CHAPTER – 2

REVIEW OF RELATED LITERATURE

2.1 INTRODUCTION

2.2 THEORITICAL REVIEW

2.2.1 CONSTRUCTIVISM

2.2.2 HISTORY OF CONSTRUCTIVISM

2.2.3 CONSTRUCTIVISM IN EDUCATION

2.2.4 MEANING OF TEACHING SCIENCE

2.2.5 CURRENT TEACHING OF SCIENCE

2.2.6 CONSTRUCTIVIST TEACHING IN SCIENCE

2.2.7 HOW DOES CONSTRUCTIVIST APPROACH IN TEACHING DIFFER FROM TRADITIONAL APPROACH OF TEACHING AND LEARNING?

2.2.8 BENEFITS OF CONSTRUCTIVIST TEACHING

2.2.9 META-COGNITION

2.2.10 META-COGNITIVE SKILLS

2.2.11 PROCESSING SKILLS

2.2.12 BLOOM’S TAXONOMY

2.3 REVIEW OF RELATED RESEARCHES

2.3.1 RESEARCHES ON CONSTRUCTIVIST TEACHING

2.3.2 RESEARCHES ON CONSTRUCTIVIST LEARNING

2.3.3 RESEARCHES ON PROCESSING SKILLS

2.3.4 RESEARCHES ON META-COGNITION

2.3.5 REVIEWS OF CONCLUSIONS DRAWN FROM THE STUDIES DONE ON CONSTRUCTIVIST TEACHING
2.3.6 REVIEWS OF CONCLUSION DRAWN FROM THE STUDIES ON CONSTRUCTIVIST LEARNING

2.3.7 REVIEWS OF CONCLUSIONS DRAWN FROM THE STUDIES ON PROCESSING SKILLS

2.3.8 REVIEWS OF CONCLUSIONS DRAWN FROM THE STUDIES ON META-COGNITION

2.3.9 OVERALL REVIEWS OF CONCLUSION DRAWN FROM ALL RESEARCHES

2.4 IMPORTANCE OF THE PRESENT RESEARCH
CHAPTER: 2

REVIEW OF RELATED RESEARCHES

2.1 INTRODUCTION:

This chapter contains two main parts, first one about reviews of related literature and the second one is about review of past researches about constructivism. The first part contains history of constructivism, constructivism in education, meaning of teaching science, current teaching of science, constructivist teaching in science, comparison between traditional approach and constructivist approach of teaching and benefits of constructivist teaching. Brief notes about processing skills and meta-cognitive skills also included in this part. The second part is about reviews of past researches on constructivist teaching, science process skills and meta-cognitive skills.

2.2 THEORITICAL REVIEW:

2.2.1 CONSTRUCTIVISM:

Constructivism is a core theory based on observation, prediction and scientific study about the way people learn. Constructivism stated that people construct their own understanding and knowledge of the world by making experience of the things and reflecting on those experiences. When people encounter something new, they have to reconcile it with their previous ideas and experiences. As a result they may be discarding the new information as irrelevant to their previous knowledge. In any case, the people are active creator of their own knowledge and understanding about the world. For doing this, they must ask questions, explore and assess what they know.

2.2.2 HISTORY OF CONSTRUCTIVISM:

From the history of constructivism it was clear that the psychological roots of constructivism began with the developmental work of Jean Piaget (1896-1980), who developed the theory of genetic epistemology that analogized the development of mind. This theory gave the information about the development of mind to evolutionary biological development and highlighted the adaptive function of cognition. After doing depth research Piaget proposed four stages of human development. These four stages were (1) the sensorimotor stage, (2) the preoperational stage, (3) the concrete operational stage and (4) the formal operational stage. For Piaget the development of human intellect progressed through adaption and organization. Adaptation is a process of assimilation and accommodation. In
assimilation external events are assimilated into existing understanding but unfamiliar events, which are not fit with existing knowledge and understanding, are accommodated into the mind by changing its organization.

There were so many studies have done and demonstrated or tried to discredit Piaget’s developmental stages. For example, it has become clear that most of the adults use their formal operations in only certain conditions and domains where they have expertise. Even though, Piaget’s theory and hypothesis that learning is a transformative rather then a cumulative process is still in central idea about learning theories. According to Piaget’s theory children do not learn about any thing at a time about some event or issue until it finally comes together as understanding. Instead, they create sense of whatever they know from very beginning. This understanding is progressed and reformed as new knowledge is acquired. The new knowledge reformed because it is incompatible with their previous understanding. This transformative view of learning has been greatly extended by neo-Piagetian research.

The Russian psychologist Lev Vygotsky’s(1896-1934) theory about language, thought and their meditation by society relevance to constructivism stated that the child gradually internalize external activities as well as social activities, including communications, with more capable and component other. Even though social speech is internalized in childhood it becomes thinking as understanding progressed, Vigotsky stated that it still preserves and remains its collaborative character.

During his experiments, Vigotsky made study about the difference between the child’s reasoning when working independently versus child’s reasoning when working with more competent and experienced person. He derived the notion of the zone of proximal development (ZDP) to reflect on the potential of such kind of difference. After doing his studies Vygotsky suggested that learning environments should involve guided interactions with more capable person and familiar person that permit children to reflect on inconsistency and to change their conceptions through communication. Vygotsky’s work about constructivism has been extended in the situated approach to learning.

As Vigotsky was social constructivist and Piaget was cognitive constructivist, their theories are often contrasted to each other in terms of individual cognitive constructivism and social constructivism. Some researchers have tried to develop a synthesis between these two approaches, though some, such as Michel Cole and James Wertsch, argued that the individual versus social orientation debate is too much emphasized. According to them, the real
difference exists on the contrast between the roles of cultural artifacts. For Vigotsky, such cultural artifacts play central role in learning, but they do not play important role in learning in Piaget’s theories.

According to American philosopher and educator John Dewey (1859-1952), education depended upon action knowledge about the world and ideas emerge only from those situations in which learner have to draw out experiences that have meaning and importance to them for their real life. Dewey stated from his research that human thought is practical problem solving, which progressed by testing rival hypothesis. These problem solving experiences occur in social context, such as a classroom, where students join together in manipulating material and generate observing outcomes. Dewey invented and addressed the method of progressive education in North America. The fostering communities of learners (FCL) program, devised by Ann Lesley Brown and Joseph Campion, is a current attempt to put Dewey’s progressive education theory to work in classroom.

In summary, Piaget proposed the cognitive theory of learning in which the idea of transformation in learning and development is in central role; Vigotsky contributed the theory of social constructivism in which the idea that learning and development are integrally tied to communicative interactions with others is in center; and Dewey contributed the idea that schools had to bring real world problems in to school curriculum.

2.2.3 CONSTRUCTIVISM IN EDUCATION:

In his theory of constructivism Piaget rarely mention about the social aspects, even though it was totally different from that of the social constructivist Vygotsky. Piaget stated that if the child is exposed to the response of more competent person such as an adult, it is not fruitful as a child doesn’t like to argue or take issues with the person. Where as if exposed to a different point of view from an equal and familiar person, it will create a pressure towards resolution of differences, and due to this pressure, in return will be likely to result a higher level learning (Light and Littleton, 1999). In brief it was first time with Piaget that cognitive constructivism was uttered fundamentally as a psychological philosophy. Peer interaction was given more emphasis as it is essential in the learning process to solve a problem, which is known as socio-cognitive conflict in the literature of constructivism (Light and Littleton 1999).

To connect and integrate the cognitive and social constructivism Jadallah (2000) suggest a planning process. Piagetian cognitive constructivism and Vygotsky’s social
constructivism are discussed. According to Piagetian cognitive constructivism the emphasis is on the individual construction of knowledge through a cognitive process of analysis and interpretation of experiences. Direct instruction is prohibited as it stifling the discovery and constructivist process of learning. The only purpose of social interaction is simply to check or to test one's understanding about some issues. The Vygotskian theory of constructivism emphasize that other students are significant part of the learning process. According to Vygovtsky the knowledge is not solely constructed within the mind of individual, rather, interactions with other compatible person within a social context involve learners in sharing (Balakrishnan 2001; Jadallah 2000), constructing, and reconstructing their ideas and beliefs. The more important thing after all these discussion is the the emphases is still student centered and experiential, the teacher is more involved in planning and guiding social interactions that allow students to build and test knowledge within a social context (Jadallah 2000). Ultimately, these views of constructivism need to be addressed in the field of education.

