible particles and phenomena. Reiner and Gilbert (2000) explain conceptual learning from this reasoning as an effect of combining tacit knowledge and logical processes: students use their visual and bodily experiences as a basis for imagining invisible phenomena, helping them generate new states of knowing.
Analysis of imagination demonstrates high relevance to both our real and school science worlds. Just like scientists, students also get benefit from being able to create images of 'hidden' science phenomena and mentally manipulate these. The benefits may include the personalized relationship and romantic understanding students develop alongside any actual conceptual learning. Encouraging students to work with images also demonstrates important ideas about science. However, the most challenging perspective is that people able to operate in imagined worlds seem to be more creative and enjoy benefits in learning in many areas of life (Johnson-Laid, 1987).

1.3.7 Distinguishing between Creativity and Innovation

It is often useful to explicitly distinguish between creativity and innovation. Creativity is typically used to refer to the act of producing new ideas, approaches or actions, while innovation is the process of both generating and applying such creative ideas in some specific context.

In the context of an organization, therefore, the term innovation is often used to refer to the entire process by which an organization generates creative new ideas and converts them into novel, useful and viable commercial products, services, and business practices, while the term creativity is reserved to apply specifically to the generation of novel ideas by individuals or groups, as a necessary step within the innovation process. For example, Amabile et al. (2005) suggest that while innovation "begins with creative ideas,"

"...creativity by individuals and teams is a starting point for innovation; the first is a necessary but not sufficient condition for the second."

Although the two words are novel, they go hand in hand. In order to be innovative, employees have to be creative to stay competitive.

1.3.8 Studies Related to Scientific Creativity

Kleiner (1991) measured the impact of the synectics process on the comprehension, creative thinking abilities in science and cognitive writing abilities of fourth and fifth grade science students. Fifty-eight low to middle achieving fourth and fifth grade students in Santee, California participated in the study. Students in the experimental groups were taught the district's standard science curriculum using the
synectics process. The control groups were taught the same curriculum without the use of synectics. There were three hypotheses: (1) students using the synectics model would show significantly higher scores in science comprehension as measured by a unit science test; (2) students in the experimental groups would show significantly higher gains in creative production as measured by the Torrance Tests of Creative Thinking; (3) students in the experimental groups would have written products rated significantly higher in the cognitive areas of recall and comprehension, application, analysis and synthesis. The study took place over a four-week period. Both groups received ten hours of science instruction covering information on the human body from the Silver Burdett Science Text. The experimental group used synectics to enhance the curriculum, while the control group completed additional activities suggested by the text. The time spent on science was equivalent for both groups. The independent variable was synectics. Results indicated that the experimental group used synectics to develop unusual analogies to better explain scientific concepts. It was observed that the synectics process led to increased vocabulary and increased class participation. These behaviors extended beyond the supportive climate of the synectics sessions and were observed during regular classroom sessions as well. While anecdotal observations provided interesting evidence of the creative impact of the synectics process on students, the data from the measurement tools did not support the three hypotheses. The statistical data showed no significant difference in the scores between the groups. No significant difference could, however, argue for synectics in that the synectics process was shown in this study to be as effective as the textbook exercises, while providing an alternative instructional model for teachers.

Wilson (1992) explored the proposition that temperament, conceptualized as the biological basis of personality, differs for those choosing scientific creativity compared to those selecting fine arts creativity. The sample included 222 science majors (89 males; 133 females), and 112 fine arts majors (33 males; 79 females), most of whom attended the Claremont Colleges in Claremont, California. The science (SMs) and fine arts majors (AMs) completed a researcher-designed questionnaire, which elicited demographic and intelligence/achievement data, measured temperament according to three dimensions, and operationalized creativity as both process and product. The three temperament dimensions included: (a) sensory threshold to environmental stimuli, (b) intensity of
reaction to social and emotional situations, and (c) general quality of mood. Two multiple linear path models investigated possible causal relationships between temperament, achievement, creative process variables, and scientific creativity or aesthetic arts creativity. Temperament traits and behaviors separated and defined the two samples. AMs reported low sensitivity threshold to more types of environmental stimuli than SMs. Difficulty adapting to novel situations was reported by 89 percent of AMs compared to 58 percent of SMs. Both AMs (83 percent) and SMs (62 percent) expressed awareness of intense emotional reactions. The path models illustrated that temperament factors, such as intense emotional reactions and perceived sensitivity to sound, had effects on both scientific and aesthetic arts creativity. However, more temperament and creative process factors affected fine arts creativity than scientific creativity. Unexpectedly, male SMs produced more science products, and female SMs produced more aesthetic arts products. The temperament and creative process variables were moderately successful predicting male science creativity, but not female's. It was recommended that science and mathematics be cohered with fine arts activity for young women beginning in junior high school to facilitate successful engagement in science and mathematics coursework.

The central focus of the research conducted by Anderson (1994) was to construct a Peircean view of artistic creativity. To achieve this he employed two analogies. The first compared Peirce's explicit accounts of scientific creativity to what he might have said about artistic creativity. It concluded that science was primarily analogical reasoning, whereas art was metaphorical reasoning. The second analogy compared Peirce's account of God's creative evolution of the universe to the way an artist develops a work of art. The two analogies taken together provided a preliminary description of Peircean artistic creativity. The central feature of this view was that creativity takes place by a developmental, not a deterministic, teleology.

A quasi-experimental study was conducted by Conrad (1995) to see whether a constructivist-based approach to science instruction could help fifth-grade students improve the elements of scientific literacy: the ability to use science ideas, processes, and inquiry; and the ability to see the relationship between science, technology, and society. As evidenced by changes in these dependent variables: student ability to use science ideas, processes, and inquiry skills in the solution of real-world problems;
scientific creativity; and student attitude. The quantitative portion of the study used criterion-referenced assessments, norm-referenced assessments, and Likert surveys. Data collected using these instruments provided qualified support for the effectiveness of a constructivist-based approach to science instruction to improve student ability to use science processes and science inquiry, to improve student scientific creativity, and to improve student attitude toward science. The quantitative analyses provided data that did not support the effectiveness of a constructivist-based approach to science instruction to improve student ability to use science ideas or to improve student figural creativity.

An exploratory study was conducted by Jay (1996) to investigate ninth-grade students' problem finding behavior while they engaged in open-ended scientific inquiry. In the study, subjects participated individually in two videotaped sessions of self-directed inquiry in which they explored either mirrors or floating and sinking materials. Sixty-six subjects from ninth-grade science classes participated in the study. Students were randomly assigned to a control group or one of two treatment groups. The treatment groups received a problem finding scaffolding intervention during either their first or second session. Scaffolding consisted of occasional interjection of explicit prompts or suggestions for generating problems and questions. Jay believed that the formulation of a problem was a key aspect of creativity in science. The videotapes were coded for problem finding behavior along various dimensions such as object manipulation, articulation, number of problems posed, type of problem, imaginativeness, and engagement. First session nonscaffolded behavior was examined to understand the nature of students' spontaneous problem finding. The effect of the scaffolding intervention on problem finding was analyzed for the two treatment groups. A written instrument collected measures of various factors including intrinsic motivation, prior knowledge, interest in science, and scientific creativity. The analysis examined the role of these and other factors on problem finding performance. Results indicated that subjects engaged in only a modest degree of spontaneous problem finding, and specific areas of difficulty were identified. There was a significant positive effect of scaffolding on problem finding performance in scientific creativity, especially for the treatment group receiving scaffolding in the first session. Two aspects of intrinsic motivation—curiosity/interest
and independent mastery—were found to be the most significant predictors of problem finding performance.

Dupree (1999) did a study on relationship that developed among the students in a small class of science for creative thinking by organizing the class on socio-constructivism of Vygotsky. The challenge of the class offered the students opportunities to engage in science in a personal way that was empowering. They all left the class with new and positive attitudes towards science and their ability to actively engage in creativity and rewards.

Philip and Weiping (2002) developed a test to measure scientific creativity of secondary school students. A scientific creativity structure model was constructed on the basis of analysis of meaning and aspects of scientific creativity found in the literature. 50 science teachers in China took part in an initial evaluation of this model. On the basis of their analysis and comments, and drawing on the experience of the experience of the Torrance test of creativity thinking, a seven items scale for measuring scientific creativity of secondary school students was developed and validated through analysis of item response data of 160 secondary school students in England. Item analysis were conducted check on item discrimination, internal consistency, agreement between scores, construct related validity, and face validity. A pilot study was done to investigate the scientific creativity of students of different age and ability level. The result indicated that scientific creativity of secondary school students increased with increase in age, and scientific ability.

Liang (2002) investigated the relationship between students' scientific creativity and selected variables including creativity, problem finding, formulating hypotheses, science achievement, the nature of science, and attitudes toward science for finding significant predictors of eleventh grade students' scientific creativity. A total of 130 male eleventh-grade students in three biology classes participated in this study. The main instruments included the Test of Divergent Thinking (TDT) for creativity measurement, the Creativity Rating Scale (CRS) and the Creative Activities and Accomplishments Check Lists (CAACL) for measurement of scientific creativity, the Nature of Scientific Knowledge Scale (NSKS) for measurement of the nature of science, and the Science Attitude Inventory II (SA III) for measurement of attitudes towards science. In addition, two instruments on
measuring students' abilities of problem finding and abilities of formulating hypotheses were developed by the researcher in this study. Data analysis involved descriptive statistics, Pearson product-moment correlations, and stepwise multiple regressions. The major findings suggested the following: (1) students' scientific creativity significantly correlated with some of selected variables such as attitudes toward science, problem finding, formulating hypotheses, the nature of science, resistance to closure, originality, and elaboration; (2) four significant predictors including attitudes toward science, problem finding, resistance to closure, and originality accounted for 48% of the variance of students' scientific creativity; (3) there were big differences between students with a higher and a lower degree of scientific creativity on the variables of family support, career images, and readings about science; and (4) many students were confused about the creative and moral levels on NSKS and the concept of "almighty of science" and purposes of science on SAI II. The results of study provided a more holistic and integrative interpretation of students' scientific creativity and proposed better ways of evaluating students' scientific creativity. In addition, the research results encouraged teachers to view scientific creativity as an ability that can be enhanced through various means in classroom science teaching.

Adey and Shen (2004) conducted a study on the influence of the cognitive acceleration through science education (CASE) programme on the scientific creativity of secondary school students. 1087 pupils from six suburban mixed comprehensive schools in England took part in the investigation. Three of the school has participated in the CASE programme and three had not. Sample of the students in the years 7-11 from each school were given the scientific creativity test for secondary school students, an instrument designed to tap various aspects of science. The result indicated that the CASE programme did promote to overall development of scientific creativity of secondary school students, although the effects on different aspects of scientific creativity varied.

In a naturalistic case study Bricker (2005) described the efforts of three elementary teachers in a rural southeastern school to use children's books in support of inquiry-based science and specifically addresses issues related to the nature of science. Data were collected through 26 classroom and meeting observations, 16
semi-structured and informal interviews, 35 documents and 76 children's books used by the teachers. Three themes were identified related to the nature of science and the selection and use of children's books in the teachers' second, fourth, and fifth grade classrooms. (1) Science was portrayed as a human endeavor that connects to the lives of people and that involves fascination, passion, and interest: imagination and scientific creativity; values; and diverse views. The collection of books was analyzed to look specifically at race, culture, and gender issues. While women, people of color, and different cultures were represented in the book collection, they were not represented well when considering the collection as a whole. (2) Books and the teachers' use of them supported firsthand investigation of the natural world and the idea that empirical evidence underlies scientific understanding. This theme involved observation and journaling, identification of questions to investigate and procedures to use, reasonable interpretations of results, and inferential thinking. (3) Books helped teach about the durable body of scientific knowledge. They were used to broaden background knowledge and as references after firsthand investigations.

Mohamed (2006) conducted a research study to develop and validate the Scientific Creativity Test for fifth-grade students to identify scientific creativity in those students. A related purpose was to investigate the gender differences in scientific creativity. The Scientific Creativity Test consisted of three subtests: Problems and Solutions, Grouping of Flowers, and Design an Experiment. The test was administered to 138 fifth-grade students from six different elementary schools. The reliability analysis showed that the Scientific Creativity Test had a .89 coefficient as a consistency of scores. The concurrent validity analysis indicated that the Scientific Creativity Test had medium correlations with Teachers' Ratings of students' Scientific Ability ($r = .42$), Science Content Knowledge ($r = .42$), and Scientific Creativity ($r = .51$). The reliability of the three items rated by two independent raters 1C (designing a construction about a solution), 2D (drawing a diagram about the relationships among the groups of flowers), and 3B (drawing an experiment to develop a solution for the environmental problem), using the Consensual Assessment Technique showed medium to high correlations. The General Linear Modeling (GLM) Repeated Measures Two-Way Analysis of Variance indicated no overall significant differences between males and females. An interaction effect, however, was found. Females performed better than males in Subtest II.
(Grouping of Flowers) and slightly better in Subtest III (Design an Experiment). The analysis using the independent-samples t test indicated no significant differences between females and males in the scientific creativity test except in four items: 2A (grouping flowers) Fluency, 2A Flexibility, 2A Originality, and 2A Complexity. These differences were in favor of females. The findings presented support of the psychometric properties of the Scientific Creativity Test in the identification of scientific creativity in children.

The ability of physicists to "imagine new realities" was correlated by Krause (2007), with what had been traditionally considered non-scientific qualities of imagination and creativity in science. Two questions were addressed by this study: First, How can we bring the sense of aesthetics and creativity, which are important in the practice of physics, into the teaching and learning of physics at the introductory college level, without sacrificing the mathematical rigor which is necessary for proper understanding of physics? Second, how can we provide access to physics for a diverse population of students which includes physics majors, arts majors, and future teachers? Further he described in detail the case study of the eleven students - seven physics majors and four arts majors - who participated in an experimental course, Symmetry and Aesthetics in Introductory Physics, in Winter Quarter, 2007, at UCSB's College of Creative Studies. The very positive results of this experiment suggested that this model deserved further testing, and could provide an entry into the study of physics for physics majors, liberal arts majors, future teachers, and as a foundation for media arts and technology programs.