Constructivism is social and epistemological view more emphasized learning rather than teaching. Constructivist stated that certain activities such as debate with more experienced person, hands on activities, experiencing different events, practical performances and enrichments in the environment can enhance the meaning making process. Also it enhances active learning and using kinesthetic in different event, visual and auditory modalities in competition, creating opportunities for dialogue delivery, fostering creativity and providing a rich, safe and engaging environment (brooks and brooks 1996, cited in osberg, 1998)

Constructivism gives more emphasis on students’ active participation in problem solving, meaning making process and critical thinking about some event or issue. It inquires the importance of understanding the situation and taking responsibility in the decision making process in critical condition. Knowledge construction in constructivism is basically based on previous knowledge experiences. Thus new knowledge is integrated with the previous intellectual knowledge constructs. Integration of such experiences is facilitated through social and collaborative nature of learning such as scaffolding (Darling-Hammond, 2000; Shunk 1995). Thus the emphasis is on social, communicative and collaborative nature of learning. Collaboration includes sharing of responses, ideas about given complex and critical problems that need higher order skills to solve it. In such sophisticated and collaborative learning environment dialogue facilitates the active learning process in constructing knowledge based
upon existing previous knowledge. In addition to dialogue, mental manipulation, visualization and the process of developing, testing and discarding hypothesis are also important (Shunk 1995).

According to constructivism the knowledge cannot simply be transferred from teacher to student, it has to be conceived through discussion. Conceptual change should be provided by the teacher through reality and experiencing things or events. According to constructivism the reality is made up the network of the things and relationships that one on in our living, and on which, we believe, and others rely on (von Glassersfeld, 1996). Reality is not exist in the ideal world like that of Platon explains, but in the tasks in which the students are involved, and deal with them. For example, when one is dealing with authentic problem solving tasks, the natural interactions occurs in his actual life is established in the learning context of him.

As stated in learning theories the constructivism also stated that the student’s conceptual understanding develops through learning experiences and is shaped and fostered through interactions with more competent other people. This approach to cognitive constructivism goes well beyond the decontextualized biological process of cognitive constructivism that emphasizes the social and historical context of learning. It is important for researcher or educator who intended constructivist learning to examine carefully how their curriculum and instructional practices involve students in understanding of related concepts, facts, and making generalizations for them as individuals and also to the broader social context (Balakrishan, 2001).

In constructivist teaching-learning environment students are asked to deliberately take action for creating meaning from what they are studying. In other words, learners adopt the role of investigators or researchers, seekers and problem solvers. While teachers become facilitators and guides, rather than presenter of knowledge. The students play active role in meaning making process. Students learn about applying the information and knowledge in diverse conditions and contexts. Generative learning activities require “students to take static information and generate fluid, flexible, usable knowledge” (Dunlop and grabinger, 1996).

Reagen (1999) discuss about some important ways where constructivism can inform and promote effective pedagogical practice in the classroom and a better understanding of such practice in a foreign language context. The author advocates that constructivist environments provide space and condition for personal and individual construction of
language context. In addition to individual construction of knowledge about some thing, collaborative work exposes misconceptions of meaning. The role of teacher in such condition is more to provide input when needed, but they also reveal a student error to encourage self-correction.

2.2.4 MEANING OF TEACHING SCIENCE:

As stated in the book ‘The Art Of Teaching Science’ 2nd Edition- Art of teaching science is a humanistic, experiential and constructivist approach of teaching and learning. It includes variety of pedagogical tools to full fill the teaching learning objectives. To become a science teacher is a creative process of encouraging students to construct their own ideas about science through their instructions with peers, mentors and instructors. These interactions done through hands-on, minds-on activities and through the activities of critical thinking to foster a collaborative, thoughtful learning environment. So teaching and learning science is a similar process as the process followed by the scientist.

2.2.5 CURRENT TEACHING IN SCIENCE:

In India at the middle era of 20th century the school curricula are commonly prepared by taking text-book in the centre of the curriculum. The textbook is the vehicle that drives the teaching (Glynn, Yeany and Britton 1991). The textbook is usually accompanied by a large bulk of resource materials, such as additional information, overhead transparencies, wall charts, cassette, tapes, teaching kits, worksheets, exercise, suggested activities and experiments and activity cards. Besides this, the there are also “very useful” teacher’s handbooks prepared by the publishers, which prescribe precisely how a concept should be taught.

The problem of heavy reliance on textbooks in teaching and learning of science lesson was discussed in the American Association For The Advancement Of Science Report(1980). The report stated that present science textbooks, teaching materials and methods of instruction emphasis on learning of answers more than the explorations of the questions. It gives importance to memory at the expanse of critical thoughts, bits and pieces of information of some teaching points instead of understanding in wide context, recitation over argument against some issues, reading in lieu of doing experiments.

In recent time, traditional teaching style still going on in which students are passive learner of science curricula who learn what the teachers tells them to learn and the way they are told to learn it. The main goal of science instruction for students is to arrive at
scientifically acceptable solutions. The role of the teacher is to provide correct information about teaching points or about questions asked in the textbook, which is then reinforced by a textbook. In this kind of situation the actual learning is accomplished by practice of same thing for many times i.e. repetition and reinforcement of correct answers by teachers. Whole curricula is broken in to contents and the content is broken in to behavioral objectives to be met or set as a result of teaching learning process, skills to be mastered at the end of content and tests to be evaluated. Educators more concentrate on how to teach content and what to evaluate at the end of teaching learning process. Nowadays educational thinkers and everyone who concern with the education feel the need of something new that enable student to do science as scientist does. In science education constructivism is a new perspective that fulfill all the need of teaching and learning science.

2.2.6 CONSTRUCTIVIST TEACHING IN SCIENCE:

The most advocated psychological influence on thinking about curriculum preparation in science since 1980 has been the constructivist view of teaching and learning(fensham,1992). Tobin(1993) remarked that as “constructivism has become increasingly popular in last ten years”. The constructivism represents a paradigm change in science education. An unification of thinking about science, research methodology, curriculum development, and teacher education appears to now be occurring under theme of constructivism. Learning of science as per the viewed from a constructivist perspective involves epistemological, psychological as well as conceptual development. According to the view of constructivism the learning is a dynamic and social process in which learner actively construct the meaning from their own experiences in accordance with their prior understandings about the event or issue and their social settings. The constructivist view of learning advocated that students do not come to the science classroom with empty head but arrive in the classroom with lots of strongly formed ideas about how the people and the natural world works. According to the view of constructivist, students should no longer be passive recipients of knowledge what is supplied by teachers and the teachers should no longer be presenter of knowledge and classroom managers. From this perspective, learning is a process of acquiring new knowledge about the natural world and about some issues or events, which is active and complex. All above stated things results from the constructivist teaching which involves active interaction between teachers and learners, and learners try to make sense about what is taught by the teachers by trying to fit these with their own experiences.
Constructivist view of teaching and learning also emphasized generative learning, counter questioning and inquiry strategies about what is taught (Slavin, 1994). An emphasis on constructivism and hands-on activities and inquiry based instructions to promote and foster conceptual knowledge which build on prior knowledge and understanding, active participation and engagement with the subject matters and its application to real world situations has been advocated in science lessons (Stofflett and Stoddert, 1994). The real science teachers are those who teach students for deep understanding and provide experiences of real world situation. They use students’ ideas about some topic of science to provide guidance about lessons, providing lots of experiences to test their understanding and challenge their ideas about science to help students arrive at more sophisticated and considerable understanding. The classroom of such constructivist teachers are learner-centered places where group discussion, exploration of knowledge and problem solving events are common places (Wildy and Wallace 1995). The term ‘constructivism’ provides some clear pointers towards teaching strategies that might assist students in conceptual reconstruction such as,

- Identifying and evaluating students’ views and ideas about science and related topics.
- Creating and providing opportunities to students for exploring their ideas and to test their robustness in explaining phenomena scientifically, accounting for events and making predictions about new events.
- Providing reinforcement and stimuli for students to develop their understanding, to modify their ideas and where necessary, change their ideas and views about learning science events or topics; and
- Supporting their attempts to re-think and reconstruct their ideas and views about learning issues.

Teaching method which are based on constructivist views are very useful to help student’s learning. They are the actual practices derived from cognitive psychology that help students to understand the learning topics, recall and apply essential information when necessary, to understand the concepts and skills to be mastered. They are used to make lesson relevant to their understanding, activate students prior knowledge to related topics, help to elaborate and encourage counter questioning during learning. Important concepts from this perspectives are (Slavin, 1994, p.237-239):
**ADVANCED ORGANIZERS:** Advanced organizers are the General statements given to the students before instructions that relate new information to students’ existing knowledge to help them in processing new information by activating background knowledge of them, suggesting relevance and encouraging accommodation with their prior knowledge.

**ANALOGIES:** Analogies are pointing out the similarities exist between things that are otherwise unlike, to help students learn new information by relating these analogies to the concepts they already have. And

**ELABORATION:** elaboration is the process of thinking out new topics and material in such a way that help to connect it with existing knowledge of the students.

To build new knowledge on students’ existing knowledge is one of the best ways to encourage deep approaches to learning science. To achieve and fulfill this, teachers should have a clear ideas of what students have already known and understood about the science so that they can create such a situation that in which students are engage in activities those help students to construct new meanings(von Glasserfeld,1992). Teachers who apply constructivist teaching try to help people to learn meaningfully whatever they want to learn. They should encourage students to accept the invitation and conditions of learning and to take action in the learning conditions in accordance with what they have learnt before. The constructivist teacher should provide opportunities to the students to explore, discover and create, as well as to propose explanations and solutions in learning conditions.

Though Wilson(2000) has suggested that science educators are need to look beyond the confines of cognitive psychology in developing pupil’s understanding of scientific concepts, the four immediate accessible points suggested for practicing teachers to consider in teaching concepts to pupils also rooted with constructivist teaching, these were:

1. Recognizing what people already know
2. Teach fewer concepts
3. Improve continuity across key stages and progression of the development of concepts.

Pupils are exposed to scientific concepts at a much earlier stage in their education; and

3. Acknowledge the diversity of learners.
2.2.7 HOW DOES CONSTRUCTIVIST APPROACH IN TEACHING DIFFER FROM TRADITIONAL APPROACH OF TEACHING AND LEARNING?

The constructivist classroom is different from the traditional classroom in many dimensions. We can see in constructivist classroom, the main focus is shift from the teacher to students. The constructivist classroom is no longer such a place where the teacher pours or fills the knowledge into passive recipient students, who are waiting like empty vessels to be filled by the information. In the constructivist classroom during teaching, the students are told and argued to be actively involved in their own process of constructing knowledge. The main work of the teacher is to do the role of facilitator and guide who coaches, trained, mediates, prompts and helps students develop and assess their knowledge and understanding, and thereby their actual and deep learning. In constructivist classroom the main job of a teacher is also asking good questions which encourage students for doing deep study about subject matter. And, in such a constructivist classroom, both teacher and students are think to be memorized, but as a dynamic by ever changing view of the world in which we live and the ability and capacity to successfully stretch and explore and elaborate that view.

The table given below makes comparison between the traditional classroom and the constructivist classroom. We can note the significant differences in arrangement, in basic assumption about knowledge, students and learning.

**TABLE 2.1**

**COMPARISON BETWEEN TRADITIONAL AND CONSTRUCTIVIST CLASSROOM**

<table>
<thead>
<tr>
<th>TRADITIONAL CLASSROOM</th>
<th>CONSTRUCTIVIST CLASSROOM</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. In this classroom the curriculum begins with the parts and completes to the whole gives more emphasis on basic skills.</td>
<td>1. In this classroom Curriculum gives importance to big and deep concepts, begins with the whole and expands by including the parts.</td>
</tr>
<tr>
<td>2. In this classroom fix curriculum is strictly adhered and followed.</td>
<td>2. In this classroom students’ curiosity and their questions are given more importance than the fix curriculum.</td>
</tr>
<tr>
<td>3. In this classroom the main study materials are primarily textbooks and workbooks.</td>
<td>3. In this classroom material include primary sources of informative knowledge and manipulative materials.</td>
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<tr>
<td><strong>4.</strong> In this classroom learning is mainly based on repetition and recitation.</td>
<td><strong>4.</strong> In this classroom more importance given to interactive knowledge building on what the students already knows from their actual life.</td>
</tr>
<tr>
<td><strong>5.</strong> In this classroom teachers are purveyor of knowledge to students; students are passive recipients of knowledge.</td>
<td><strong>5.</strong> In this classroom teachers play the role of facilitator and have a dialogue and discussion with students; helping students construct their own knowledge and understanding.</td>
</tr>
<tr>
<td><strong>6.</strong> In this classroom teacher plays the role of director, rooted in authority to control the class.</td>
<td><strong>6.</strong> In this classroom teacher’s role is facilitator and interactive, rooted in negotiation to remove the confusion of students.</td>
</tr>
<tr>
<td><strong>7.</strong> In this classroom assessment is done through testing correct answers according to pre-prepared answer keys.</td>
<td><strong>7.</strong> In this classroom assessment based on students works, observations, their understanding and points of view as well as tests. Process is given as important as product.</td>
</tr>
<tr>
<td><strong>8.</strong> In this classroom knowledge is seen as inert and fix.</td>
<td><strong>8.</strong> In this classroom knowledge is seen as dynamic, flexible and ever changing with our daily life experiences.</td>
</tr>
<tr>
<td><strong>9.</strong> In this classroom such kind of situation provided where students work primarily alone.</td>
<td><strong>9.</strong> In this classroom such kind of atmosphere is provided where students works primarily in groups.</td>
</tr>
</tbody>
</table>

### 2.2.8 **BENEFITS OF CONSTRUCTIVIST TEACHING:**

During constructivist teaching the children are learn more, and enjoy learning when they are already involved learning process, rather then passive recipients of knowledge.

In constructivism education works best because it concentrates on thinking, negotiations and understanding of knowledge, rather than on rote memorization of fix syllabus. Constructivist teaching concentrates on learning of how to think, and how to understand.

Constructivist teaching is flexible and transferable. In Constructivist classrooms, students are involved in creation of knowledge and in organizing principles that they retrieved during learning.
During constructivist teaching the students are given ownership of what they have learn since learning flexible and is based on student’s creative questions, discussions and explorations, and often students are involved in designing the assessment as well. Constructivist assessment involves students’ initiatives and their own investment in their journals, reports about their research, physical models, and creative representations. Constructivist teaching engages the creative instincts which facilitate students’ abilities to express their own knowledge through a variety of ways. The students are providing the opportunity to retain and transfer their own knowledge to their real life.

Constructivism stimulates, encourages and engages students by grounding in an authentic, real world context and providing real life situation to face. Students in Constructivist classroom are learn to question about different things and given opportunity to apply their natural curiosity to the world.

Constructivist teaching promotes and provides social and communication skills by creating classroom environment more joyful and collaborative that emphasizes discussion and exchange of their ideas. Students must learn how to articulate and advocate their ideas clearly as well as to collaborate on learning tasks and conditions effectively by sharing their understanding in group projects. Students must learn to “negotiate and discuss” with others and making evaluation of their contributions in socially acceptable manner. This is essential to get success in the real world, since students will always be exposed to a variety of real life experiences in which they will have to cooperate, negotiate and navigate among the ideas of others.

2.2.9 META-COGNITION:

“Meta-Cognition” is the word fist time used by J. H. Flewell. “Meta” is Greek prefix with meaning beyond or behind of something. The meaning of “Cognition” is the mental result of perception about some thing, learning and reasoning. The meaning of whole term is what behind the ways of thinking, that result in perception and reasoning and thinking about thinking. It is also like thinking about the ways of thinking. The most popular and widely used definition of meta-cognition “knows about knowing”. It advocates the process of considering, overviewing and regulating one’s own learning and thinking. In meta-cognition the core processes included are,

- Assessing, overviewing and reviewing one’s current and previous knowledge,
- Identifying gaps and lakes of information in that knowledge,
• Planning about the gap filling strategies,
• Identifying and determining the relevance and necessity of new information and
• Potentially revising beliefs regarding the subject.

2.2.10 META-COGNITIVE SKILLS:

Meta-cognitive skills means the person’s own ability to know and understand his or her internal thinking and plans, as well as share his or her thought with others. Memories are very important in meta-cognition. Memories give opportunity to a child to remember his past experiences and how he coped with those past experiences. He is then using those past coping strategies again in new situations. This allows a child to plan and prepare for new experiences and for giving his better abilities in self regulations. If he is feeling upset and uncomfortable, he will be able to understand his feelings and emotions and express how he is feeling against another person.

Meta-cognitive skills make you aware and understand about your own knowledge. A meta-cognitive skill provides you abilities of understanding, controlling and manipulating your own cognitive process. In short, it makes you learn to learn. It is important for you to know the process of learning and understanding your own approach to it.