Charyton and Snelbecker (2007) investigated similarities and differences in general, artistic, and scientific creativity between engineering versus music students, as 2 groups respectively representing scientific and artistic domains. One hundred music and 105 engineering students from a large, Northeastern university completed measures of general creativity, music creativity, engineering creativity, and a demographic questionnaire. Results indicated that musicians scored higher in general and artistic creativity, with no significant differences in scientific creativity. Participants had higher levels of creativity, compared with normative data from previous studies. Gender, age, and specialization within major yielded no significant differences.
Farooq (2008) investigated the feasibility, effectiveness, and consequences of supporting scientific creativity with computer-supported awareness in distributed collaboration. This research was conducted in five phases. The first phase was a survey of creativity literature to speculate how awareness, and in particular activity awareness, can support scientific creativity in distributed collaboration. The second phase was an exploratory experiment that identified four breakdowns in creativity in distributed collaboration. The third phase was the design and prototyping of three novel activity awareness strategies and mechanisms to support creativity in science. The fourth phase was a main experiment that studies the effectiveness and consequences of using the activity awareness mechanisms. The fifth phase validates resulted from the main experiment through follow-up analysis. The results showed that groups with activity awareness support were more likely to be among the most scientific creative than groups without activity awareness support. 62% of the groups with activity awareness support were ranked in the upper tier of being creative versus 37.5% of the groups without activity awareness support. The most significant results involved structured activity updates, one of the three activity awareness mechanisms, which allowed group members to update and share their work status. The structured activity updates increased awareness of group members with respect to what they had worked on. Further, the structured activity updates increased awareness of group members over time with respect to what they would do next, a relationship that was stronger for the groups with structured activity updates than groups without structured activity updates. Group members with higher metacognitive knowledge found the structured activity updates more useful than group members with lower metacognitive knowledge. The results contributed to the basic science of creativity, to the design science of supporting creative activity, and to the empirical science of measuring creativity.

Hilal and Omer (2008) conducted a study to investigate the effects of teaching scientific process skills education to students to promote their scientific creativity, attitude, towards, science and achievements in science. The research included a pre-test post-test research model with a control group. The subjects of research were 40 VII grade students of an Elementary school existing in Buca District of Izmir province, Turkey. The data collection, tools for the research included the "combination of Force and Motion - The Energy" Chapter. Achievement scale, the
science attitude scale and scientific creativity scale (Hu & Adey, 2002). As a result of the research, it was determined that scientific process skill and education increased the student's achievement and scientific creativities, however, no meaningful progress was made on their attitudes towards science when compared to the teacher-centered method.

Jang (2008) in his study investigated how web-based technology could be utilized and integrated with real-life scientific materials to stimulate scientific creativity of elementary school students. One certified science teacher and thirty-one seventh graders participated in the study. Several real life experiences science sessions integrated with online teaching were used for semester. The study used an interpretative methodology, which was qualitative analysis rather than quantitative analysis. The main data included student's online data, interviews, videotape recordings and the teacher's journals. The result also showed that the study provided information to enhance student's expression of sensitivity, fluency, flexibility, originality and elaboration of scientific creativities. Student's creativity was motivated by online interactivities and teacher's inquiry.

Jo (2009) through the review of creativity research he found that studies lack certain crucial parts: (a) a theoretical framework for the study of creativity in science, (b) studies considering the unique components related to scientific creativity, and (c) studies of the interactions among key components through simultaneous analyses. The primary purpose of the study was to explore the dynamic interactions among four components (scientific proficiency, intrinsic motivation, creative competence, context supporting creativity) related to scientific creativity under the framework of scientific creativity. A total of 295 Korean middle school students participated. Well-known and commonly used measurements were selected and developed. Two scientific achievement scores and one score measured by performance-based assessment were used to measure student scientific knowledge/inquiry skills. The results showed that scientific proficiency and creative competence correlates with scientific creativity. Intrinsic motivation and context components do not predict scientific creativity. The strength of relationships between scientific proficiency and scientific creativity (estimate parameter=0.43) and creative competence and scientific creativity (estimate parameter=0.17) were similar [$\chi^2_{0.05}(1)=0.670, P>.05$]. In specific analysis of
structural model, he found that creative competence and scientific proficiency play a role of partial mediators among three components (general creativity, scientific proficiency, and scientific creativity). The moderate effects of intrinsic motivation and context component were investigated, but the moderation effects were not found.

Lee (2010) argued that science was a peculiar form of industry in that the product of science, unlike other forms of industry, was "intrinsically and necessarily unenvisaged and un-envisageable 'a priori'.” Creativity and the creative process were therefore argued to be intrinsic to science, which was described as an "essentially communal creative process." A timely reminder of the importance of creativity to science was therefore provided within this work. He offered some reflection on the role of creativity in industry, explored the role of recognition in science (and creativity) and highlighted the importance of ontology when considering the philosophy of science.

Newton and Newton (2010) reported on a series of studies designed to explore teachers' conceptions of creative thinking in primary school science. Study #1 examined pre-service primary teachers' ideas of what constitutes creativity in science lessons, using a phenomenographic analysis. The study found that their conceptions tend to be narrow, focusing on practical investigations of fact and are prone to misconceptions. Although teachers were often encouraged to support creativity, their notions of how to accomplish this within specific school subjects may be inadequate. Study #2 involved asking primary school teachers to rate lessons according to the opportunity offered to children to think creatively in science. This study found that teachers generally distinguished between creative and reproductive (as in mimetic) activities, but tend to promote narrow conceptions of creativity in school science, where fact-finding and practical activities were prominent. Some teachers identified creativity in reproductive activities as well as on the basis of what simply stimulates student interest and generates on-task discussion. Study #3 was designed to check pre-service teachers' conceptions of scientific creativity through an assessment of creative elements in children's explanations of simple scientific events. This study found little agreement in teachers' personal assessments of creativity. Implications of the findings for teacher training are discussed. Since teachers' conceptions of creativity might be inadequate, they were unlikely to recognize significant
opportunities for creativity involving the construction and testing of explanations, and the assessment of quality solutions.

Meyer (2011) described and elaborated on the characteristics of instruction that supported and hindered the demonstration of scientific creativity among students. He believed that concern over the ability of U.S. classrooms to develop learners that would become the next generation of innovators, particularly given the present climate of standardized testing, warranted a closer look at the treatment of scientific creativity in classrooms. The concern was not generally with student understanding of the role of creativity within the development of scientific knowledge (NOS) or within the processes of science, but more specifically with students’ ability to be creative and likewise with the ability of a science classroom and teacher to foster the development of that creativity. The research question addressed within this study: how does teachers’ classroom practice influence student demonstration of scientific creativity was further broken down into two sub-questions:

a) What are the characteristics of instruction that facilitate scientific creativity among students both when creativity is planned for versus when it is unintended?

b) What are the characteristics of instruction that act to hinder instances of potential creativity among students both when creativity is planned for versus when it is unintended?

The study provided a snapshot of how the creative aspect of science was included and excluded by science teachers. This information was valuable for both curriculum developers and methods instructors as they develop materials and prepare teachers for instructional practices that should support the development of the skills necessary for critical thinking, scientific reasoning and innovation.

1.3.9 Studies Related to Achievement and Creativity

Gakhar (1985) found significant and positive correlation between mathematics achievement and measures of creativity.

Yadav (1985) concluded that creativity can be fostered among the students by providing suitable academic environment. Hence curricula formulated keeping in view the I.Q., academic achievement and age of learners will have a profound
influence on the development of creative abilities. The high inter correlations among intelligence, academic achievement and creativity indicate that creativity can be fostered within the individual by providing enriched academic achievement.

Kaur (1992) in her study, “Relationship among creativity, intelligence and academic achievement in different subjects of X-grades”, found positive and significant correlation between measures of creativity and academic achievement.

Pathak and Verma (1995) studied on creativity and their scholastic achievement. The sample consisted of 200 male students of X class of Bihar district. The results revealed that, the high and low creative subjects were found to be significantly differed on scholastic achievement in the field of science. It signifies that, the high creative were of high scholastic achievement in science field. However Kapoor (1996) in his study, “A study of creative thinking ability of high school pupils of Arunachal Pradesh in relation to their sex and academic achievement”, found that the mean scores of high and low achievers do not differ significantly on the variable of creativity.

Chowdhary and Ghosh (1998) conducted a study to find out the relationship between the achievement in science and creativity. The sample comprised of 160 students of class 9th (85 boys and 75 girls) studying in the English medium schools under CBSE. Achievement test in science and Wallach Kagan test of creativity were used to assess the factors of the learners. It was found that, there was significant relationship among the achievement in science and scores in creativity.

Sood (1999) in her study on 460 students of X+1 stage (260 from residential schools and 200 from non residential schools) found that out of all measures of creativity only fluency has significant positive correlation with the mathematical achievement of the students in case of residential school students.

Rangarajan (2000) conducted a study on creative autonomy in learning and academic achievement in teacher trainees. Study was conducted on sample of 83 teacher trainees, studying Diploma in teacher education (DTE) course, with an objective of finding out that whether there was difference between men and women teacher trainees in creativity an academic achievement and whether there was relation between these variables such as creativity, academic achievement. The study revealed
that there were no gender differences in creativity, achievement and relation between variable was negligible.

Kaur (2001) worked to find out correlation with the values of self-concept and independent variables such as intelligence, creativity and achievement of rural and urban schools. Descriptive school survey method as well as qualitative approach was adopted for the study. A sample of 510 girls students (230 rural + 280 urban), studying in Class IX, from Punjab, using probability sampling for the study. Tools were used: (1) Children self-concept scale, (2) Group Test of General Mental Ability, (3) Creative Activities Checklist, and (4) Academic Achievement Test. Findings showed that variable of intelligence and creativity were positively significant with self-concept in urban as well as in rural. (2) No correlation found between the variable of achievement and self-concept. (3) It was revealed that variable of achievement contributed 13.6% variance in predicting the self-concept of urban girls. (4) It is clear that conjoint effect of variable of intelligence, creativity of achievement is higher in both the samples as compared to predicting the self-concept.

Khoon (2001) studied the changes in education and its new emphasis and interest in creativity and computer technology in Singapore schools. The purpose of this study is to investigate whether the use of computers could enhance creativity among Primary 4 gifted pupils in Science, encompassing both general creativity and creativity in science. This study also explored the relationship between the two and whether attitude towards Science and achievement in Science would be enhanced in the process of using computers. The data were collected by a number of instruments administered to a sample of 40 Primary 4 pupils comprising 33 boys and 7 girls from a Special Assistance cum Gifted Education Programme School. The pupils were partially randomly assigned to either the experimental or control groups. The instruments used were a personal data survey, online Student style questionnaire, research-constructed general creativity tests and Science creativity tests, New south Wales Examination in Science and teacher-constructed Science Continual Assessments 1 and 2. Results of the data analysis showed a significant difference for General Creativity for the control group over the experimental group. There were no significant improvements for Creativity in Science and achievement in Science. There was a significant improvement in pupils' attitude towards Science for the control
group over the experimental group. Finally, the results also showed no significant correlations among general creativity, creativity in Science and observation power. Prasad (2004) also found significant positive correlation between mathematical creativity and achievement.

Habibollah, Rohani, Aizan, Jamaluddin, & Kumar (2006) examined the relationship between creativity and academic achievement and if the relationship differed between males and females. Participants (N= 153; male = 105 and female = 48) completed creativity test. Cumulative grade point average (CGPA) was used to select the participants. Creativity was measured using the Khatena-Torrance Creative Perception Inventory (KTCPI). Pearson Correlation analysis indicated that aspects of creativity were positively related to academic achievement for both males and females.

Stuart, Yager, Yager and Lim (2006) examined the advantages of an STS approach over a typical textbook dominated approach in middle school science. Two sections of middle school science were taught by two longtime teachers where one used an STS approach and the other followed the more typical textbook approach closely. Pre- and post assessments were administered to one section of students for each teacher. The testing focused on student concept mastery, general science achievement, concept applications, use of concepts in new situations, and attitudes toward science. Videotapes of classroom actions were recorded and analyzed to determine the level of the use of STS teaching strategies in the two sections. Information was also collected that gave evidence of and noted changes in student creativity and the continuation of student learning and the use of it beyond the classroom. Major findings indicated that students experiencing the STS format where constructivist teaching practices were used to (a) learn basic concepts as well as students who studied them directly from the textbook, (b) achieve as much in terms of general concept mastery as students who studied almost exclusively by using a textbook closely, (c) apply science concepts in new situations better than students who studied science in a more traditional way, (d) develop more positive attitudes about science, (e) exhibit creativity skills in science more often and more uniquely, and (f) learn and use science at home and in the community more than did students in the textbook dominated classroom.
Victor, Richards, Walter and Uta (2007) investigated the relative validities of a battery of "creativity tests" and an IQ tests for predicting several indices of achievement in high school science. Criteria included grade-point average in science courses, percentile rank on the STEP Science Achievement Test, teacher rating of overall scientific potential, number of high school science courses taken, and a measure of involvement with science. Results indicated that the creativity tests did have considerable predictive validity against each criterion for each sex and that the criterion variance accounted for by the creativity tests is to a substantial degree independent of IQ.

Paltasingh (2008) in her research work indicated that the training in creativity by teaching through synectics model produce significantly higher achievement in science.

Relationship between creativity and academic achievement was investigated by Palaniappan (2008). To understand the nature of these relationships in the intelligence continuum among 497 Forms Four groups of Malaysian students were selected. Intelligence was measured using Cattel's Culture Fair Intelligence tests and Creativity was measured using Torrance Tests of Creative Thinking. Four groups were formed based on creativity and intelligence scores, namely, High IQ – High Creative, High IQ – Low Creative, Low IQ – High Creative and Low IQ – Low Creative. The mean academic achievement scores of these four groups were compared. One-way ANOVA indicated that there were significant differences in the mean academic achievement scores among the four groups. There were significant differences between High IQ – Low Creative and Low IQ – Low Creative groups as well as between High IQ – High Creative and Low IQ – Low Creative groups. These findings were only to be expected as the difference in IQ between these pairs of groups is 48 and 50 points respectively. However, there were no significant differences in academic achievement between the High IQ - Low Creative and Low IQ – High Creative groups. Although the Low IQ – High Creative group had a mean IQ 46 points lower than the High IQ – Low Creative group, the former appeared to be able to compensate for this with their higher level of creativity. Another significant finding was the equivalent academic achievement levels of the High IQ – High Creativity and the Low IQ – High Creativity groups although the latter has a mean IQ 50 points lower than the former group. These findings had important implications in
curriculum design and instruction aimed at infusing creative thinking and enhancing academic achievement among students of varying level of intelligence.

Lam, Yeung, Lam and McNaught (2010) collected data from 311 secondary school students who took part in a two-year science enrichment programme at The Chinese University of Hong Kong. These students’ scores in the Torrance Tests of Creative Thinking (TTCT) were recorded during the early stage of the programme. Following the progress of the students in the programme after one year, we examined students’ TTCT scores and their overall performance scores in the science enrichment programme. There was a positive but mild correlation between creativity and science learning achievement.

Grosul (2010) investigated whether personality was a valid predictor of creativity in science above and beyond demographic characteristics, such as career age, gender, and scientific discipline. Creativity was an act of making something new, original, and useful. Creative achievement in science was the personal ability to generate original, useful, and adaptive scientific theories, research methods, or empirical findings. Personality characteristics operated as valid predictors of creative achievement in science. This study surveyed 145 scientists throughout the United States. Total creativity index was computed by standardizing and summing the total number of publications, total number of citations, h-index, and Soler’s creativity index. As expected, openness and neuroticism were significantly positively correlated to creativity in science, while, interestingly, psychoticism was negatively correlated with creativity.