2.2.11 PROCESSING SKILLS:

Processing skills are useful and important means for learning and are very essential to conduct and understand the science. The best way to teach and inculcate the process skills is to let students carry out their scientific investigations and then to point out the process skills they used in during the investigations.

Science processing skills are important skills that simplify the process of learning science, activate and encourage students, develop students’ sense of responsibility in their own learning, increase the ability of learning, as well as teach them the research methods (Carey, Evans, Honda, Jay & Unger, 1989; Korkmaz, 1997; Karamustafaoğlu, 2003). Besides, these are the thinking skills that we often use to get information, to think on the problems and to formulate the results. These are also the skills that scientists regularly use in their studies and investigations. Bredderman told that these are very important cognitive skills which are used to understand and develop the correct information. These skills are appropriate and useful for all science fields, and are reflect on the correct approach of scientists while they are solving a problem and planning about an experiment. These skills also constitute the important of thinking and investigating within science. It is more important.
for the students of science to learn how to apply principals of science than learning reality, concepts, generalizations, theories and laws during learning science lessons. Therefore, it is necessary for them to make often use of the science processing skills. These skills are considered to be very effective and efficient in learning and teaching of science reserved a significant importance in teaching programs of various countries. The program developed by American Association for the Advancement of Science between 1963 and 1974 was ‘Science-A Process Approach’ (SAPA). In this approach, the teaching and inculcating science process skills was specially focused on in elementary and high school science curricula (Preece&Brotherton, 1997).

The American Association for the Advancement of Science (AAAS) advocated the following science processing skills.

1. **Observation**

   This is the most fundamental and important skill of all of the processes. Observation means gathering of information by the use of any one, or by combining all five basic senses. The basic senses are sight, hearing, touch, taste, and smell. The term observation is used to describe the result of observing or viewing. In other words one might observe and, as a result, get observations. These observations are also called data or facts. Skilled observers are seem to be proceeding from general perceptions of a event to more specific ones. So the nature of skilled observation is analytical. Events are first observed as a whole process and then analyzed for proper information. Subsequently, this information can be treated as a whole and subjected to further analysis for gathering specific information. To amplify the basic senses powerful technology can be used, which provides deep analysis of event or incident. In summary, observation is an objective process of gathering data through the use of one's senses applied in an analytical way.

2. **Recall or Retrieval**

   Recall or retrieval of memory or learning things are refer to re-accessing of events or information which gain during learning or some other experiences. The events or information which are already stored and encoded in mind or in brain are re-accessed in the process of recalling. During recalling the information the brain arrange the information in perfect order and in particular patterns.
3. **Measurement**

Measurement is more specific observation made by comparing some attribute of a system to a standard of reference. An example is when the length of an object is expressed in terms of the length of a meter or when the mass of an object is expressed by referring to a standard such as a gram. Measurement and observation are the only process skills that are actually two forms of the same thing.

4. **Comparing**

To compare means to examine two or more objects, events or ideas in order to note similarities and differences. For example to make comparison between two events or to make comparison between two natural scenes etc. During comparison we examine resemblance between two or more things according to the characteristics of those things. In comparing some thing the learners must have knowledge about the things which they want to compare. The process of comparison during learning combines the process of recalling, remembering and comprehending.

5. **Classification**

Classification means making groups of objects on the basis of their similar traits. Objects having same characteristics as stated can be said to belong to the same set characteristics. As the process of classification is depending upon the identifying same traits so it is said to be arbitrary process. It is very important process of science because in making comparison one should underlie assumption that kinship in one regard may entail kinship in others. Science assumes that to a large degree the universe is consistent with its laws holding true everywhere. Therefore, if a set of objects share one thing in common they may well share other attributes. The nature of the skill of classification is two fold. (1) One must be able to identify traits and (2) One must select traits that express the deep essence of the system.

6. **Quantification**

The process of using numbers for describing observations rather than relying only on qualitative descriptions is called quantification. The process of quantification has two major values. (1) In expressing something in numerical form the need for translation of verbal
meaning is reduced. (2) While using numbers the mathematical logic must be applied in attempts to explore, describe and understand nature.

7. **Inferring**

An assumption is made on observing the event for the investigation of reason behind its causation and about its effects Inferring is referred as inferring. It is an inventive process. It is pre-process of prediction. This is a very common function and is influenced by culture and personal theories of nature.

8. **Predicting**

The process of making prediction deals with projection of events depending upon a source of information. For making prediction about some event the investigator may project in a future tense or he or she may look for an historical causation for current circumstance. In either case, the prediction made from a data base rather than it made from just by guessing about event. Only guessing is not a prediction. From the definition it should be clear that the predictions must be testable. From this we can say that the acceptance or rejections of predictions depends upon observed criteria or evidences. If they are not testable they are not predictions.

9. **Relationships**

The processing skill of relationships relates with the interaction of variables. This kind of interaction occurs between the variables through the influence of variables on one-other. This kind of relationships can occur either in multiple dimensions or in single dimension. Counting speed of moving object by dividing distance with time is the example of multiple dimension relationship. An example of single dimension relationship is location of object in relation of other object in space. The location of object can only be expressed with relative terms such as over, under, near, far, etc. The nature of this skill is internally analytical in which dissection of cause from effect is in central of thought. The causal elements are generally variables of system and the effect is the resulting through the interaction between them.
10. **Communication**

This process of communication actually refers to a group of processing skills. During communication data were systematically reported to one another. The simplest examples of reporting data are display tables, charts and graphs. The process of reporting data include two or three dimensional matrix with the axes representing the system variables and the cells of the matrix representing the interactions. The main purpose of the communication skills is to represent information or data in such a way that the maximum data can be covered and can be reviewed with simple observation.

11. **Interpreting data**

The process of interpretation of data in includes determining the relationship among the data through various analytical processes. It is one kind of recognizing patterns associated within bodies of data. The pre processes like data collection, communication etc. are important contributors in interpreting data. It is important to represent data properly for detecting associations within the data. Interpretation of data might be requiring creative thinking that result in the invention of conceptual validation that can encompass the data.

12. **Controlling variables**

Controlling variables is one kind of group process in which one may engage in many different activities to control variables. In general, this skill is a attempt to isolate a single influent of a system so that it's role can be inferred. The process is an attempt to achieve a circumstance or condition in which the impact of one variable is clearly exposed. The use of experimental and control circumstances, standardizing procedures and repeated measures are only a few of the ways in which variables might be controlled. Understanding the nature of the skill requires analytical thinking in which the system under study can be reduced to a set of interacting components. The next step is to establish some circumstance that allows the scientist to observe one component in isolation.

13. **Hypothesizing**

Hypothesizing is, again, an intrinsic and creative mental process rather than a more straight forward and obvious behavior. Consequently, developing this ability is probably less a product of linear training but more a function of intuitive thinking that emerges from
experience. For our purposes we will insist upon a rather rigid use of the term and will restrict it to the second step in the classical scientific algorithm as outlined in the next process.

14. Imagining

Imagining means to form a mental image about something which is not actually present or exist. During the process of imagination one may thing about the thing or event which is created in his mind. Imagination is a process of thinking about those things which are beyond in reach of our physical senses. In imagination our learned things, experiences events play very important roles.

2.2.12 BLOOM’S TAXONOMY:

In present research the researcher examined the effectiveness of constructivist teaching approach on students four phases of learning. These four phases of learning were information getting, applying, analyzing and creating. These phases of learning are described in revised Bloom’s taxonomy originated from the original taxonomy of educational objectives formed by Benjamin Bloom in 1956. Here some brief information about Bloom’s taxonomy of educational objectives and its revised version is given.