Two studies were reported by Furnham, Batey, Booth, Patel and Lozinskaya (2011) that used multiple measures of creativity to investigate creativity differences and correlates in arts and science students. The first study examined Divergent Thinking fluency, Self-Rated Creativity & Creative Achievement in matched groups of Art and Science students. Arts students scored higher than Science students on two of the three measures. Regression analysis indicated that the educational domain demographic variable was the most consistent predictor of all three measures of creativity. The second study compared natural science, social science and arts students on two performance and two preference measures of creativity, whilst controlling for the effects of general intelligence. Results indicated only Self-Rated Creativity displayed significant group differences, with the regression analysis suggesting a stronger role of personality variables.
Proyer (2011) examined the relation between subjectively assessed adult playfulness and psychometric and self-estimated intelligence in a sample of 254 students. As expected, playfulness existed widely independently from psychometric intelligence. Correlations pointed in the direction of higher expressive playfulness and numeric intelligence and lower creative playfulness and figural intelligence. However, the size of the coefficients suggests that the results should not be over-interpreted. The same was true for self-estimates of intelligence. Those scoring lower in the total score of all self-estimates (median split) yielded higher scores in creative playfulness but those with higher self-estimates were higher in the silly-aspects of playfulness (i.e., childlike or unpredictable). Playfulness was associated with better academic performance (i.e., better grades in an exam). Also, students who described themselves as playful were more likely to do the extra reading that went beyond what was needed to pass the exam. This can be seen as first evidence of a positive relation between playfulness in adults and academic achievement.

1.4 Responsible Environmental Behaviour

Our species is now at its most important turning point since the agricultural revolution. Sustaining the earth means that each of us must change our individual consumption habits and lifestyles to reduce our environmental impact.

Miller, 1991

It is increasingly recognized that contemporary ways of life are harming the environment and, in turn, that the environment is harming, or at least threatening to harm, contemporary ways of life. In a recent statement the United Nations Environment Programme (UNEP) dramatically declared: “Imagine a world, in which environmental change threatens people’s health, physical security, material needs and social cohesion. This is a world beset by increasingly intense and frequent storms, and by rising sea levels. Some people experience extensive flooding, while others endure intense droughts. Species extinction occurs at rates never before witnessed. Safe water is increasingly limited, hindering economic activity. Land degradation endangers the lives of millions of people. This is the world today.” (UNEP, 2007)
These doom-laden tones and apocalyptic visions are no longer the preserve of newspaper scare stories or disaster films, but are increasingly common from all corners of society, discussed in the corridors of Whitehall, business boardrooms and even family dinner tables. Environmental change and its impact on society is increasingly seen as a crisis, and has become something of a backdrop to normal everyday life (Hargreaves, 2005). There is a general, creeping sense that something is wrong with the way we are currently living and that something needs to be done to reduce human impacts on the environment. It seeks to explore large questions such as: How do individuals make sense of these environmental ideas in the course of their everyday lives? What are the relationships between environmental ideas and everyday behaviour? What different roles does the environment play in the many different aspects of contemporary lifestyles? And what can be done to bring about more responsible behaviour of an individual towards environment?

Machiavelli (1999) warns, however, that ‘a man who neglects what is actually done for what should be done moves towards self-destruction rather than self-preservation’. Many researchers have showed that human behaviour is identified as root cause of all environmental problems (Gigliotti, 1992; Newhouse, 1990). Malone (1996) refers to environmental crisis as crisis of maladaptive behavior.

All of this led to realization that the current behaviour of people towards their environment needs to change, implying that people need to learn how to behave in an environmentally responsible way (Linke, 1998).

The term ‘responsible environmental behaviour’ refers to ‘the variety of recognized approaches to environmental action available to individuals or groups for use in preventing or resolving environmental problems or issues’(Peyton, 1977; Marcinkowski, 1989). Environmentally responsible behaviour is a measure of how far a person is prepared to take an active part in protecting the environment. It is one of the three components of environmental consciousness (the other two being the understanding of environmental issues and attitude towards the environment) that educators, environmentalists and curriculum agencies (Greenall & Gough, 1990) are seeking to promote. To a large extent it is a reflection of a person’s understanding of environmental issues and his or her views towards them. Environmentally responsible behaviour is a composite attribute involving both personal habits and collective action. The first group of behaviour can be considered in terms of how far one is used to minimizing his or her negative impact on the environment in everyday life, such as
writing on both sides of paper and putting used cans and plastic bottles into specified bins for recycling instead of into trash bins for disposal. To a large extent, these positive personal habits are based on a concern for environmental quality rather than personal comfort or convenience. The second group of responsible behavior is more oriented towards encouraging others to do the same and exerting collective pressure on the government for it to be environmentally minded in shaping and implementing public policy. Common examples in this regard include taking part in tree planting and clean-ups, encouraging others to reduce the waste of electricity and water.

The ultimate aim of education is shaping human behavior. Societies throughout the world establish educational systems in order to develop citizens who will behave in desirable ways. In education, some of the desired behaviors are sharply defined, how might responsible environmental behavior be operationalized? In order to answer this question, we must look to the objectives for environmental education (EE) as defined by the Tbilisi Intergovernmental Conference on Environmental Education (1978). These objectives, which can be found in the Tbilisi Declaration, are:

**Awareness**: to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems/issues.

**Sensitivity**: to help social groups and individuals gain a variety of experiences in, and acquire a basic understanding of, the environment and its associated problems/issues.

**Attitudes**: to help social groups and individuals acquire a set of values and feelings of concern for the environment and motivation for actively participating in environmental improvement and protection.

**Skills**: to help social groups and individuals acquire skills for identifying and solving environmental problems/issues.

**Participation**: to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems/issues.

By using these objectives, we might define an environmentally responsible individual as one who has: (1) an awareness and sensitivity to the total environment and its allied problems or issues, (2) a basic understanding of the environment and its allied problems or issues, (3) feelings of concern for the environment and motivation for actively participating in environmental improvement and protection, (4) skills for
identifying and solving environmental problems or issues, and (5) active involvement at all levels in working toward resolution of environmental problems or issues.

Instead, we are faced with a set of objectives which paint a broad picture of behavior encompassing not only knowledge, attitudes, and skills, but also active participation in society. The challenge for educators is to translate the Tbilisi Objectives into instructional reality and, since the objectives focus on responsible behavior, it would be appropriate and helpful to consult traditional thinking about behavior as well as research into environmental behavior.

The traditional thinking in the field of environmental education has been that we can change behavior by making human beings more knowledgeable about the environment and its associated issues. This thinking has largely been linked to the assumption that, if we make human beings more knowledgeable they will, in turn, become more aware of the environment and its problems and, thus, be more motivated to act toward the environment in more responsible ways. Other traditional thinking has linked knowledge to attitudes to behavior. An early and widely accepted model for Environmental Education has been described in the following manner: "Increased knowledge leads to favorable attitudes . . . which in turn lead to action promoting better environmental quality" (Rickson, 1977). Both of these models are, in fact, very similar and can be illustrated in the following manner:

![Figure 1.4: Model for environmental education by Rickson, 1977](image)

Research into environmental behavior, unfortunately, does not bear out the validity of these linear models for changing behavior. Numerous researchers have investigated a variety of variables hypothesized to be associated with responsible environmental behavior. Hines, Hungerford & Tomera (1987) published an important meta-analysis of the behavior research literature in EE. The researchers analyzed 128 studies which had been reported since 1971. They assessed variables in association with responsible environmental behavior and which reported empirical data on this relationship. An analysis of data (from these studies) resulted in the emergence of a
number of major categories of variables which had been investigated in association with responsible environmental behaviour. In the end, fifteen separate variables were meta-analyzed in an effort to determine the strength of their association with environmental behavior. From this scientific analysis, a model of responsible environmental behavior emerged. This model is displayed below.

**Hines model of Responsible environmental behavior**

![Diagram of Hines model of Responsible environmental behavior](image)

*Figure 1.5: Hines model of Responsible environmental behavior*

Adapted From Hines, Hungerford & Tomera, 1987)
In discussing this model, Hines, Hungerford & Tomera (1987) made the following inferences:

- An individual who expresses an intention to take action will be more likely to engage in the action than will an individual who expresses no such intention. However, it appears that intention to act is merely an artifact of a number of other variables acting in combination (e.g., cognitive knowledge, cognitive skills, and personality factors).

- Before an individual can intentionally act on a particular environmental problem, that individual must be cognizant of the existence of the issue. Thus, knowledge of the issue appears to be a prerequisite to action.

- An individual must also possess knowledge of those courses of action which are available and which will be most effective in a given situation.

- Another critical component is skill in appropriately applying this knowledge (i.e., knowledge of action strategies to a given issue).

- In addition, an individual must possess a desire to act. One’s desire to act appears to be affected by a host of personality factors, locus of control, attitudes (toward the environment and toward taking action), and personal responsibility toward the environment.

- Situational factors, such as economic constraints, social pressures and opportunities to choose different actions may serve to either counteract or to strengthen the variables in the model.

1.4.1 An Evolution of the Behavior Model

Concurrently with or subsequent to the Hines, et al. research, a number of other researchers were making substantial contributions to the literature on behavior (Borden & Schettino, 1979; Holt, 1988; Marcinkowski, 1989; Ramsey 1987; Sia, Hungerford & Tomera, 1986; Simpson, 1989; Sivek & Hungerford, 1989). Hungerford and Volk (1990) proposed changing learner behavior through environmental education. Based on their model there are three corresponding categories of variables that contribute to behaviour. These categories are entry level,
ownership and empowerment variables. In each of the categories, variables are divided into major and minor variables as shown in the following behavior flow chart:

<table>
<thead>
<tr>
<th>Entry Level Variables</th>
<th>Ownership Variables</th>
<th>Empowerment Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Variables:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Environmental Sensitivity</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Minor Variables:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge of ecology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Androgyny</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attitudes toward pollution, technology, and economics</td>
<td></td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Citizenship Behavior</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Major Variables:</strong></td>
</tr>
<tr>
<td>Knowledge of and skill in using environmental action strategies</td>
</tr>
<tr>
<td>Locus of control (expectancy of reinforcement)</td>
</tr>
<tr>
<td>Intention to act</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Minor Variables:</th>
<th>Minor Variables:</th>
<th>Minor Variables:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of the consequences of behavior- both positive and negative</td>
<td>Knowledge of the consequences of behavior- both positive and negative</td>
<td>In-depth knowledge about issues</td>
</tr>
<tr>
<td>A personal commitment to issue resolution</td>
<td>A personal commitment to issue resolution</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 1.6: Distribution of Major and Minor variables in Responsible Environmental Behaviour**

The variables listed in the above behavior flow chart, at certain points, show the synergistic relationship that appears to exist between certain, closely related variables. While the categories of variables probably operate in a linear fashion, the variables within each category do not necessarily operate in a similar manner.

**Entry-level Variables**

Entry level variables are good predictors of behavior which are prerequisite variables or at least variables that will strengthen the decision-making, once an action is undertaken. These variables are briefly introduced here.

**Environmental sensitivity** is defined as an empathetic perspective toward the environment. It is the one entry-level variable that has shown a dramatic relationship...
to behavior in the research. Given these data, considerable attention must be given by environmental educators to this variable.

Androgyny (in a psychological sense) is a variable which is often associated with individuals who are active in helping resolve environmental issues. Androgyny refers to those human beings who tend to reflect non-traditional sex-role characteristics. For example, an androgynous male may be a very sympathetic individual and able to cry in a sad situation (a traditional female characteristic). An androgynous female, for example, may exhibit certain male characteristics such as assertive behavior. Androgyny is not as strong a predictor as environmental sensitivity.

Knowledge of ecology is listed here because it is almost always prerequisite to sound decisions regarding solutions to issues. “Knowledge of ecology” refers to an ecological conceptual basis for decision-making, e.g., concepts associated with population dynamics, nutrient cycling, succession, homeostasis, etc. The research would indicate that knowledge of ecology does not, in itself, produce environmental behavior. Still, it is an important variable when one considers the importance of ecological concepts in decision making.

Attitudes toward pollution/technology/economics are variables that have shown themselves to be significant in some of the research. Although these attitudes appear to be involved with behavior, the extent of their involvement is still unknown and, thus, they are shown here as minor variables.

Ownership Variables

Ownership variables are those that make environmental issues very personal. The individual “owns” the issues, i.e., the issues are extremely important, at a personal level, to him/her. The variables appear to be critical to responsible environmental behaviour. The two major variables in this category are in-depth knowledge of the issues and personal investment.

In-depth knowledge (understanding) of issues appears crucial to ownership. It appears that, before individuals can engage in responsible behaviour, they must understand the nature of the issue and its ecological and human implications. When individuals have an in-depth understanding of issues, they appear more inclined to take on citizenship responsibility toward those issues.
Personal investment in an issue or an action is another variable that we hypothesize to be a major factor in this category. Personal investment is much like “ownership” itself. Here the individual identifies strongly with the issue because he/she has what might be called a proprietary interest in it. For example, an individual who thoroughly understands the economics of recycling and who uses a substantial amount of recyclable material might feel a substantial personal economic investment in recycling. However, the motivation might not necessarily have to be economic. It could be environmental in nature if the person has good ecological concepts about waste disposal, biodegradability and nutrient cycles and understands the broad human involvement in these things. Recycling might then become a strong personal need which could be translated as “personal investment”.

Empowerment Variables

Empowerment variables are crucial in the training of responsible citizens in the environmental dimension. These variables give human beings a sense that they can make changes and help resolve important environmental issues. “Empowerment” seems to be the cornerstone of training in environmental education. Unfortunately, it is a step that is often neglected in educational practice. A discussion of “empowerment variables” follows.

Perceived skill in using environmental action strategies is one of the best predictors of behavior. Simply put, perceived skill in using action strategies can be translated as human beings believing that they have the “power” to use citizenship strategies to help resolve issues. Further, these skills are fairly easy to teach learners. Training in action skills also results in improved students’ self-concepts and a belief that they have been more fully incorporated into society. These are very powerful considerations when the aim is to make students more responsible citizens in their own communities.

Knowledge of environmental action strategies is a variable that sometimes shows a relationship to behaviour in the research. The extent to which this variable is separate and apart from “perceived skill in using action strategies” is unknown. It is probable that the skill component is dependent on the knowledge variable to a great extent. Knowledge about action strategies per se is not as powerful a predictor as the skill
variable. This explains why these two variables are listed together in the behavior flow chart.

A word of caution may be necessary here. In the studies which examined behavior, learners gained an in-depth knowledge of issues as well as learning about action strategies. It is suspected that these two major variables operate synergistically, not separately. Thus, it would appear unlikely that citizenship action skills taught without issue-related knowledge would prompt responsible behavior in individuals.

Locus of control, although not as good a predictor as perceived skill in using action strategies, is important also. And, like many of the other variables discussed here, this one is probably interconnected with others. Locus of control refers to an individual’s belief in being reinforced for a certain behavior. A person with an “internal locus of control” expects that he/she will experience success or somehow be reinforced for doing something. Success, in turn, appears to strengthen his/her internal locus of control. On the other hand, a person with an “external locus of control” does not believe that he/she will be reinforced for doing something and, therefore, probably will not do it.