SUMMARY OF BLOOM’S TAXONOMY:

The Bloom’s taxonomy of educational objectives is a well arranged framework for classifying statements or objectives of what we expect or intend students to learn as result of instruction. The framework was done by exchange of test items among different faculty at various universities in order to create bunch or banks of items in such a way that each item measuring the same educational objective. Benjamin S. Bloom (Associate Director of the Board of Examinations of the University of Chicago) advocated this idea, stated that the taxonomy of educational objectives would reduce the labor of preparing annual comprehensive examinations and making evaluations. To aid in his effort, Bloom listed out and made a group of measurement specialists from across the universities of United States, many of them repeatedly faced the same problem of comprehensive evaluation. This group decided to met about twice a year beginning in 1949 to consider progress of work, make revisions about their research, and plan about the next steps. Their final draft was published in 1956 under the title, Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain (Bloom, Engelhart, Furst, Hill, &
Krathwohl, 1956). Then after, it was referred as the original Taxonomy of educational objectives. The revision of this framework was done by Anderson and Krathwohl for the issue of ‘Theory In to Practice’, was developed in much the same manner 45 years later (Anderson, Krathwohl, et al., 2001). After this revision work this is referred as the revised Taxonomy of educational objectives. Bloom’s original Taxonomy was referred and known more than a measurement tool. He believed that

- It could served as a common language about learning goals which facilitate communication across persons, subject matter and learned topics, and grade levels;
- It could served as a basis for determining a particular course or curriculum for the specific meaning of broad educational goals, such as those goals found in the currently prevalent local, state level and national level standards;
- It could served as a means for determining the similarities and congruence of educational objectives to the activities, and assessments in a unit, course, or curriculum; and
- It could served as a panorama of the range of the educational possibilities and educational goals against which the fraction of limited breadth and depth of any particular educational course or curriculum could be contrasted.

**BLOOM’S ORIGINAL TAXONOMY:**

Benjamin Bloom started to prepare his taxonomy of educational objectives by arranging educational objectives into ordered categories or groups. The main of his goal was to find out common language of educational measurement that experts could use to share their educational findings and exchange test items with each other.

Bloom’s Taxonomy of educational objectives emerged from a lots of informal discussions and negotiations with colleagues that began at the American Psychological Association in 1948. At the time, educators of different educational field were started questioning about good education and educational system. Many of them were veterans of World War II wanted to enrolling in college. The veterans wanted a good education, but the core question was what makes an education “good”? How could instructors or educators ensure that learners graduated with more than just lower-level factual knowledge?

Lee S. Shulman, a Bloom’s student, recalls that when these questions were asked or raised, educational thinkers were just begun to prepare assessment. Benjamin Bloom, as a director of the examiner’s office at the University of Chicago, was started to develop
classifications learning outcomes. When he shared his ideas about educational objectives and test items with other educators and evaluators, he saw that educators agreed that they wanted learners to “understand,” but they had very different ideas about the meaning of understanding.

Bloom wanted to develop taxonomy of educational objectives by organizing educational goals into a hierarchy, in a way as biologists classify living creatures into categories that ascend from species to kingdom. In preparation of Bloom’s taxonomy so many collaborators, reviewers, contributors of case studies and examples and a core working group of 30 people were gave their important contributions. As a result of their hard work, the taxonomy was first time published in 1956, is became popular as Taxonomy of Educational Objectives. Bloom often called this work The Handbook of Educational Objectives. However, everybody who concerns with the educational system and use this taxonomy is refer it as Bloom’s taxonomy. This is due to Bloom’s foundational contribution to the project: He made agree his team to organize and set learning objectives or behaviors on a continuum from the simplest to the most complex.

**Four Key Principles**

Bloom identified four principles that guided the development of the taxonomy. Categories should:

- Be based on student behaviors
- Show logical relationships among the categories
- Reflect the best current understanding of psychological processes
- Describe rather than impose value judgments

During his discussion with his collaborators about above four principles Bloom expected about some of the most considerable criticisms of his work. The whole taxonomy is based on behavioral objectives so that teachers can observe the behavior of the students, so its language does not conduct the complexity and intectisity of internal learning processes. In the middle of 20th century the psychological thinking did not reflect about the way or process the learners construct their knowledge, how they regulate their mental processes. Benjamin Bloom also accepted that the taxonomy of educational objectives was not prepared to provide a complete theory of learning. Even though, he assumed that this taxonomy would support the development of a comprehensive theory of learning. It would provide a framework to educators that they could use it for identification of research studies, in developing hypotheses,
in planning learning, and identifying methods and metrics. It could also use in preparation of learning goals, measuring outcomes and sharing findings by defining a common language to use for those.

Now days Bloom’s taxonomy is most widely used as a guide in developing learning objectives by educators and trainees of educational field. In broad research field the researchers used Bloom’s taxonomy to measure learning and research outcomes. They used it to compare the learning theories and methods.

**Main Three Domains of Bloom’s Taxonomy:**
Bloom’s original taxonomy consisted of three domains:
(1) Cognitive Domain: It is a knowledge-based domain
(2) Affective Domain: It is an attitude-based domain
(3) Psychomotor Domain: It is a physical skills-based domain

The table given below describes the three domains of Bloom’s original taxonomy with the abilities associated with each domain.

**TABLE 2.2**
**AN OVERVIEW OF THREE DOMAINS OF BLOOMS’ TAXONOMY**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Overview</th>
<th>Abilities</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cognitive</strong></td>
<td>It is based on content and intellectual knowledge. The core question for setting objectives regarding this domain is ‘What do I want learners to know?’</td>
<td>Conceptualization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Comprehension</td>
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<td></td>
<td></td>
<td>Application</td>
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<td></td>
<td>Evaluation</td>
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<td></td>
<td></td>
<td>Synthesis</td>
</tr>
<tr>
<td><strong>Affective</strong></td>
<td>It is based on emotional knowledge. The core question for setting objectives regarding this domain is‘What do I want learners to think or care about?’</td>
<td>Receiving</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Responding</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valuing</td>
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<tr>
<td></td>
<td></td>
<td>Organizing</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Characterizing</td>
</tr>
<tr>
<td><strong>Psychomotor</strong></td>
<td>It is based on physical/mechanical knowledge. The core question for setting objectives regarding this domain is‘What action(s) do I want learners to be able to perform?’</td>
<td>Perception</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Simulation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conformation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Production / Mastery</td>
</tr>
</tbody>
</table>
2.1 HIERARCHY OF COGNITIVE DOMAIN:

The first phase of learning is based on knowledge which is set at the bottom of the hierarchy. The Knowledge means remembering or retrieving previously learning things. The Learning objectives prepared for this level based on retrieving, recognizing, recalling, identifying and listing of some thing. The knowledge-level objectives are very important as are foundation for understanding additional materials. As it is very easy to construct learning objectives of this level the learners and educators frequently used these by preparing different types of objectives based on different learning outcomes.

The second from the bottom of hierarchy is comprehension. This level constitutes the bulk category of cognitive skills and mental abilities. The important skill to be achieved at this level is processing new information. To prepare the learning objectives for this level the core words should kept in mind are to construct, to write, to interpret, to exemplify, to classify, to summarize etc. The level comprehension is very near to the level application. Once you make comprehension of your learning then you can better apply it in other learning conditions and real life situations.
The third one from the bottom is application level in cognitive hierarchy. The main goal of this level is to apply the learning knowledge. Objectives at this level prepared for application of learning things in other learning situations. In application level the learners have to interpret information they get during learning, demonstrate mastery of a concept, or apply a skill learned. The objectives framed for this level by using words like to apply, to calculate, to manipulate, to compare, to classify etc. for making analysis of any learning topic you must apply previous knowledge regarding that topic.

At the middle of the hierarchy of cognitive domain it is analysis level. In doing analysis learners have to identify relationships among learning topics. For preparing the objectives of this level learners often use verbs like differentiate, compare according to differences and similarities, criticize, or experiment. It is important for the learner to analyze before synthesize.

The level of synthesis is put at the second position from the top of hierarchy of cognitive domain. At this level learners are expected for creative behavior and construct new and unique products. The words like synthesize, predict, infer, plan, produce, create etc. are used in preparation of the objectives of this level.

At the top of the hierarchy of cognitive domain the final and important level is evaluation. Evaluation means making judgments about learning value. The judgment is based on previously set standard and criteria. Learning objectives at this level require learners to measure, value, estimate, choose, or revise something, perhaps information, a product—or solve a problem.

The lower order objective like knowledge, comprehend and apply are focused on learning things during learning situations. It gives importance to make understanding about what is learned and use this learning where it is necessary. Higher-order objectives require learners to use what they have learned and can give them practice in developing new approaches to problems, identifying critical variables, and making needed judgments. Educational thinkers and educators wanted to revise the Bloom’s taxonomy of educational objectives as it was too old and must needed some modifications. Therefore after doing many researches and negotiations regarding the Bloom’s taxonomy they produced a revision of the taxonomy in 2001 widely known as ‘The Revised Bloom’s Taxonomy.’
THE REVISED BLOOM’S TAXONOMY:

As stated above Lorin Anderson and his collaborators published a revision of Bloom’s taxonomy in 2001 is known as A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom’s Taxonomy of Educational Objectives. This version is widely accepted by the educators. Anderson, one of the student of Bloom and David Krathwohlone of his principal collaborators in making taxonomy were gave very useful contributions in making revision of original Bloom’s taxonomy. The very important thing is they describe their work as an extension of the original framework of Bloom’s taxonomy rather than a fetching credit of new research.

According to Bloom the taxonomy of educational objective was never prepared to be definitive but it should be used as guideline for the preparation of educational outcomes. Bloom expressed concern that the too much use of taxonomy might freeze the thinking of people about curriculum, instructional process, evaluations technique and about learning patterns of different students. Therefore he and his collaborators considered the framework of taxonomy as a work in progress. Bloom ideally thought that each field of education would have its own taxonomy of objectives and learning outcomes written in its own disciplinary language. Therefore the revision published in 2001 is not separate work from the original Handbook, but it published as a continuation of Bloom’s original work.

The main reasons behind doing a revision of original taxonomy were:

1. To re-concentrate on the value of the original framework for the development of ethical and responsible programs, arranging curriculums, and designing assessments.

2. To update the original framework based on new patterns and understanding of learning and new methods and techniques of teaching.

Changes to the Categories

The diagram given on next page shows the most obvious differences between the taxonomies of 1956 and 2001. In the revised taxonomy, evaluation is stand at the second position from the top level of the pyramid. Creating, a new category is set on the peak of pyramid. This category was previously known as synthesis. Another significant change in revised taxonomy is the names of categories are given in verbal form and not in noun form. For example, knowledge is become understanding. The objectives prepared regarding revised Bloom’s taxonomy are known as learners’ thinking processes rather than behaviors.

The other differences are minor but more important. The categories were given more important in original Bloom’s taxonomy. Six categories were arranged in a hierarchy and order was strictly followed while preparing educational objectives. It was assumed that learners must master the learning behaviors of lower level of the hierarchy before they reach to the next higher level of learning behaviors. The revised taxonomy also follows the original taxonomy and arranges skills from the most basic to the most complex. Even though, the skill like understanding can be exercised and practiced on many levels, the collaborators and developers allowed categories to overlap on each other. For instance, ‘understand’ is technically at lower level on the hierarchy than ‘apply’. However, explaining is more cognitively difficult than executing, even though it is associated with a higher category.

The new terms are defined as:

(1) **Remembering**: Remembering means retrieving, recognizing, and recalling relevant information from long-term memory.
(2) **Understanding**: Understanding means constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.

(3) **Applying**: Applying means to implement knowledge and ideas in different learning situations.

(4) **Analyzing**: Analyzing means breaking material into constituent parts, determining how the parts relate to one another by stating their similarities and differences to each other.

(5) **Evaluating**: Evaluating means making judgments based on criteria and standards through checking and critiquing.

(6) **Creating**: Creating means putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing. (Anderson & Krathwohl, 2001, pp. 67-68)

2.3 REVIEW OF RELATED RESEARCHES:

This part contains review of past researches about Constructivist approach in teaching, effectiveness of constructivist learning and, researches on processing skills and meta-cognitive skills.

2.3.1 RESEARCHES ON CONSTRUCTIVIST TEACHING:

Kiew SiawFui (2010) at faculty of Education University Technology Malaysia investigated the implementation of Constructivist approach among chemistry student teachers in teaching chemistry during their teaching practices. In order to fulfill the purpose of this study, six research questions were developed. First, “What is the student teacher’s understanding about constructivist approach?” Second, “What is the usage percentage of constructivist approach among student teachers during their teaching practices?” Third, What are the factors that influence student teachers to use constructivist approach during their teaching practices?” Fourth, “What are the obstacles faced by student teachers in implementing constructivist approach during their teaching practices?” Fifth, “What are the solutions for the obstacles faced by student teachers in implementing constructivist approach during their teaching practices?” Sixth, “What are the measures that can be taken to enhance the usage of constructivist approach?” A total of seventy chemistry student teachers from
faculty was constructed according to the research objectives for data collection. Findings from this study reveal that majority of the chemistry student teachers have good understanding about constructivist approach but the usage of this approach in their teaching is very low. Results also reveal that microteaching class is the major factor influencing student teachers to implement constructivist approach in their teaching. However, the main obstacle in implementing constructivist approach is time insufficiency, and thus requires the concern of faculty. To enhance the usage of constructivist approach, alternative assessment is suggested by majority of the student teachers as the best practice.

The study by Koray Kasapoglu (2010) of the graduate school of social sciences of Middle East technical university aimed at determining whether classroom teacher’s attitudes toward change correlate with their perceptions of constructivist curriculum change and implementation of constructivist teaching and learning activities in class at primary school level. Through a questionnaire, data were collected from 236 classroom teachers teaching in all public primary schools in the city center of Afyonkarahisar, Turkey. Demographical data of the participants, their attitudes toward change, perceptions of constructivist curriculum change, and implementation of constructivist teaching and learning activities were reported in terms of frequencies, percentages, and means. Bivariate correlations were employed to understand the relations among classroom teachers’ attitudes towards change, perceptions of constructivist curriculum change, and implementation of constructivist teaching and learning activities at primary school level. The result revealed that classroom teachers were open to change and often implemented constructivist teaching and learning activities in class whereas they had mixed perceptions about constructivist curriculum change carried out in Turkey in 2004-2005 academic year. Classroom teachers’ attitudes toward change were we significantly but moderately correlated with their perceptions of constructivist curriculum change and implementation of constructivist teaching and learning activities at primary school level. Besides, classroom teachers’ perceptions of constructivist curriculum change were significantly but moderately related to their implementation of constructivist teaching and learning activities.

Brown-Lopez, Priscilla, Alva, Marie (2010) Analyzed the effects of a Constructivist-based Mathematics problem solving Instructional Program on the achievement of grade five students in belize. This research examined whether socialconstructivist activities can improve the mathematical competency of grade five students in Belize, Central America. The sample included 342 students and eight teachers from two rural and urban schools. A switching
replication design was employed enabling students in the experimental groups to be taught using social constructivist activities for 12 weeks and the controls exposed to similar instructional practice from weeks 7 to 12. Students’ performance was assessed using pre-test, post test 1 and 2 with an internal consistency of 0.89, 0.90 and 0.93 respectively. As revealed by the repeated measures ANOVA within subject analysis, there were significant differences among the pre-test and post test 1 and 2 results. That is, students in the control groups, who were instructed using a procedural approach from weeks 1 to 6, demonstrated higher gains than the experimental groups who were immersed in similar activities from weeks 7 to 12, they continued to outperform the experimental groups who were exposed to social constructivist activities alone. Hence, due to this unexpected results, the aim of this thesis became to explain why these result came about and what implications for teaching were highlighted by the consideration. Besides the quantitative results highlighted above, qualitative data was also obtained as part of the study. For example, students were videoed within constructivist math groups and their performance analyzed using pirie and kieren’s (1994) Model of Growth for Mathematical Understanding. The data from the video recording revealed that use of one step math problems did not enable students to restructure their thinking to solve innovative problems. Data from semi-structured interviews also revealed that some students lacked basic math skills and were not exposed or guided to solve complex problems. Besides the need for careful examination of social constructivist activities on performance, this thesis underscore the importance of relevant teaching and learning activities, the important role of teachers during social constructivist activities and the need to identify suitable forms of assessment to measure performance.

Theera Haruthaithanasan (2010) studied about The effects of experiences with constructivist instruction on attitudes toward democracy among THAI college st in Graduate school at the university of Missouri. The study draws on Dewey’s theory that constructivist instruction embraces the philosophy of democracy with regards to enhancing students’ individual and social constructivist learning. As a result, the hypothesis is that constructivist learning practices might be an effective indirect way to learn and value democracy. The hypothesis was confirmed by the structural-equation modeling analysis result, indicating that thai students’ prior experiences with constructivist instruction were positively correlated with their attitudes toward democracy. Through a multistage sampling method, a group of 717 freshman college students were randomly selected from one public university in Bangkok, Thialand. They were surveyed by group administration with a student questionnaire about their prior constructivist learning experiences in high school, as well as about their attitudes
towards democracy. Moreover, the students’ personal profiles such as gender, parent education, hometown location, and academic department were examined to find potential variables in the Thai students’ attitudes toward democracy. The key findings derived from these statistical results were highlighted and discussed in order to provide some educational policy implications for Thailand.