An individual who believes that he/she has good fishing skills is more likely to attempt fishing because there is an expectation of success or reinforcement for this behavior. This person has an internal locus of control for fishing. An individual who believes that he/she is powerless to make changes in society will probably not act in a citizenship dimension. There is no expectation of success or reinforcement for acting. This person would have an external locus of control for trying to help resolve environmental issues. An internal locus of control probably cannot be developed directly in the classroom. However, there is research that indicates that locus of control can be improved as a consequence of teaching citizenship action skills. An improved locus of control may well result when students have had an opportunity to apply these skills successfully in the community.

Intention to act seems also related to the “empowerment” variable. If a person intends to take some sort of action, the chances of that occurring are increased. It is likely that this variable is closely related to both perceived skill in taking action and locus of control. “Intention to act” may also share a synergistic relationship with “personal investment”, which was discussed earlier under the “ownership” heading.
1.4.2 Building an Environmentally Responsible Citizen

The ultimate goal of environmental education is to “produce a citizen 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” (Stapp, 1969). To reach this goal, people must be active in the identification and solution of environmental issues.

Educators have an obligation to impart to learners more than a basic understanding of the environment and its associated problems. Awareness and knowledge are not the sole factors contributing to environmentally responsible behaviour. Knowledge of ecological concepts and environmental problems will provide an informational foundation, but people will fail to act if they do not possess the desire or confidence required to tackle the important issues at hand. This barrier to action establishes an educational need to develop environmental sensitivity in learners. Similarly, learners must perceive that they have the ability to make a difference. This innate belief is characterized as having an internal locus of control. Though research indicates that classroom instruction has limited impact at improving these characteristics, we can enhance sensitivity through extended outdoor experiences in pristine settings or through positive interactions with role models (Sia, Hungerford, and Tomera 1986).

In addition to fundamental ecological knowledge and environmental sensitivity, an environmentally literate individual is also able to identify issues, and possesses the skills necessary to address those issues. A person does not derive these skills from nature study, but acquires these skills through applied training in environmental education strategies related to real issues they have identified (Ramsey and Hungerford, 1989). When we take classes to school forests, or establish schoolyard butterfly gardens, perform roadside cleanups or develop recycling programs in our schools, we must determine how these activities fit within the context of our ultimate goal. At all levels, learners need to build upon one or more of the variables associated with improved behavior:

- Knowledge of ecological concepts and issues,
- Sensitivity to the environment,
Belief that individually or collectively the student can make a difference (locus of control),

Knowledge of and skills in using environmental action strategies.

Research studies pertaining to the IJAT program on seventh and eighth grade students support this hypothesis (Ramsey & Hungerford 1989; Ramsey 1993). This program emphasizes that there is a need to instruct learners in the application of environmental action skills; and the learner’s application of newly acquired skills is critical for learners in constructing a cognitive foundation for citizen action.

1.4.3 The Key Variables Associated with "Responsible Citizenship Behavior"

In the models described above, numerous variables were shown to be significant and associated with responsible environmental behavior. This seems like an odd assortment. Yet, they have some very strong glue holding them together. "Behavior", in the sense of issue investigation and environment responsibility seems rather straightforward and cogent here. Hwang, Kim and Jeng (2000) surveyed trail users at an arboretum in Korea. They considered knowledge as a prerequisite component to other responsible environmental behavior related variables and intention to act was considered as a substitute to behavior. The primary focus of their study was the relationship between locus of control, attitude, general knowledge, personal responsibility, and intention to act. Their conclusions indicated that locus of control had the largest effect upon intention, in addition to a strong effect on attitude. Personal responsibility and general knowledge had a weak or nonexistent effect upon intent, leading Hwang et al. to the conclusion that in order to influence responsible environmental behavior, environmental educators should focus upon material and programmes that stimulate internal locus of control and provide opportunities to apply action skills. When discussing their results, the authors acknowledged that intention to act is different from actual behavior.

While there is some discussion of how exactly these factors breakdown, there is agreement that they can be classified as cognitive and/ or affective. Locus of control (internal or external, group and individual), knowledge of environmental issues, knowledge of and skill in environmental action strategies and knowledge of ecological concepts, personal responsibility, beliefs and values related to environmental issues, environmental sensitivity, and attitude have all been identified.
as factors related to responsible environmental behavior (Ramsey & Hungerford, 1989; Sivek & Hungerford, 1989; Newhouse, 1990; Ramsey, 1993; Hwang, Kim & Jeng, 2000). Most research has focused upon the cognitive factors, such as locus of control, knowledge of ecological concepts and issues, and environmental action strategies (Newhouse, 1990) although it is commonly held that affective factors, especially attitude, are among the most important factors influencing behavior (Sivek & Hungerford 1989; Hwang, Kim & Jeng, 2000).

Sivek and Hungerford (1989) attempted to assess eight selected variables affecting the prediction of Responsible Environmental Behaviour. These were Level of environmental sensitivity, Perceived individual Locus of Control, Perceived group Locus of Control, Perceived knowledge of environmental action strategies, Perceived skill in using environmental actions strategies, Beliefs about / attitudes toward pollution, Beliefs about / attitudes towards technology and Psychological sex role classification. They found that perceived skill in environmental action strategies was an extremely strong predictor of Responsible Environmental Behaviour. Locus of Control, both individual and group, was also significant component. The third significant factor was regarding environmental sensitivity. They determined that major precursors for sensitivity include variables associated with the outdoors and related activities. Ajzen and Fishbein (1980) depicted behavioral intentions as the strongest predictors of overt behavior. They argued that the predictive strength of the intention construct of overt behavior is dependent on the strength of the interaction between its component variables (i.e. attitude and normative beliefs) and the effect of other external/ situational variables (e.g. Personality trait, Locus of Control etc.).

According to Ramsey and Hungerford (2002) the research indicates that responsible environmental behavior is associated with the following variables:

- Environmental sensitivity (i.e. feeling of comfort in and empathy towards natural areas),
- Knowledge of ecological concepts,
- Knowledge of environmental problems and issues,
- Skill in identifying, analyzing and evaluating environmental problems and solutions,
Belief and values (i.e. beliefs and what individuals hold to be true and values are what they hold to be important regarding problems/ issues and alternative solution/ action strategies).

Knowledge of environmental action strategies (i.e. consumerism, political action, persuasion, legal action; and physical action). Skill in using environmental action strategies, and

Internal locus of control (i.e. the belief that by working alone or with other an individual can influence or bring about desirable outcomes).

1.4.4 Studies Related to Responsible Environmental Behaviour

Fishbein and Ajzen (1975) developed a theoretical framework for the evaluation of environmentally responsible behavior. In their theory of reasoned action, they distinguished four basic concepts: beliefs, attitudes, intentions, and behavior. They postulated a specific pattern of effect relations among these four components. In their view, actual behavior was, first, a function of behavioral intentions and second, one of attitudes that in turn was affected by knowledge.

Sia, Hungerford and Tomera (1986) in their research indicated that the classroom instruction has limited impact at improving the Responsible Environmental Behaviour in 5th graders. We can enhance it through extended outdoor experiences.

Hines, Hungerford and Tomera (1987) analyzed responsible environmental behavior by identifying four elements in environmental education: (a) knowledge of environmental issues; (b) knowledge of specific action strategies to apply to these issues; (c) the ability to take action on environmental issues; and (d) the ownership of certain affective qualities and personality attributes. These elements were used as a framework for constructing learning about global issues that was related and integrated to a student's life. Further they believed whichever approach is used, the relationship of the individual action in regard to global issues must be central to the instruction if the desired outcome is that of responsible environmental behavior. When studying about global issues, the goal needed to be more than merely acquiring scientific knowledge. A relationship must be made between the individual action and responsibility to the global issue.

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Schahn and Holzer (1990) reported on analyses concerning the interplay of environmentally relevant knowledge, attitudes, and responsible behavior as well as gender differences in environmental concern and the role of "background variables" for the prediction of (self-reported) behavior. In a sample of 167 German adults, the results showed that knowledge and gender moderated the relationship between attitudes and behavior. For a second sample of 105 people active in conservation groups, these moderator effects were not as clear. For both samples, women were more environmentally concerned in those topical areas that refer to household behavior, whereas men knew more about environmental problems. Possible reasons for these effects are discussed. Finally, the role of "background variables" is investigated by means of stepwise regression and discriminant analyses, using self-reported behavior as the central dependent variable. For the purpose of this study, a new measurement instrument was constructed and validated. Compared with other scales, a new aspect is the substantially broader spectrum covered. Moreover, various topical areas of environmental concern (e.g., residential energy conservation, environmentally aware purchasing, recycling of solid wastes, and so forth) can be measured simultaneously with the well-established conceptual variables (knowledge, attitude, behavior).

Liou (1992) examined environmental knowledge, attitudes, behavioral intention and behavior of the pre-service elementary teachers in Taiwan. An additional purpose was to explore the relationships between environmental knowledge, attitudes, behavioral intention from their respective predisposing and socio demographic variables. Environmental behavioral intention, experience of Environmental Education, and residence were found to be most significant predictors of environmental behavior. Environmental attitudes and political ideology were most significant predictors of environmental behavior intention. Environmental world view, knowledge and a number of socio-demographic variables were significantly related to environmental attitude. Environmental knowledge and academic discipline were significantly related to environmental worldview. It was concluded that environmental behavior, like health behaviors, can be predicted from its predisposing and socio demographic factors.
Whiston (1992) presented research on the relationship between college students' attitude and behaviour. It reviews models of environmental paradigms and relates them to an assessment of college student's attitudes and action with respect to responsible environmental behavior. Attitudes such as satisfaction, optimism, commitment, urgency and increase in concern are tested against a students level of reported action with respect to environmental issues. Its particular significance is the way in which the attitudes may easily be suspended or contradicted in terms of behaviour on self reported actions.

Carmen (1993) in her article, Global Issues and Environmental Educational reminded us that whichever approach is used, the relationship of the individual action in regard to global issues must be central to the instruction if the desired outcome is that of Responsible environment behaviour. A relationship must be made between the individual action and responsibility to the global issue.

Ramsey (1993) used issue investigation and action training (IAT) with eighth graders. His findings were similar to 7th graders, that IAT promoted the specific knowledge, skills, and beliefs critical to Responsible Environmental Behaviour. One difference was the indication that subject’s Locus of Control was significantly promoted, although earlier studies had shown the group Locus of Control to be greater than individual Locus of Control.

Hammitt and Freimund (1994) studied the changes in Responsible Environmental Behaviour for students in the National Outdoor leadership school (NOLS), a prominent outdoor education organization. Results revealed that students reported behaviour was significantly more environmentally responsible after NOLS. Students responded more positively after NOLS to construct of a theoretical predictive model for Responsible Environmental Behaviour.

Culen (1994) reported on an evaluation using the issue investigation/evaluation and action skills training model to assess the effect of an extended case study on the subject of wetland issues. A modified pre-test/post-test nonequivalent control group design was used with fifteen intact seventh and eighth grade classes. Experimental treatment I (four seventh grade and two eighth grade classes), including four levels of instruction, ran 10-14 weeks. Experimental treatment II (two seventh grade and two eighth grade classes) was completed in four to six weeks and only
included two levels of instruction. The control group (two seventh grade and three eighth grade classes) received 12 weeks of traditional science instruction. Experiment treatments were presented by four teachers. Five different instruments were used to collect data. Post-test data was collected to measure the variables of: overt environmental behaviour, knowledge of citizenship action skills; knowledge of ecological foundations; individual locus of control; group locus of control; and perceived skills in the use of citizenship action skills. Covariance analysis compared means of treatment groups and control group. Statistically significant differences were found for the overt environmental behaviour variable. Result indicated that the two treatments were more effective than the control.

Scott and Willits (1994) suggested that despite the growing concern among US Citizens of the need to protect the environment, few have adopted a more environmentally responsible lifestyle. They offer following explanation for the discrepancy. According to them all the media coverage of environmental problems and issues resulted in people learning the language of environmentalism, without developing a simultaneous behavioural commitment. They add that people may simply be unaware of how their personal behaviour impacts on the environment. In other words people may simply lack the necessary information on what specific actions that they can engage in, to become more environmentally responsible.

Ballantyne & Packer (1996) in their published paper on ‘Teaching and learning in environmental education: Developing environmental conceptions’ mentioned that active engagement with, and care towards the environment changes students’ environmental perspectives. Students who experience “real-life” issues develop a perception they can bring about change through their behaviour. As students hold these perceptions, they therefore often engage in environmentally responsible behaviour. They further suggested that the continued longevity of this behaviour is highly dependent on the duration of the environmental or stewardship education programming.

Bogner (1998) examined the influence of short-term outdoor ecology education on long-term variables of environmental perspective and confirms that, to foster responsible environmental behaviour, teachers must engage students in direct experiences for a sufficient time. In his study, students involved in a 5-day program
were more willing to plan and take action toward the environment following the program as compared to students in a 1-day program.

In the Dutch National Assessment Program, environmental knowledge, environmental attitudes, and environmentally responsible behavior were studied by Kuhlemeier, Bergh, & Lagerweij (1999) in a nationwide sample of more than 9,000 students (aged ± 15 years) from 206 secondary schools. Fifty-seven percent of the 9th-grade students had a (very) positive attitude toward the environment, and 35% were prepared to take extra pains or to make (financial) sacrifices for the environment. The students' knowledge about environmental problems was fragmentary and often incorrect, however. Similarly, the environmentally responsible behavior of many of the students was inadequate. The relation between environmental knowledge and environmental attitudes and behavior proved to be very weak. There was a substantial relation between environmental attitude, willingness to make personal sacrifices, and environmentally responsible behavior. Consistent with theories on attitudes, environmentally responsible behavior was more strongly connected with willingness to make sacrifices than with attitude toward the environment.

Hsu (1999) worked to assess the predictors of science teacher's responsible environmental behaviour (REB) through environmental literacy variables. A nine-page questionnaire was mailed to 300 randomly selected secondary science teachers in Hualien Country, Taiwan. The response rate was 78.7%. Stepwise multiple regression analysis showed that the most parsimonious set of predictors of REB for all teachers included perceived knowledge environmental action strategies (SKILL; total $R^2 = .3236$). For urban teacher, the most parsimonious set of predictor included IA, SKILL and environmental responsibility (total $R^2 = .3705$). For rural teachers, the most parsimonious set of predictors included KNOW, IA, and perceived knowledge of environmental problems and issues (total $R^2 = .3001$). Implications for program development and instructional practice were presented and recommendation for further research were provided.

Corraliza and Berenguer (2000) investigated the influence of the interaction between personal and situational variables in environmental behavior and the predictive power of values and beliefs. Three different kinds of questions
(environmental beliefs, Schwartz's measure of values, and physical-environmental inhibition level) and 1 item of general environmental concern were presented, along with a 16-item list of environmental actions, to 125 randomly selected undergraduate students. The results permitted two main conclusions. First, responsible environmental behavior depends on personal and situational variables in an interactive way. Second, when high conflict level was generated between personal dispositions and situational conditions, the predictive power of attitudes tend to be minimal, whereas in the case of consistency between them it tends to be maximal. The influence of situational variables was found to depend on the environmental action considered. In some cases, situational variables were the most important, whereas in others, commitment or moral obligation played an essential role.

Vaske and Kobrin (2001) believe that place attachment facilitates the development of Responsible Environmental Behaviour. They operationalized place attachment as place dependence which referred to a functional attachment to a specific place and place identity which referred to an emotional attachment to that specific place. According to them a person would engage in Responsible Environmental Behaviour towards a place (natural setting) if they had emotionally meaningful ties to that place. Environmental Education (EE) programmes should therefore be designed in such a way that they help learner form an emotional attachment to their immediate environment and the broader or global environment.

Yeung (2002) examined the enquiry teaching approaches and reported that they were widely considered as more useful than didactic approaches for the development of environmentally responsible behaviour. The paper was a report of an empirical study on the validity of this belief with reference to higher-ability and lower- to medium-ability groups drawn from geography classes at the Advanced Level in Hong Kong. The hypotheses were that, taken together, enquiry approaches were more effective than didactic approaches for the development of environmentally responsible behaviour in both the short and long terms for students as a whole, and for students within the same range of academic ability. A quasi-experimental control group design was used for selecting students and classes from schools in the territory. A questionnaire survey and a series of interviews were conducted to collect data about students' behaviour before and after they were taught a people-environment topic with
a didactic approach or an enquiry approach. The results suggest that the students on the whole were not behaving as positively for the environment as their peers in other countries. For both the higher- and the lower- to medium-ability classes, those who were taught with an enquiry approach were behaving positively in more areas than those who were taught with a didactic approach in both the short and long terms. This trend could be attributed to their greater attention to critical thinking, positive behavioural changes, and the development of Internal Locus of Control, while society as a whole was still largely apathetic to personal efforts for improving environmental quality. To further enhance the effectiveness of enquiry for the development of environmentally responsible behaviour, it was suggested that teachers should give more attention to the elements of concern and empathy in the classroom. Improvements in teacher education, training and in the guidelines for teachers, restructuring and revision of Environmental Education in schools, providing adequate funding and resources, and revision of the style and content of questions in public examinations are also recommended.

Colen and Mony (2003) collected data on environmental literacy and was used among Florida 4-H youth participating in non-formal science education activities as a part of their 4-H experience. Using "The Middle School environmental literacy instruments", 4-H participants were tested on several variables, which appear to be important precursor to responsible environmental behaviour. The examination of the data related to these variables and the self reported history of taking environmental action presented a vive of effectiveness of this type of science education programme in the development of responsible environmental citizens.

Adams (2003) evaluated the effectiveness of the Globe environment Programme in promoting environmentally responsible behaviour in the learners in one South African school. The Globe environment Programme was proved to be supportive of not only promoting environmentally concerned attitude but also environmentally responsible behavior. It was an Environmental Education and science programme that has been implemented in more than 80 countries. It follows the guidelines identified at Tbilisi conference held in 1977.

Huang and Larry (2004) explored the cultural influences on children’s self-reported environmental behaviors, perceptions, and understandings; investigated the
differences between two culturally distinct groups; and developed models of children's responsible environmental behavior. English and Mandarin questionnaires developed with reasonable validity and reliability were used to collect data regarding children's environmental behaviors, attitudes, concerns, emotional dispositions, knowledge, and situational factors causing children's irresponsible behavior. Useable data collected from 278 grade 5 children from Victoria, BC, Canada, and 483 grade 5 children from Kaohsiung, Taiwan, were analyzed using descriptive statistics, t-tests, and multiple regression analyses. The results revealed more similarities than differences with small to moderate effect sizes within and between these Canadian and Taiwanese children. Television was the most popular source of environmental information for both groups of children. Canadian children had much more variety and frequency of nature activities than Taiwanese children. Children from both countries expressed positive environmental behavior, positive attitudes toward the environment, high concern about the environmental problems, high emotional disposition toward current environmental situations, and moderate environmental knowledge. The original model of children's responsible environmental behavior did not fully reflect these Canadian and Taiwanese data; therefore, alternative models were developed. Affective variables appear to be stronger influences on children's responsible environmental behavior than the cognitive variable.

Hsu (2004) studied the effect of environmental education course on college students' responsible environmental behaviour and associated environmental literacy variables. This undergraduate science course emphasized issues investigating evaluation and action training. A non equivalent control group design was used. The result of the study showed that the course significantly promoted the student's responsible environmental behaviour, locus of control, environmental responsibility, intention to act, perceived knowledge of evaluation and skills in using environmental action strategies.

NEETF & Roper Research (2005) reported that individuals having higher attitudes towards environment also display higher environmental behavior.

Sarkar (2006) developed a comprehensive framework for understanding the approaches adopted by firms to address their environmental responsibilities when confronted with a variety of pressures. The framework was used to analyse the
economic rationale behind a firm's environmental strategy from the point of view of the environmental manager. Thus, the focus of the study was on the private costs incurred and benefits obtained by firms. The public nature of environmentally conscious activities of firms is also looked at, but only in the managerial context. In addition to exogenous pressures such as regulations and changing consumer preferences, various endogenous motivating and de-motivating factors for environmentally responsible behaviour had been identified using a case study approach. Factors inhibiting pollution prevention initiatives are identified and highlighted. Four in-depth case studies of steel and paper producing firms, covering both the public and private sector had been conducted. Within-case and cross-case analysis had yielded several useful insights like people should be responsible towards the environment which have been translated into appropriate policy recommendations.

Goldman, Yavetz and Peer (2006) worked on the environmental literacy of teacher training in Israel and investigated the relationship between future teachers’ responsible environmental behaviour and background in three major teacher-training colleges. Their study revealed that those future teachers manifest a low level of environmental literacy which was reflected in their environmental behavior.

Alp, Ertepinar, Tekkaya and Yilmaz (2006) presented a statistical analysis of children’s environmental knowledge and attitudes in Turkey. They studied with a sample consisting of 1977 students from urban schools and proposed that environmental knowledge does not have a direct influence on responsible environmental behaviors of students but mediated by behavioral intentions and environmental affect.

Diane et al. (2006) invited teachers participating in climate change education course to voluntarily demonstrate new environmental behaviour. They were interviewed and described the process of change, they experienced. Facilitating professional development activities were participation in a community of change, construction of knowledge of climate change, a solo activity in nature, and a continuum of values. Organizational skills, personal advantage, and case of chosen actions were facilitating factors. Limiting factors included lack of time, lack of awareness of people around them and the difficulty of affirming one's differences.
Bamberg and Ser (2007) studied meta-analysis on psycho-social determinants of pro-environmental behavior. Their study was a replication as well as an extension of the work done by Hines et al. on responsible environmental behavior. Based on information from a total of 57 samples the meta-analysis found mean correlations between psycho-social variables and pro-environmental behaviour similar to those reported by Hines et al. In a second step, the matrix of pooled correlations was used for a structural equation modeling (SEM) test of theoretically postulated structural relations between eight determinants of pro-environmental behaviour (so-called Meta-analytic SEM (MASEM)). MASEM results confirmed that pro-environmental behavioural intention mediated the impact of all other psycho-social variables on pro-environmental behavior (27% explained variance). Results also confirmed that besides attitude and behavioural control personal moral norm is a third predictor of pro-environmental behavioural intention (52% explained variance). The MASEM also indicated that problem awareness was an important but indirect determinant of pro-environmental intention. Its impact seemed to be mediated by moral and social norms, guilt and attribution processes.

Kalantari, Fami, Asadi and Mohammadi (2007) found that environmental problems such as air and water pollution, urban garbage and climate changes in urban areas were the results of human behavior. Only change in human behavior can reduce these environmental problems. Thus studying attitude and behavior of people was a precondition to change this situation. The main objective of the study was to find out individual and social factors affecting environmental behavior of urban citizens. To achieve this objective a conceptual framework derived out from review of literature to examine relationships among personal factors, attitude towards environment and environmental behavior. To examine this conceptual model, 1200 individuals of Tehran residents were randomly chosen and interviewed about their environmental behaviors, opinions, knowledge and sources of information on environment. The data were analyzed using correlation analysis, student’s t-test, analysis of variance (ANOVA) and path analysis by SPSS software. It was emerged from their study that education and improving problem-based knowledge of Tehran residents could change their environmental attitude and increase their feeling of stress towards environment. These changes in turn improved their preparedness to act friendly with the environment, particularly with the help of environmental legislation. Results of the
study showed that environmental behavior of people in urban areas directly and indirectly were under the influence of variables like age, gender, income, education, problem-based knowledge, environmental legislation, environmental attitude, feeling of stress and preparedness to act of the residents. All these together can influence and change people’s behavior to preserve urban environment.

Kaur (2007) conducted a study on environmental knowledge, sensitivity, attitudes and action strategies in relation to locus of control of Prospective and In-service teachers. 400 Prospective and in-service teachers from different schools and colleges of Education of Chandigarh were selected. She found that In-service teachers exhibited better total environmental knowledge, better total environmental sensitivity and better total environmental action strategies than prospective teachers. She also found that there was a significant interaction between teacher type and locus of control with respect to total environmental knowledge, total environmental sensitivity and total environmental action strategies.

Abraham (2008) studied the Green Marketing which was the marketing of products that were presumed to be environmentally safe. Green marketing covered more than a firm’s marketing claims. While firms must bear much of the responsibility for environmental degradation, ultimately it was consumers who demand goods, and thus create environmental problems. One example of this was McDonald’s, which was often blamed for polluting the environment because much of their packaging finishes up as roadside waste. It must be remembered that it was the uncaring consumer who chooses to dispose of their waste in an inappropriate fashion. Ultimately green marketing required those consumers who want a cleaner environment and were willing to "pay" for it, possibly through higher priced goods, modified individual lifestyles, or even governmental intervention. Until this occurs it would be difficult for firms alone to lead the green marketing revolution.

Tuncer et al. (2009) conducted a study on ‘Assessing pre-service teachers’ environmental literacy in Turkey as a mean to develop teacher education programs’ and found that the more pre-service teachers have environmental attitudes and concern the more they have environmental uses or responsible environmental behavior.
Lee (2008) in his article ‘Making Environmental Communications Meaningful to Female Adolescents’ investigated factors that were important in predicting female adolescents’ environmental behavior in Hong Kong. Data from a survey conducted with a sample of 3,035 female adolescents show that environmental concern was the top predictor of environmental behavior, followed by perceived environmental responsibility, perceived effectiveness of environmental behavior, and perceived seriousness of environmental problems. It was found that environmental attitude was found to be the least important predictor of environmental behavior in the female adolescents of Hong Kong.

Upham (2009) reviewed primarily theories and studies from the environmental psychology and (more briefly) the environmental sociology literature. He also made some reference to the multi-disciplinary risk perception and science and technology study literatures. He found that there was no simple relationship between attitudes, engagement and behaviour change. A very wide range of contextual factors like habit and routine influences the attitude and constrain behaviour. If engagement was undertaken for the purpose of changing attitudes and/or encouraging behaviour change, then these wider factors would also needed to be addressed.

Kaur (2009) conducted study on effectiveness of outdoor environmental education program for enhancing critical thinking, social skills and responsible environmental behaviour among fifth grade students. After administrating intelligence test to 300 students, students were selected and allocated to 3 groups viz. High Intelligence, Average Intelligence and Low Intelligence. Each of three groups of students was randomly allocated to two sub groups i.e. experimental and control group. So, the final sample comprised of 120 students. For data collection instructional material on outdoor environmental education programme was prepared by investigator. Cornell Critical Thinking test Level X (2005) by Robert and Jason and Social Skills Rating Scale (2006) by Kalaimath and Kumaran was used. Responsible environmental behaviour test was developed by investigator. Findings revealed that students taught through environmental education by outdoor environmental programme exhibited better mean gain scores on Critical thinking, social skills and responsible environmental behaviour as compared to students of control group who were taught traditional method. Also students with high intelligence exhibited comparable mean
gain scores on critical thinking, social skills and responsible environmental behaviour than students with average and low intelligence. For dimensions of responsible environmental behaviour viz. knowledge of ecological concepts and knowledge of environmental issues and problems, further findings revealed that students with high intelligence exhibited significantly better mean gain scores than students with average and low intelligence.

Teksoz, Sahin and Ertepinar (2010) examined the level of pre-service chemistry teachers’ environmental literacy and their perceptions on environmental education. The study was realized during the fall semester of 2006-2007 academic years with the participation of 60 students enrolled in five-year chemistry teacher education program. The data collected by administration of Environmental Literacy Test and Environmental Education Perception Survey were analyzed by descriptive statistics and content analysis. The pre-service chemistry teachers strongly emphasized promotion of feelings of concern for the environment, development of awareness and sensitivity to the total environment, and gaining social values to protect the natural resources through teaching on environmental issues. The results also revealed that these participants had favorable attitudes toward the environment and feelings of personal responsibility to create a better environment. However, pre-service chemistry teachers did not have a sound understanding of environmental issues. Although the participants were lack of necessary subject matter knowledge, they were willing to integrate environmental issues into their teaching practice.

Lake, Flanagan and Osgood (2010) presented a descriptive analysis of trends in the environmental attitudes, beliefs and behaviour of high school seniors from 1976 to 2005. Across a range of indicators, environmental concerns of adolescents showed increase during the early 1990s and declines across the remainder of the three decades. Declining trends in reports of personal responsibility for the environment, conservation behaviors, and the belief that resources are scarce are particularly noteworthy. Across all years, findings revealed that youth tended to assign responsibility for the environment to the government and consumers rather than accepting personal responsibility.
1.5 Intelligence

Psychologists have been generous to a fault to their definitions of intelligence. They do not manufacture the concept of intelligence. Philosophers have pondered over it, teachers have evaluated it in their pupils and the man on the street has assumed without questions that he knows what it is. In spite of its wide and common current usage and ancient roots, intelligence is relatively a recent concept in psychology. Almost every writer on the subject has put forward his own definition and some in the fullness of time have offered even more than one. It is true that some of the apparent disagreement is mainly verbal but many of them reflect fundamental differences of opinion concerning the concept of intelligence. The fact that intelligence is a concept rather than a power or a thing that can be observed causes difficulty when its definition is attempted and leads to a great variety of interpretation.

Intelligence, as far as a layman is concerned, manifests itself in terms of how an individual behaves in society. It is not a thing or object but the way of acting in a situation. Psychologists have disagreed as to just what are essential factors of behaviour we label as ‘intelligence’. Some have emphasized adaptability to new circumstances, some abstractness to complexity and some facility in the use of symbols. To some intelligence seemed to represent one central uniform trait, to others the sum of or average of a great many separate and diverse mental abilities.