The effect of constructivist teaching strategies on science test scores of middle school students” by Vaca, James L., Jr., Ed.D., Walden University (2010) stated as international studies show that the United States is lagging behind other industrialized countries in science proficiency. The studies revealed how American students showed little significant gain on standardized tests in science between 1995 and 2005. Little information is available regarding how reform in American teaching strategies in science could improve student performance on standardized testing. The purpose of this quasi-experimental quantitative study using a pretest/posttest control group design was to examine how the use of a hands-on, constructivist teaching approach with low achieving eighth grade science students affected student achievement on the 2007 Ohio Eighth Grade Science Achievement Test posttest (N=76). The research question asked how using constructivist teaching strategies in the science classroom affected student performance on standardized tests. Two independent samples of 38 students each consisting of low achieving science students as identified by seventh grade science scores and scores on the Ohio Eighth Grade Science Half-length Practice Test pretest were used. Four comparisons were made between the control group receiving traditional classroom instruction and the experimental group receiving constructivist instruction including: (a) pretest/posttest standard comparison, (b) comparison of the number of students who passed the posttest, (c) comparison of the six standards covered on the posttest, (d) posttest’s sample means comparison. A Mann-Whitney Test revealed that there was no significant difference between the independent sample distributions for the control group and the experimental group. These findings contribute to positive social change by investigating science teaching strategies that could be used in eighth grade science classes to improve student achievement in science.

Brooks and John from Walden university (2010) done the research as “The effectiveness of constructivist science instructional methods on middle school students’ students achievement and motivation.” The theoretical framework for this study was based on reformed and research efforts that have informed science teachers that using constructivist is the best method of science instruction. The purpose of this study was to investigate how the constructivist method of science instruction affected student achievement and student.
motivation in a sixth grade science classroom. The guiding research question involved understanding which method of science instruction would be most effective at improving student achievement in science. Other sub-questions included the factors that contribute to student motivation in science and the method of science instruction students receive that affects motivation to learn science. Quantitative data were collected using a pre-test and post-test single group design. T-test and ANCOVA were used to test quantitative hypotheses. Qualitative data were collected using student reflective journals and classroom discussions. Students’ perspectives were transcribed, coded and used to further inform quantitative findings. The findings of this study supported the recommendations made by science reformists that the best method of science instruction was a constructivist method. This study also found that participant comments favored constructivist taught classes. The implications for social change at the local level included potential increases in student achievement in science and possibly increased understanding that can facilitate similar changes at other schools. From a global perspective, constructivist-oriented methods might result in students becoming more interested in majoring in science at the college level and in becoming part of a scientifically literate work force.

Aytunga Oguz (2008), Assistant professor, Department of Educational Science, Dumlupinar University done the research under the title “The Effects of Constructivist Learning Activities on Trainee Teachers’ Academic Achievement and Attitudes The aim of this study is to find out the effects of active learning methods based on constructivist approach on the prospective teachers’ achievements, attitudes towards the subject matter and perceptions about the learning process. Experimental design and qualitative research method were used in the study. In the experimental group, constructivist learning learning methods were applied and in the control group, traditional learning approach was followed. The participants consisted of 43 sophomores at Dumlupinar University Education Faculty. The results revealed a significant difference between the achievement levels of the experimental and control groups in favor of the experimental group, but no significant difference was found in their attitudes. Depending on the findings, it can be said that constructivist learning activities enable the students to become more successful and to develop positive perceptions.

Ken Rowe (2006) Australian Council for Educational Research made some researches on effective teaching practices as “Effective reaching practices for students with and without learning difficulties” at Sydney. Much of what is commonly claimed as ‘effective teaching practice’ and implemented during the early and middle years of schooling in Australian schools, for either mainstream students or for those experiencing learning difficulties, is not
grounded in findings from evidence based research. Of particular concern is that despite a lack of supporting evidence for its utility, the prevailing educational philosophy of constructivism (a theory of self-directed learning rather than a theory of teaching) continues to have marked influences on shaping teachers’ interpretations of how they should teach aided and abetted by the content emphasis given during pre-service teacher education, as well as in-service teacher professional development programs. However, in contrast to teacher-directed methods of teaching there is strong evidence that exclusive emphasis on constructivist approaches to teaching are neither initially nor subsequently in the best interest of any group of students, and especially those experiencing learning difficulties. Following a brief outline of controversies surrounding ‘effective teaching practice’, this paper focuses on teaching strategies that are demonstrably effective in maximizing the achievement progress of student during the early and middle years of schooling. Further, key findings are presented from a recent national project designed to identify effective teaching practices for year 4-6 students with learning difficulties in Reading and Numeracy, drawn from government, catholic and independent schools. These findings indicate that since teachers are the most valuable resource available to schools, an investment in teacher professionalism is vital by ensuring that they are equipped with an evidence-based repertoire of pedagogical skills that are effective in meeting the developmental and learning needs of ALL students.

Kong sow lai University sains Malaysia (2006) done the research under the title “The effects of constructivist strategy and direct instruction using multimedia on achievement among learner different psychological process” The main research question of the study was “Do two different instructional strategies contribute to differences in learning different levels of knowledge tasks for learners with different psychological profiles on the chemistry topic of the periodic table?” Two modes of instruction, Constructivist-Strategies Instruction (CSI) and Direct Instruction (DI), using similar validated multimedia materials were taught by teacher assistants following protocols and supervised by two assessors, for a period of 5 weeks. Six research questions associated with six hypotheses (together with the sub hypotheses) were formulated and tested using inferential statistics (t-test). All hypotheses formulated were a priori directional hypotheses and tested at the level of significance of p<0.05. Other existing variables were analyzed using correlation, ANCOVA, and Stepwise Linear Regression to determine the contributions towards the dependent variables. The study used a 2×2 quasi-experimental factorial design with repeated measures for the moderator variables in a non equivalent Control Group Pretest-Posttest Design, involving a total of 156 From Four students aged between 16 to 17 years old from four rural secondary schools. Intact
classes were randomly assigned the CSI or DI mode of instruction, the independent variable of this study. The dependent variables were the mean gain score for lower and higher order knowledge tasks and the problem solving score. Moderate variables were the cattle measure for intelligence/ability and the internal locus of control (LOC) of students. The two treatments, CSI and DI, had led to differential attainments for the dependent variables of mean gain scores for higher order knowledge tasks and problem solving scores. There were no significance differences in attainments with regards to lower order knowledge tasks for the two treatment groups. The study concluded that CSI was more effective than DI for higher order knowledge tasks, and the effects of CSI were stronger for high ability and high internal LOC learners. This study found that DI and CSI were equally effective for lower order knowledge task. By integrating multimedia resources into the lesson protocol prescribed for the study, both modes of instruction have potential in promoting learning, depending upon the inherent nature of the topic in Chemistry. This study suggested that the practicing teacher should select the best instructional strategies to meet the needs for students for each type of learning tasks. As DI is effective time-wise, the instructor can “manage instruction” using DI for lower order knowledge tasks, and revert to CSI for higher order knowledge tasks. However in the CSI mode, since learners are directed to draw upon their own experience and be actively involved in “knowledge construction”, this would lead to efficient schema construction based on the study’s model. Thus the recommendation is to employ this Eclectic approach (CSI) in the classroom as constructivist approach is student-centered and has more potentials in creating meaningful learning.

Anderson and Wallin (2006) analyzed a research program for the improvement of science teaching. The idea of the program was that researchers in science education and teachers in school had better work together to design teaching sequences and to assess how they functioned in practice. The results of the study showed that the most important product of the design was that it was a detailed guide for teachers, which they looked upon as a tool for further knowledge construction. According to the results of the study, the researches suggested that the idea of domain-specific theories be worth examining and developing. It might also contribute to strengthen science education as an autonomous discipline.

Leach, Ametler, Hind, Lewis and scott (2005) conducted a study to verify the feasibility of designing short teaching sequences, and which based on insights from research and scholarship on teaching and learning science, which were measurably better at promoting conceptual understanding amongst students than the teaching approaches usually used by their schools. The research team consisted of 9 teachers 9 (3 biology, 3 chemistry and 3
physics) to design, implement and evaluate 3 teaching sequences in which there were students who were between the ages of 11-15. The findings showed that the use of authentic assessment questions and student-centered instructional strategies increased students’ motivation and change students’ perception in a better way in science education.

Osborne (2005) conducted a study which had two phases. The researcher worked with a group of 12 science teachers in the first phase. The main purpose was to develop sets of materials and strategies to support argumentation. In phase 2, teachers taught the experimental groups a minimum of nine lessons and a comparison group at the beginning at the end of the year. The results showed that argumentation was an effective strategy and argumentation in scientific context was more difficult than that in a socio-scientific context.