Butcher (1968) identifies five main causes for different concepts of intelligence:

1. The research into original, ‘creative’ or ‘divergent thinking’ was made the basis for contrasting it with the ‘analytic’ to convergent’ kind of thinking studied in the past and assessed by conventional kinds of intelligence tests. The former was known as creativity and latter as intelligence.

2. Psychologist Piaget (1950) introduced a novel approach to study intelligence. By observing children’s process of thinking from the detached viewpoint of a biologist, Piaget discovered many previously unsuspected basic differences between the concepts of children and of adults. Accordingly nature and functioning of intelligence was believed to be changing quite radically from one age to another. Intelligence, as displayed and exercised by adults, works in a different manner and makes use of different kinds of concepts from concrete intelligence (typical or mild childhood) and is still more different from sensory motor intelligence, which is all that is available to young infant.
3. The computer revolution has made intelligence to denote little more than the complex of performances which we happen to respect but do not understand.

4. The liberalized neo-behaviorism has attempted to describe and explain even the most complex and abstract human thinking in terms of simple mechanism, whether these operate by chains of stimulus-response connections, by feedback loops or by other kinds of elements. As such many experimental psychologist and cyberneticists argue that ‘intelligence’ is a cloak for our ignorance of the mechanics of thinking and little else.

5. The most influential factor in changing attitudes to the study of human intelligence has been growth of educational sociology. This view has emphasized environmental influences to the neglect of hereditary factors and the common features and mutual influence with in social groups.

Thus, it has been seen that intelligence is an example of a multi-definable concept. The following observations on the nature of intelligence, made by various eminent authorities bring into sharp relief the force of our present contention.

Binet (1916) who was the pioneer of intelligence testing considered intelligence as complex set of qualities, including the appreciation of a problem and the direction of the mind towards its execution: the capacity for making the necessary adaptation to reach a definite end; and the power of self criticism. According to Spearman (1904) “Intelligence consists of the ability to discover the essential relations between items or ideas and having in mind an idea and relation, the ability to educe a correlative idea.” According to Stern (1914) "intelligence is a general capacity of an individual consciously to adjust his thinking to new environment. It is general mental adaptability to new problems and conditions of life.” In the words of Terman (1921), "An individual is intelligent in proportion as he is able to carry on abstract thinking". Freeman (1926) made a mention of intelligence terms of adjustment to new situations, to solve new problems and to learn. Thorndike (1927) defined intelligence as "the capacity for mere associations, but for controlled association." Wechsler (1943) opined that intelligence could be accepted as an aggregate capacity of an individual to act purposefully, to think rationally and to deal effectively with his environment. Stoddard (1943) considered intelligence as the ability to undertake activities, characterized by difficulty, complexity, abstractness, economy adaptiveness to a goal, social value and the emergence of original to maintain such activities under conditions demanding a concentration of energy and resistance to emotional forces.
Knight (1943), who felt that simple education of relations and correlates as discussed by Spearman (1904) was insufficient. He developed his own definition of intelligence as "the capacity of relational constructive thinking directed to the attainment of some end." Burt (1955) defined intelligence as "innate all round cognitive ability." This definition puts emphasis on abilities a child is born with, that are of a general non specific nature as discussed by Spearman, (1904. According to the British psychologist Vernon (1960) that intelligence is "a general innate capacity, underlying all our abilities, dependent on the genes we inherit, and therefore, fairly, constant through life, to be unrealistic." He sees intelligence as referring mainly to the ability to grasp relationships and to think symbolically again with an emphasis on the cognitive side. Anstey (1966) in his definition of intelligence stressed that it is the "Capacity to utilize past experience to solve new problems.

Biological definitions have equated intelligent behaviour with adaptation to environment, plasticity, or ability to learn and capacity to profit by experience. Heim's (1970) definition of intelligent activity as consisting of grasping the essentials in a given situation and responding appropriately to them; goes a long way in accepting the biological and psychological views of intelligence in the construction of intelligent tests. According to Good (1973), "Intelligence is nothing but the ability to learn and to criticize, what is learnt." The Oxford advanced learner’s dictionary (2000) mentioned that intelligence is the ability to learn, understand and think in logical way about thinks.

Thus, the exact nature of intelligence has been a disputed topic. Unfortunately no two definitions agreed in themselves. After analyzing the above various definitions of intelligence one is convinced to believe and accept that intelligence may be considered in terms of ability to adjust, to learn and ability to carry on abstract thinking (As quoted by Narula, 1985/1986).

1.5.1 Theories of Intelligence

Regarding the nature of intelligence, psychologists and philosophers developed various theories:

(i) **Monarchic Theory:** This theory was put forward by Stern (1914). Intelligence is single unit or capacity to solve all types of problems. According to this theory a man who is intelligent in doing one task will also be intelligent in doing other tasks because intelligence is the all round capacity of the individual.
(ii) **Oligarchic Theory:** According to Oligarchic theory intellectual abilities belong to certain groups which are not related to each other. But there is close relationship between. The abilities belonging to the same group, i.e., they have got positive correlation. So, according to this theory, a child who is intelligent in one group of knowledge may not be intelligent in the other group. But he may be equally intelligent in the various subjects of that very particular group.

(iii) **Anarchic Theory:** This theory was put forward by Thorndike (1926). According to Thorndike Intelligence is composed of highly particularized and independent faculties. There is no significant relation between them. According to this theory, from man's ability to do one activity in one sphere we cannot infer anything as to his ability to do another kind of work. According to Thorndike there is no general intelligence. He distinguished four aspects of intelligence (i) Level - it refers to the degree of difficulty of a task that can be solved. (ii) Range or width - refers to a number of tasks at any given degree of difficulty that we can solve (iii) Area - area in a test means the total number of situations at each level to which the individual is able to respond. (iv) Speed - by speed and mean rapidity with which we can respond to test items.

Thorndike has also given three types of intelligence:

1. Abstract intelligence: It consists in ability to solve problems presented in form of symbols, words, numbers, formulae and diagrams.
2. Concrete intelligence: It consists in ability to deal with things as in skilled trades and appliances.
3. Social intelligence: It consists in ability to understand and deal with persons.

(iv) **Two Factor Theory:** Two factor theory was developed by an English psychologist. Spearman (1904). According to him intellectual abilities were comprised of two factors. General ability or Common ability is known as 'G' factor and group of specific abilities known as 'S' factor. The factor 'G' is universal inborn ability. It is general mental ability. The amount of 'G' differs from individual to individual. 'S' ability varies from activity to activity in the same individual. Individuals differ in amount of 'S' ability.

Thurstone (1938) more or less agreed with Spearman, but thought the concept of general intelligence required elaboration. After studying data obtained from various
intelligence tests he consisted a list of seven primary mental abilities which he thought lay somewhere between what Spearman called general intelligence and specific abilities and Thurstone called primary mental abilities. The abilities were: spatial ability, perceptual speed, numerical ability, verbal meaning, memory, verbal fluency and inductive reasoning.

(v) **Factor-Analytic Theory** : Vernon (1950) developed another actor analytic theory of the organization of intelligence, which he called as hierarchical group factor theory. Vernon theory suggests that intelligence tests measure an overall 'actor 'G' as well as two main types of mental abilities. The major group factors are (i) **Ved** : Verbal, educational and numerical (2) **KM** : Practical, Mechanical, Spatial and Physical. These two major factors can be divided into minor group factors and ultimately these minor factors can be further divided into various specific factors. Thurstone's work on multiple factors established a pattern followed by many other psychologists, probably the most prominent multifactor theorist today is Guilford's (1967). He classified abilities according to their (i) Content (2) Operations and (3) Product.

Guilford (1959) while giving structure of intellect (SOI) suggests that mind is composed of 3 dimensions of intellectual abilities, namely operations, contents and products. He states that each dimension of intellect is sufficiently distinct which may be detected by factor analysis. Every intellectual ability in the structure is characterized in terms of type of operations, the content and sort of product which results. However, these dimensions of intellect can be classified because of similarities among themselves. Five major groups of operational dimensions of intellectual abilities are 1) Cognition, (2) Memory, (3) Divergent thinking, (4) Convergent thinking and (5) Evaluation. The content may be (1) Figural, (2) Symbolic, (3) Semantic (4) Behavioural. The six type of products are (1) Units, (2) classes, (3) Relations, (4) Systems, (5) Transformations and (6) Implications. The three kinds of classifications of factors can be represented by means of a single solid model, which is called structure of intellect. The view of Guilford has been most comprehensive view of intellect, which has been presented so far. He takes into consideration all possible aspects of intellectual activity. This is the only theory, which has been presented in the form of some model, which is presented below. The
model illustrated by the cube in the figure is three-dimensional and comprises of 120-cell (5 x 4 x 6) representing independent abilities.

**OPERATION (5)**

**CONTE NTS (4)**

**PRODUCTS (6)**

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Figure 1.7: SOI Model of Guilford

Cattell (1963) developed advanced theory of intelligence which is based on factor analysis of many different intelligence tests. Cattell’s theory includes more factors or abilities. But an important contribution made in his observation was that intellectual abilities may be placed into two different categories. One category is called fluid intelligence and other crystallized intelligence. Fluid intelligence involves insightful performance such as reasoning, in which learning experience plays a little part, and corresponds closely with what others have called pure ability. Crystallized intelligence involves learned skills and knowledge (e.g. vocabulary) that are acquired over time and through experiences, corresponding to achievement level. Crystallized abilities are developed through and determined by the quality of fluid intelligence and the learning opportunities available. High-quality crystallized abilities require both appropriate learning experiences and adequate fluid intelligence.
Thus, it may be observed that the various theorists like Spearman, Burt. Vernon, Thurstone, Guilford and Cattell have advanced viewpoints which are quite useful in understanding and explaining the nature and functioning of the structure of human ability. Although there have been studies showing the relationship of intelligence and attitude and interest of the teachers toward; teaching, yet there is need to explore the relationship of intelligence with the teaching effectiveness of teachers as intelligence plays an important role in teaching learning situation.

1.5.2 Studies Related to Intelligence

Charles and Bruce (1976) administered tests of R. B. Cattell's (1965, 1971) fluid and crystallized intelligence and ergs and sentiments (e.g., Culture Fair Intelligence Test and the School Motivation Analysis Test), and the Torrance Tests of Creative Thinking to 163 9th graders. Results support the hypothesized distinction between fluid and crystallized intelligence, but they indicate that the distinction between ergs (defined as traits reflecting basic biological needs for emotional expression) and sentiments (defined as source traits which come into existence because of an individual's contacts with important cultural institutions) may be more conceptual than empirical. Multivariate analyses of these results and achievement data substantiate the importance of institutionally learned intellectual skills in both achievement and creativity.

Dixit (1985) in her study found that in the case of boys there is very high correlation between intelligence test scores and academic achievement whereas in the case of girls there was an average correlation between intelligence test scores and academic achievement.

Pillai (1986) reported that though biology achievement of secondary pupils can be predicted by given intelligence and Scientific Aptitude of the subjects, the contribution of intelligence was found to be more than that of Scientific Aptitude which was comparatively low. In another study by the same researcher on the interactive effect of scientific Aptitude and attitude towards science on biology achievement, it was found that the two variables contribute independently to the biology achievement showing no significant interaction between scientific aptitude and Attitude towards science.
Pillai and Muraleedharan (1987) administered a science achievement test, a group test of intelligence, and a socioeconomic status (SES) scale to 146 male and 165 female Indian secondary school students. No sex differences in science achievement were found, but high-SES and high-IQ Ss had higher science achievement scores than low-SES and low-IQ groups.

Sibia (1989) found no relationship between intelligence and achievement in Mathematics.

Chadha (1990) conducted a study which dealt with correlation between creativity, intelligence and scholastic achievement sample consisted of 79 students (42 boys and 37 girls) of grade 11th from reputed Delhi school.

(a) Correlation was found to be positive and significant between creativity and intelligence, creativity and scholastic achievement.

(b) There was positive and significant relationship between intelligence and scholastic achievement when the effect of creativity was partialled out.

Patel (1992) in his study, “An inquiry into the scholastic achievement in the context of intellectual ability, creativity, personality traits, family background and other personal variables of talent search scholars of Gujarat”, found positive and significant relationship between intelligence and academic achievement.

Sawhney (1993) concluded that above average and average ability students secured significantly higher score than the below average students irrespective of teaching strategy.

Kumar (1994) found positive and significant correlation between intelligence and achievement in Biology.

Mishra (1997) in his study, “Correlates of academic achievement of high school student in India”, found positive and significant correlation between intelligence and achievement.

Bajwa (1998) found that intelligence and achievement in Physics were positively correlated.

Yadav (2000) studied the vocational preferences of adolescents in relation to their intelligence and achievement in relation to their intelligence and achievement.
Objectives of the study were: (1) To find out the vocational preferences of the study; (2) to find out the relationship of vocational preferences with intelligence and achievement. Descriptive survey method as well as qualitative approach was adopted for the study. The sample was taken 200 intermediate students of 4 intermediate colleges of Agra, using probability sampling method for the study. The tools were R.K. Tandon’s Group Test of Intelligence; Thurston’s Interest Schedule; and Achievement Test used for data collection. He found that the students preferred administrative jobs than job related music and artistic. Highly intelligent students preferred to go to jobs related to the area of Physical Sciences. Average and below average intelligence groups did not differ significantly in any of the area. (4) The level of intelligence influenced the vocational preferences to a great extent. Achievement and intelligence had good correlations with the area of physical science and executive jobs. Achievement got negative correlation with the area of computation and business.

Mehra and Khare (2002) conducted a study to compare the effect of three teaching strategies viz. - inductive thinking model, advanced organizer model and conventional method of teaching on attitudes of students towards science technology. The sample consisted of 108 students belonging to two colleges of Rewari. The results showed that students taught by inductive thinking model lead to development of better attitudes towards science technology as compared to advanced organizer model or conventional method of teaching. But low intelligence group was benefited more than their high intelligence counterparts.

Kalyani and Radhakrishna (2002) conducted the study to measure the impact of classroom environment on the intelligence of Ashrama school children. The sample of 180 tribal schoolchildren was randomly selected in the age range of 9-12 years. RPM was used to assess the intelligence and a pre-tested schedule with a maximum score of 159 with 61 items was used to measure the classroom environment of the children. The results indicated that, some of the components of classroom environment namely, physical facility, methods of teaching, teacher’s characteristics were significantly correlated with the intelligence.

In a study by Minikumari (2003) about the effect of intelligence, adjustment and anxiety on process outcomes in science of secondary school children, using
800 standard IX students as sample, it was found that a positive and significant correlation ($r=0.5503$) exists between intelligence and process outcomes in science of secondary school pupils.

Mehra and Mondal (2005) studied the effects of Peer Tutoring on Learning Outcomes of High School Science Students. Objectives of the study were: (1) to determine the effect of peer tutoring and traditional instruction of learning outcomes, viz. achievement in science of students with high and low intelligence; (2) To compare learning outcomes in science of high and low intelligence groups of students; (3) To study the learning outcome of students in science at knowledge and comprehension category of objectives; (4) To study the interaction effects of the instructional treatments intelligence. A sample of 108 students (54 high intelligence and 54 low intelligence) was randomly selected. Ninety five per cent of the students were from middle and low socio-economic status Muslim families and their average age was 13 years. Raven’s advanced progressive matrices (RPM) used to determine the intelligence of the students. Achievement test was developed on 6 units from the science syllabus of Class IX of SEBA, Guwahati, Assam, viz. organisation of the living body at different levels, population and community, our universe, periodic classification of elements and chemical bonding. The final draft of the achievement test comprised 115 items: 53 items were developed at knowledge category and 47 items were developed at comprehension category. Reliability of the test was 0.88. The test was used as pretest and post-test. Lesson plans were developed on the above mentioned topics for teacher directed instruction. Six units tests were developed on the units mentioned above for formative evaluation and formed the basis for peer tutoring. The experimental study employed a pre test /post control group with one experimental group design. The $2\times2\times2$ factorial design and ANOVA was employed for analyzing the data. Findings were (1) Peer tutoring exhibited better gain in achievement in science compared to those taught was traditional instruction. (2) It was found two important aspects: Together students achieve better; and learning by teaching which help them.

Dhall and Thukral (2006) investigated the relationship of intelligence with self confidence and academic achievement relationship of secondary school students. The sample of study consisted of 1000 students of ninth class drawn from government and
government aided schools of four districts of Punjab i.e. Amritsar, Jalandhar, Ludhiana and Bathinda. The results of the study revealed that intelligence is significantly and positively related with self-confidence and academic achievement.

Habibollah, Rohani, Tengku, & Jamaluddin (2008) examined intelligence and gender as predictors of academic achievement among undergraduate students. Participants (N= 153, 105 = male & 48= female) completed intelligence test and the cumulative grade point average (CGPA). The finding showed a lower correlation independent variables (score of intelligence and gender) and CGPA in this study. A multiple regression analysis revealed an interesting pattern of relationship. Further, multiple regression analyses indicated that intelligence and gender explained 0.019 of the variance in academic achievement.

Massalski (2009) conducted a case study where he used Gardner's framework in examining cognition and creativity in a Navajo/Dineh university student creating in fine arts and nominated in bodily-kinesthetic and intra-personal intelligence. This explorative case study revealed that he also excelled in other intelligence domains: linguistic and spatial. Meta-cognitive interviews with the case study subject and his notebooks provided the data sources concerning his cognition and his creativity. Indigenous educators and researchers asserted that there was a discernible difference in perspectives concerning western science conceptions and Indigenous experience. This research discovered points of resonance as well as tangential trajectories of cultural difference from Gardner's research conclusions. Discoveries in this exploration confirmed the importance of culture and zeitgeist in knowledge development, pedagogy, schooling and the creativity process. Conclusions from this inductive research supported Gardner's framework in the cultural study of cognition and creativity, underscored the value of Multiple Intelligence theory, and provide examples of praxis consonant with Indigenous learning processes for Gifted & Talented Education.

Batey and Premuzic (2009) conducted two studies to examine the relationships between measures of intelligence, personality and divergent thinking (DT) in student samples. Study one investigated the incremental validity of measures of IQ and fluid intelligence with the Big Five Personality Inventory with regards to DT. Significant relationships of DT to fluid intelligence, Extraversion and Disagreeableness were
observed. Study two investigated the incremental validity of measures of fluid and crystallised intelligence (as assessed by a test of general knowledge) with the Big Five Personality Inventory with regards to DT. Hierarchical regression analyses revealed a significant relationship between crystallised intelligence and DT. The nature of the relationships of IQ, fluid and crystallised intelligence, in addition to personality traits to tests of DT were considered.

Towne (2009) conducted a quantitative case study to determine whether adolescence was a critical period for students to learn formal thinking skills. The study also investigated whether a formal thinking skills focused program could improve students' intelligence. In this study 32 students who had not developed any formal thinking skills, ranging in age from 10-16, underwent an intensive four-week, inquiry-based, formal thinking skill intervention program that focused on two formal thinking skills: (1) the ability to control and exclude variables; and (2) the ability to manipulate ratios and proportionalities. The students undergoing the training were matched with control students by age, gender, formal thinking skill ability, and intelligence and achievement. The control group attended their traditional science course during the intervention periods. The results of the study showed that the intervention program was successful in developing students' formal thinking skills and achievement in science. The pre-adolescents (males, age 10-11, females, age 10) were unable to learn formal thinking skills. The data indicated that there was not a significant difference between adolescents and post-adolescents (up to 16-years-old) ability to learn formal thinking skills. Both groups (adolescent and post-adolescent) showed improvement in their formal thinking skill ability after the intervention. The intervention also demonstrated evidence of improving students' intelligence scores.

Habibollah, Rohani, Tengku and Jamaluddin (2010) examined relationship between intelligence and academic achievement. Participants (N=153; male=105 and female=48) completed creativity test. Cumulative grade point average (CGPA) was used to select the participants. Intelligence was measured using the Catell Culture Fair Intelligence Test (CFIT-3a & b). Pearson Correlation analysis indicated that aspects of intelligence were not related to academic achievement for both males and females.
Cho and Lin (2011) examined predictive relationships among perceived family processes, intrinsic and extrinsic motivation, incremental beliefs about intelligence, confidence in intelligence, and creative problem-solving practices in mathematics and science. Participants were 733 scientifically talented Korean students in fourth through twelfth grades as well as 71 individuals in fifth grade, tenth grade, and former Korean Science Olympians. Across all students, perceived positive family processes directly predicted creative problem-solving practices in mathematics and science and were indirectly predicted through enhancing confidence in intelligence and intrinsic motivation, which, in turn, predicted students' creative problem solving in mathematics and science. Confidence in intelligence was the best predictor of creative problem solving for scientifically talented fifth- and tenth-grade students but not for Olympians.

Wilbourn and Gottfried (2011) studied the relationship between consistency of hand preference, left hemispheric specialization, and cognitive functioning was examined in an ongoing longitudinal investigation. Children were classified as consistent or inconsistent in their hand preference across 5 assessments from ages 18 to 42 months. Findings demonstrated that (a) this early classification continued to reveal differences in cognitive functioning from 10 to 17 years but only for girls, (b) consistent girls' performances were continually higher relative to the inconsistent girls on measures of verbal intelligence and reading achievement, (c) differences between the female groups were specifically related to left-hemispheric language specialization, and (d) one factor influencing the consistent girls' development may be the amount of reading exposure received during infancy.

1.6 Overview

Traditional teaching and learning is the process of the transmission of knowledge from teacher to student. It is essentially a one-way process. This teaching method can hinder the development of individual student's active and creative abilities, and students who experience only this model of education may no longer be considered sufficient for the needs of a future educated citizenry. Constructivism is basically a theory about how students learn. Fosnot (1996) has provided a recent summary of these theories and has described constructivist teaching practices. Cognitive psychologist, Vygotsky (1986), shared many of Piaget's assumptions
about how children learn, but he placed more emphasis on the social context of learning. Piaget's cognitive theories have been used as the foundation for discovery learning models in which the teacher plays a limited role. In Vygotsky's theories both teachers and children play very important roles in learning. There is a great deal of overlap between cognitive constructivism and Vygotsky's social constructivist theory. However, Vygotsky's constructivist theory, which is often called socioconstructivism, has much more room for an active, involved teacher. Socioconstructivist teaching approach not only emphasizes active and collaborative learning, but also emphasizes students and teachers discovering and constructing knowledge together. It presents the students with opportunities to construct new knowledge based on their prior knowledge and understanding from previous authentic experiences. This approach encourages students to confront real world problems which are within their everyday experience. The characteristics of socioconstructivist teaching include: prompting students to observe and formulate their own questions; allowing multiple interpretations and expressions of learning; encouraging students to work in groups; and in the use of their peers as resources to learning.

Although Vygotsky died at the age of 38 in 1934, most of his publications did not appear in English until after 1960. There are, however, a growing number of applications of social constructivism in the area of educational technology. We call Vygotsky's brand of constructivism is social constructivism because he emphasized the importance of the social context for cognitive development. Vygotsky's the zone of proximal development is probably his best-known concept.

In linking the goals and principles of environmental education to constructivists learning theories Klein & Merritt (1994); Brody (1997); Palmer (1998); Lord (1995); Zhao (2003); Dillon (2003); Zandvliet (2007) found many similarities which suggested that students and teachers were actively engaged in constructing knowledge of the environment through their experiences rather than passively learning pre-determined knowledge. According to them constructivist teaching played an important part in teaching environmental science. They also found that students who learned concepts of environmental science using a constructivist approach were better able to recall information many months after the completion of a
unit. James and Prout (1990); Cobb et al; (1991). O’loughlin (1992); Munn and Schaffer (1993); Wood and Bennet (1997); Alan (1998); Bloom, Perlmutter and Burrel (1999); Santmire, Giraud and Grosskopf (1999); Pear and Corne-Todd (2002) explored strategies for constructivist perspective on social context for classroom management. Galton and Williamson (1992); Swanepoel (1994); Wood et al. (1995), Allan (1998); Brown (1999); Ferreira and Mueller (2000); Broadhead (2001); Kaufman (2004); Turgut (2006); Curtis (2007); Eskelinen and haapasolo (2007); Haapasalo (2008); Panagiotis and Panagiotis (2008); Inbal and Kali (2009); Nguyen (2010); Kusumawati (2010) found collaborative learning as a powerful organizing principle in constructivist education as it was based on interaction between the student and his or her social environment. They described how social constructivism can be applied to encourage collaboration and cooperative work, which facilitates children's holistic development. Gerace, Dufresne and Leonard (1999); Ferreira and Mueller (2000); Balakrishnan (2001); Doolittle and Hicks (2003); Eskelinen and haapasolo (2007); Mackenzie (2008); Alonso et.al. (2009) suggested technology based socio-constructivist learning classroom environment that was lively and rich, where cooperative learning, discussions and interactive classroom instruction was carried out without losing control of the class. Vygotsky (1978; 1988); Gergen (1995); Kaufman (2004); Reznitskaya, Anderson and Kuo (2007); Xu (2011) found a full range advantage of student discussion in socio-constructivist classroom which allows students to generalize and transfer their knowledge of classroom learning and builds a strong foundation for communicating ideas orally through language. Increasing students’ opportunity to talk with one another and discuss their ideas increases their ability to support their thinking, develop reasoning skills, and to argue their opinions persuasively and respectfully. Galtin (1992); Yildirim, Ozden, and Aksu (2001); Akar (2003); Dogru and Kalender (2007) and Karaduman and Gultekin (2007) found that the students who learned through constructivist methods showed better retention of knowledge than those who learned through traditional methods. Constructivist approach to teacher training was suggested by Tippins et al (1995); Anderson and Piazza (1996); Brody (1997); Buchanan and Smith (1997); Samaras and Gismondi (1998); Simmons (1999); Margare, Lynne and William (1999); Teague (2000); Tenenbaum et al (2001); Joia (2001); Joia (2002); cho (2002); Kesal (2003); Plourde and Alawiye(2003); Sullivan (2007); Eskelinen and haapasolo (2007); Mackenzie
Irvin (2008) to allow the schools to influence for a better organizational structure and strategy. More knowledgeable student teachers were in regards to constructivism; the more likely they would be able to apply constructivist principles in the classroom. The authors strongly believed that most teacher educators were aware of the assets of constructivism and suggested the need to broaden teaching approaches to allow for multiple learning styles.

Several studies by different authors (Pratton and Hales, 1986; Sherman, 1989; Lazarowitz, Lazarowitz and Baird, 1994; Banerjee and Vidyapati, 1997; Lieberman and Hoody, 2000; Korkmaz, 2001; Bahar, 2003; Olubunmi, 2003; Naida, David and Gail, 2005; Young and Lee, 2005; Dhindsa and Emran, 2006; Krishnasamy, 2007; Folashade and Akinbobola, 2009; Oludipe and Oludipe, 2010; Chinwe and Chinyere, 2010 etc.) have dealt with variable achievement of students in science when taught with different methods of instructions. The results showed that these various instructional strategies have made a difference in the degree of student learning and academic achievement on both normative and objective scores. Some also found correlation with between intelligence test scores and performance was positive and significant for the subjects taught by different instructional techniques. While these findings are important, it should be noted that design of these studies differ largely. Parr, (1990); Kleiner (1991); Wilson (1992); Anderson (1994); Pathak and Verma (1995); Philip and Weiping (2002); Mohamed (2006); Farooq (2008) etc. recognized the importance of creativity in science education, and started to work on method and techniques which can improve creativity. The result of the studies by Bricker (2005); Conard (1995); Jay (1996); Liang (2002); Adey and Shen (2004); Hilal and Omer (2008); Jang (2008); Jo (2009); Lee (2010); Newton & Newton (2010); Meyer (2011) provided more holistic and integrative interpretation of students' scientific creativity that could proposed better ways of evaluating students' scientific creativity. In addition, the results of these researches encouraged teachers to view scientific creativity as an ability that could be enhanced through various means in classroom science teaching and further indicate various methods to promote overall development of scientific creativity, although the effects on different aspects of scientific creativity varied. However there are not many studies proceeding creativity improvement and supporting methods for Science students, and the studies
have generally used the cognitive aspects to determine the scientific creativity of students.

Further one might argue about ecological crisis which is really a crisis of maladaptive behaviour and not a technological problem (Newhouse, 1990). Because everyone lives in the natural and built environment, everyone has some knowledge of these environments. Based on the constructivist theory, everyone therefore has the background and the potential ability to learn about and acquire knowledge of environmental science. In order for Environmental Education to be effective, Sia, Hungerford and Tomera (1986) and Hammitt and Freimund (1994) suggested the need to help in shifting the behaviour to be more environmentally mindful. Carmen (1993). Hines, Hungerford and Tomera (1987) believed whichever approach is used, the relationship of the individual action in regard to global issues must be central to the instruction if the desired outcome is that of responsible environmental behavior. Focus of the studies by Bamberg and Ser (2007); Kalantari, et al. (2007); Lee (2008); Upham (2009); Lake, Flanagan and Osgood (2010) was to find out individual and social factors affecting responsible environmental behavior of citizens. Ramsey (1993); Hammitt and Freimund (1994); Bogner (1998); Hsu (1999); Yeung (2002); Adams (2003); Hsu (2004) evaluated the effectiveness of various instructional strategies for promoting environmentally responsible behaviour in learners. According to Scott and Willits (1994), Kuhlemieier, et al. (1999) the environmentally responsible behavior of many of the students was inadequate and the relation between environmental knowledge and environmental attitudes and behavior was very weak. It is important for the teacher to actively pursue methods that bring about behaviour change or positive behaviour development in learners. Behaviour change or positive behaviour development are personal endeavours, selection of methods therefore should aim at making the education learner centered. 

To date, these studies have failed to clarify many of the questions pertaining to socio-constructivist and conventional instruction; rather the findings of the various studies, when taken to face value, often seem to be contradictory. A review of related literature shows that many of the relevant variables have been explored to a marked degree, while others have received relatively little attention. Many of the investigators have been primarily concerned with the amount of time involved and type of external
guidance to which the learner is subjected. Others have been concerned chiefly with the role of teacher in the constructivist and conventional teaching process. In addition to lack of clarity of research evidence pertaining to the socio-constructivist conventional dilemma, there is another factor which often disturbs the practitioners who depend on research to determine the best instructional techniques for classroom use. Socio-constructivist approach of learning can therefore be a useful approach to teaching environmental science concepts as students within the group should actively participate in every issue related with environment. Environmental Education has the potential to combine an increase in environmental awareness and personal development & therefore be effective in changing environmental attitude & behaviour. It would be generalized to class room practice with more confidence than would the results of the typical short-term laboratory experiment. Thus the emergence of the present study evolved. The present study was undertaken to investigate the effect of socio-constructivist approach of teaching on achievement, scientific creativity and responsible environmental behaviour.

1.7 Significance of the Study

One important human response to the wonder and awe of nature from the earliest time has been to observe the physical and biological environment carefully, look for any meaningful patterns and relations, make and use new tools to interact with nature, and build conceptual models to understand world. Thus, human endeavors have led to modern science. The attainment of independence marked a change in National Science Policy. The various commissions and committees appointed by government of India have given the stress on importance of science teaching and the advanced research in science education. As given by Indian Education Commission ‘1964-66), "The basic approach and philosophy underlying the reconstruction of education adopted by in this report tests our deep conviction that the progress, welfare and security of the nation depends critically on a rapid, planned and sustained growth in he quality and extent of education, and research in science and technology." Today, we cannot think of world without knowledge of science. Science is a dynamic, expanding body of knowledge, covering ever-new demands of experience. Good science education is true to child, true to life and true to science. At
the primary stage, the child should be engaged in learning principles of science through familiar experience. Group activities, discussions with peers and teachers, in the schools are important components of pedagogy. The pedagogical process, centered on teaching through Socio-Constructivist approach, sets out to build in students more scientific notions. Also through the Socio-Constructivist approach the students learn with the assistance of each other.

As one interacts with others and shares ideas a new level of understanding is reached and more advanced knowledge is sought. As courses get more difficult when students advance through college; they ultimately have to rely on others for full comprehension of the material. Socio-constructivism emphasize the construction of an agreed upon socially constructed reality. Learning takes place through interactions with environment viz. nature, things and people, both through actions and through language. Much of our school learning is still individual based (although not individualized). The teacher is seen as transmitting 'knowledge' to children and organizing experiences in order to help learners. But interaction with teachers and with peers can open up many more rich learning possibilities. Learning in the company of others is a process of interacting with each other and also through the learning task at hand.

Creative thinking is necessary to search for solutions to all kinds of problems that are encountered in daily life and to make new products. The individuals who use creativity can make their science education functional, and therefore, the scientific information can be the basis for producing a valuable product instead of just amassing information. Therefore, for students to gain scientific creativity, they need understanding of scientific concepts as adults and at each stage of their education, beginning from primary school (Koray, 2003). Science educators recognized the importance of creativity in science education, and started to work on methods and techniques which can improve creativity. However there are not many studies highlighting improvement in creativity and supporting certain methods for teaching Science, and the studies have generally used the cognitive aspects to determine the scientific creativity of students.
It has been recognized that cause of environmental problems is human behaviour. In order to solve environmental problems, it is necessary, beside the technical and scientific solution that everybody adopts a different behaviour towards environment. Developing responsible environmental behaviour becomes one of the prominent tasks of science education. Environmental Educators agree that respect for the environment, the teaching of values as related to the environment and encouraging Responsible Environmental Behaviour should be the integral parts of any Education curriculum. Actually involving students in their communities and in solving local environmental problems encourages them to become more active at global level. Knowledge alone cannot influence the protection of environment. Action is intimately related to how people value their knowledge and how much they feel they can control surroundings and what happens within those surroundings (Hines, Hungerford & Tomera, 1987). Ecological crisis is really a crisis of maladaptive behaviour and not a technological problem (Newhouse, 1990). In order for education to be effective, it needs to help to shift behaviour to be more environmentally mindful. It is important for the teacher to actively pursue methods that bring about behaviour change or positive behaviour development in learners. Behaviour change or positive behaviour development are personal endeavours, selection of methods therefore should aim at making the education learner-centred.

Further, down the years, there has been a massive expansion of the education system in India and qualitative improvements are visible too. We live in a fast moving technological society where the explosion of knowledge around us is a streak reality. Educational curricula and teaching methods are changing. One component of the current redevelopment of all subject area curricula is the change in the focus of instruction from the transmission curricula to transactional curricula. Teachers can no longer merely function as dispensers of information because there is far too much information to impart, and it is changing quickly as it is created. Education is in the midst of a paradigm shift from an information processing explanation of learning to a constructivist approach of learning. According to cognitive scientists, learning is a mental process and can occur only by giving meaning to knowledge which is reaching the mind. For this reason, it is very important to provide students with learning environments in which students construct their concepts by interacting with each other and also through the learning task in hand. This new approach requires teachers.
to act as a researcher in class environment and to actively participate in process of development and implementation of teaching programs.

Giving due thought to all these views, the investigator decided to study the effect of Socio-constructivist approach of teaching on achievement, scientific creativity and responsible environmental behavior on elementary school students.

1.8 Statement of the Problem

EFFECT OF SOCIO-CONSTRUCTIVIST APPROACH OF TEACHING ON ACHIEVEMENT, SCIENTIFIC CREATIVITY AND RESPONSIBLE ENVIRONMENTAL BEHAVIOUR OF CLASS VII SCIENCE STUDENTS

1.9 Objectives of the Study

1(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Achievement in Science.

1(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Achievement in Science.

1(c). To find if there is any interaction effect between teaching approaches and intelligence on Achievement in Science of class VII students.

2(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Scientific Creativity.

2(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Scientific Creativity.

2(c). To find if there is any interaction between teaching approaches and intelligence on Scientific Creativity of class VII students.

2.1(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Fluency viz. dimension I of Scientific Creativity.

2.1(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Fluency viz. dimension I of Scientific Creativity.
2.1(c). To find if there is any interaction between teaching approaches and intelligence on Fluency viz. dimension I of Scientific Creativity of class VII students.

2.2(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Flexibility viz. dimension II of Scientific Creativity.

2.2(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Flexibility viz. dimension II of Scientific Creativity.

2.2(c). To find if there is any interaction between teaching approaches and intelligence on Flexibility viz. dimension II of Scientific Creativity of class VII students.

2.3(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on originality viz. dimension III of Scientific Creativity.

2.3(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on originality viz. dimension III of Scientific Creativity.

2.3(c). To find if there is any interaction between teaching approaches and intelligence on originality viz. dimension III of Scientific Creativity of class VII students.

3(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Responsible Environmental Behaviour.

3(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Responsible Environmental Behaviour.

3(c). To find if there is any interaction between teaching approaches and intelligence on Responsible Environmental Behaviour of class VII students.

3.1(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Knowledge of Ecological concepts viz. dimension I of Responsible Environmental Behaviour.
3.1(b). To study whether class VII students with high, average and low intelligence
differ in mean gain scores on Knowledge of Ecological concepts viz. dimension I of Responsible Environmental Behaviour.

3.1(c). To find if there is any interaction between teaching approaches and
intelligence on Knowledge of Ecological concepts viz. dimension I of Responsible Environmental Behaviour of class VII students.

3.2(a). To study whether groups of class VII students taught through Socio-
Constructivist Approach and Traditional Teaching Approach differ in mean
gain scores on Knowledge of Environmental issues and Problems viz. dimension II of Responsible Environmental Behaviour.

3.2(b). To study whether class VII students with high, average and low intelligence
differ in mean gain scores on Knowledge of Environmental issues and Problems viz. dimension II of Responsible Environmental Behaviour.

3.2(c). To find if there is any interaction between teaching approaches and
intelligence on Knowledge of Environmental issues and Problems viz. dimension II of Responsible Environmental Behaviour of class VII students.

3.3(a). To study whether groups of class VII students taught through Socio-
Constructivist Approach and Traditional Teaching Approach differ in mean
gain scores on Appropriate decision making viz. dimension III of Responsible Environmental Behaviour.

3.3(b). To study whether class VII students with high, average and low intelligence
differ in mean gain scores on Appropriate decision making viz. dimension III of Responsible Environmental Behaviour.

3.3(c). To find if there is any interaction between teaching approaches and
intelligence on Appropriate decision making viz. dimension III of Responsible Environmental Behaviour of class VII students.

3.4(a). To study whether groups of class VII students taught through Socio-
Constructivist Approach and Traditional Teaching Approach differ in mean
gain scores on Beliefs and values related to environment viz. dimension IV of Responsible Environmental Behaviour.

3.4(b). To study whether class VII students with high, average and low intelligence
differ in mean gain scores on Beliefs and values related to environment viz. dimension IV of Responsible Environmental Behaviour.
3.4(c). To find if there is any interaction between teaching approaches and intelligence on Beliefs and values related to environment viz. dimension IV of Responsible Environmental Behaviour of class VII students.

3.5(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Personal Responsibility viz. dimension V of Responsible Environmental Behaviour.

3.5(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Personal Responsibility viz. dimension V of Responsible Environmental Behaviour.

3.5(c). To find if there is any interaction between teaching approaches and intelligence on Personal Responsibility viz. dimension V of Responsible Environmental Behaviour of class VII students.

3.6(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Intention to Act viz. dimension VI of Responsible Environmental Behaviour.

3.6(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Intention to Act viz. dimension VI of Responsible Environmental Behaviour.

3.6(c). To find if there is any interaction between teaching approaches and intelligence on Intention to Act viz. dimension VI of Responsible Environmental Behaviour of class VII students.

3.7(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Locus of Control viz. dimension VII of Responsible Environmental Behaviour.

3.7(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Locus of Control viz. dimension VII of Responsible Environmental Behaviour.

3.7(c). To find if there is any interaction between teaching approaches and intelligence on Locus of Control viz. dimension VII of Responsible Environmental Behaviour of class VII students.
3.8(a). To study whether groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach differ in mean gain scores on Environmental Sensitivity viz. dimension VIII of Responsible Environmental Behaviour.

3.8(b). To study whether class VII students with high, average and low intelligence differ in mean gain scores on Environmental Sensitivity viz. dimension VIII of Responsible Environmental Behaviour.

3.8(c). To find if there is any interaction between teaching approaches and intelligence on Environmental Sensitivity viz. dimension VIII of Responsible Environmental Behaviour of class VII students.

1.10 Hypotheses

1(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Achievement in Science.

1(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Achievement in Science.

1(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Achievement in Science.

2(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Scientific Creativity.

2(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Scientific Creativity.

2(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Scientific Creativity.

2.1(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Fluency viz. dimension I of Scientific Creativity.

2.1(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Fluency viz. dimension I of Scientific Creativity.
2.1(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Fluency viz. dimension I of Scientific Creativity.

2.2(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Flexibility viz. dimension II of Scientific Creativity.

2.2(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Flexibility viz. dimension II of Scientific Creativity.

2.2(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Flexibility viz. dimension II of Scientific Creativity.

2.3(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on originality viz. dimension III of Scientific Creativity.

2.3(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on originality viz. dimension III of Scientific Creativity.

2.3(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on originality viz. dimension III of Scientific Creativity.

3(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Responsible Environmental Behaviour.

3(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Responsible Environmental Behaviour.

3(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Responsible Environmental Behaviour.

3.1(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching
Approach in mean gain scores on Knowledge of Ecological concepts viz. dimension I of Responsible Environmental Behaviour.

3.1(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Knowledge of Ecological concepts viz. dimension I of Responsible Environmental Behaviour.

3.1(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Knowledge of Ecological concepts viz. dimension I of Responsible Environmental Behaviour.

3.2(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Knowledge of Environmental issues and Problems viz. dimension II of Responsible Environmental Behaviour.

3.2(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Knowledge of Environmental issues and Problems viz. dimension II of Responsible Environmental Behaviour.

3.2(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Knowledge of Environmental issues and Problems viz. dimension II of Responsible Environmental Behaviour.

3.3(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Appropriate Decision Making viz. dimension III of Responsible Environmental Behaviour.

3.3(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Appropriate Decision Making viz. dimension III of Responsible Environmental Behaviour.

3.3(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Appropriate Decision Making viz. dimension III of Responsible Environmental Behaviour.

3.4(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Beliefs and values related to environment viz. dimension IV of Responsible Environmental Behaviour.
3.4(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Beliefs and values related to environment viz. dimension IV of Responsible Environmental Behaviour.

3.4(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Beliefs and values related to environment viz. dimension IV of Responsible Environmental Behaviour.

3.5(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Personal Responsibility viz. dimension V of Responsible Environmental Behaviour.

3.5(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Personal Responsibility viz. dimension V of Responsible Environmental Behaviour.

3.5(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Personal Responsibility viz. dimension V of Responsible Environmental Behaviour.

3.6(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Intention to Act viz. dimension VI of Responsible Environmental Behaviour.

3.6(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Intention to Act viz. dimension VI of Responsible Environmental Behaviour.

3.6(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Intention to Act viz. dimension VI of Responsible Environmental Behaviour.

3.7(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Locus of Control viz. dimension VII of Responsible Environmental Behaviour.

3.7(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Locus of Control viz. dimension VII of Responsible Environmental Behaviour.
3.7(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Locus of Control viz. dimension VII of Responsible Environmental Behaviour.

3.8(a). There exists no significant difference between groups of class VII students taught through Socio-Constructivist Approach and Traditional Teaching Approach in mean gain scores on Environmental Sensitivity viz. dimension VIII of Responsible Environmental Behaviour.

3.8(b). There exists no significant difference among high, average and low intelligent groups of class VII students in mean gain scores on Environmental Sensitivity viz. dimension VIII of Responsible Environmental Behaviour.

3.8(c). There exists no significant interaction between teaching approaches and intelligence of class VII students on Environmental Sensitivity viz. dimension VIII of Responsible Environmental Behaviour.

1.11 Delimitations

1. The study was conducted only on Class VII students.

2. The Socio-Constructivist approach based instructional material was developed on some topics of science from the prescribed syllabus of NCERT/CBSE for Class VII.

3. The study was confined to students of Class VII from English medium Government schools of Chandigarh affiliated to CBSE.

4. The study was limited to a sample of 120 students.

5. The present study was delimited with respect to variables of Achievement in science, Scientific Creativity and Responsible Environmental Behaviour as dependent variable, Intelligence as classifying variables.

6. The study was delimited with respect of the tools. The results were guided by the data collected by these tests and interpretations were governed by the theoretical consideration underline these tests.

7. The duration of the treatment was 45 working days.