Tabago (2005) developed constructivist approach experiments to determine its effectiveness in teaching physics concepts by Lorelei C. City. The quasi experiment following a non equivalent control group design was used. Two sections of 2nd year BSIT students of Isabela State University Cauayan City Campus were involved. The study administered pre-test and post-test. The scores in the achievement test and standardized attitude inventory test were compared and the significance of their difference was determined using the t-test. The control group and the experimental group were equal in terms of cognitive level in physics. However, the students exposed to the constructivist approach of laboratory teaching had significantly higher post-test scores and higher mean gain scores than the students exposed to the traditional approach after the study was conducted. The experimental group developed a more positive attitude towards physics than the control group. Moreover, there was a significance difference between the post achievement scores and post attitude scores of the students exposed to constructivist approach based experiments and traditional experiments. The Constructivist Approach Experiments are effective in enhancing students’ achievement and in developing a more positive attitude towards the subject than the traditional approach.

In 2004 the Australian Government Department of Education, Science and Training commissioned the Catholic Education South Australia Office to undertake an investigation under the title “Building mathematical understanding in the classroom: a constructivist teaching approach” into effective constructivist teaching strategies designed to support students in improving their numeracy skills. An action research approach using quantitative and qualitative method was used in nine mathematics classrooms. The research addressed the questions: What does a mathematics classroom look like when working with constructivist learning theory? What strategies do teachers use to facilitate learning in an environment that
engages all students in the construction of their own knowledge? Research indicated that the teaching and learning process is influenced by the social and physical environment where it takes place. There is no single aspect of teaching or environment feature that produces learning for all students; rather, a combination of techniques and environmental elements must be employed to enable the learning of an entire class. The assessment of individual students’ mathematical understanding, combined with follow-up by the teacher on understanding of new concept, was a major factor in the improvement of all students’ numeracy skills. Finally, professional learning through collaborative action research supported the teachers to further develop their own knowledge of mathematics, their understanding of students’ thinking and how a constructivist approach to mathematics teaching can contribute to students’ learning.

Esen Uzunt Ryak (2003) the graduate school of natural and applied sciences of the Middle East Technical University compared the effectiveness of instruction based on constructivist approach over traditionally designed chemistry instruction on ninth grade students’ understanding of chemical bonding concepts. In addition, the effect of instruction on students’ attitude toward chemistry as a school subject and the effect of gender difference on understanding of chemical bonding concepts were investigated. Forty-two ninth grade students from two classes of a chemistry courses taught by the same teacher in METU Development Foundation Private School 2000-2001 spring semester were enrolled in the study. The classes were randomly assigned as control and experimental groups. Students in the control group were instructed by traditionally designed chemistry instruction whereas students in the experimental group were taught by the instruction based on constructivist approach. Chemical Bonding Concept Test was administered to both groups as a pre-test and post-test in order to assess their understanding of concepts related to chemical bonding. Students were also given Attitude Scale Toward Chemistry as a School Subject at the beginning and end of the study to determine their attitudes and Science Process Skill Test at the beginning of the study to measure their science process skills. The hypotheses were tested by using analysis of covariance (ANCOVA) and two-way analysis of variance (ANOVA). The results indicated that instruction based on constructivist approach caused a significantly better acquisition of scientific conceptions related to chemical bonding and produced significantly higher positive attitudes toward chemistry as a school subject than the traditionally designed chemistry instruction. In addition, science process skill was a strong predictor in understanding the concepts related to chemical bonding. On the other hand, no
significant effect of gender difference on understanding the concept about chemical bonding and students’ attitudes toward chemistry as a subject was founded.

Stinger and Garfingel (2003) conducted a study lasting two months. A classroom of fifteen language minority first graders participated in an open ended constructivist project with the aim of fostering critical thinking skills, creating independent and motivated learners, and meeting the state of reflections, surveys, and formal assessment were used to report the project. At the end of the project, it was found that students were engaged in the constructivist approach to learning.

Gholam Reza Zarei at Isfahan University of Technology, Iran using a constructivist approach, studied the development of students’ conceptions of L2 reading is an important skill in the ESP context. The analysis of initial and final descriptions of ‘reading’ indicated that reading was conceptualized in five different ways: (1) reading as a set of binding rules; (2) reading as an integration of various language elements; (3) reading as a sampling technique; (4) reading as a confrontation between reader and writer; and finally (5) reading as an attempt to identify and comment on the content features. The subjects tended to move towards the last three categories in their final essays while in their beginnings essay they were heavily dependent on the first two categories. Upon the constructivist treatment, the subjects showed the following categories of change in their descriptions: (1) adding new concepts; (2) redefining the formerly stated concepts; (3) forming a complete framework and picture before initiating to conceptualize (define) reading; (4) arriving at an abstractive level of conceptualization; and finally (5) evolving descriptive into explanatory concepts.

Marie (2002) investigated and revealed that the study provides a strong support for a positive relationship between constructivist learning environment and student attitudes, but little support for a direct relationship to student achievement in Algebra and Biology. Multiple regression findings showed that neither overall constructivist-learning environment nor standards-based teaching practices predicted achievement in any of the content areas. Overall, constructivist learning environment and standards-based teaching practices were significant positive predictors of student intrinsic value and learning strategies in all three content areas, after controlling for student and classroom demographic variables. Overall, both the practices were also significant positive predictors of self-efficacy in Algebra.

Tytler (2002) provided some clues about teaching methodologies for constructivist, conceptual change of students. The research on student learning of science conceptions was reviewed and the major findings were presented. Generative learning model and interactive approach were compared and some suggestions were provided to the educators such as
providing students with the opportunities to express their own ideas and providing experience which could relate to students’ prior ideas. Identifying the students’ needs and being aware of their characteristics would help to organize creative and effective environments for meaningful concept learning.

Gary (2001) conducted a research project that determined the measurement of learner characteristics, learner perceptions of the classroom and constructs of the learners. The research study showed that the issues related to the assertion that attainment and retention of knowledge and understanding by students in a middle school science classroom could be achieved with the application of constructivist epistemology. The Learning Environment Survey was used as a measurement tool for this study. 29 students’ responses used for data analysis for the study and although the participants’ response did indicate that the researcher had yet to reach in a fully constructivist manner, it was required that feel more confident about the design and assessment of the teaching and learning process. The paper and pencil test and concept plan showed a variety of prior constructs had been narrowed and the western construction of scientific knowledge and understanding regarding cosmology and astronomy had been successfully hidden out in the student’s cognitive structures.

Ibrahim (2001) conducted research to examine the impact of the guided constructivist teaching method on students' misconceptions about concepts of Newtonian physics. The results of the study indicate that: (i) Guided constructivist group had significantly higher mean than the other group. (ii) Significant relationship was found between achievement, conceptual structures and beliefs about content. (iii) No statistically significant difference was found between the two methods on achievement of males and females. (iv) Greater conceptual learning was fostered when teachers use interactivity based teaching strategies.

Tsai (1999) conducted a study to measure the interplay between students’ scientific epistemological beliefs and their perceptions of constructivist learning environments. 1,176 Taiwanese tenth grade students participated in the study and provided answers to the questionnaire. The main results of this study showed that teachers needed to be aware of students’ epistemological orientation towards scientific knowledge, and to complement the preferences during the designing process of learning experiences, especially providing constructivist based lessons to enhance science learning for students who were epistemologically constructivist oriented.

Sahlstrom and Lindblad (1998) addressed two questions how is student work constructed in the science classroom and how are students' science lessons related to the
construction of their school careers. Using a lesson on magnetic fields as a case analysis, the study reported large differences between the lessons of the two focused students in terms of opportunities for learning both about science and about their social identities. The differences found between the two girls in terms of the development of their grades and their social networks in the class seemed to closely mirrored in the classroom interaction.

Baker and Piburn (1991) investigated the process of constructing science in middle and secondary school classrooms. It was reviewed by Harris (1999) who discussed about how to bring about constructivist learning in a classroom. It was said that constructivist education requires that the learners' prior knowledge be taken into account from the outset — telling them what is correct, just doesn't work. Instead, show them generate those insights in the minds of our students. Textbooks reduce science to its least common denominator on lecture format teaching. Any dialogue that takes place within a single voice is no dialogue at all and is inconsistent with the constructivist perspective. Research was carried out to compare the students' epistemological beliefs of constructivist versus objectivist learning situations by Windschitland Andre (1998). The constructivist approach resulted in significantly greater conceptual change than the objectivist approach for 2 of 6 commonly held alternative conceptions; the other 4 of 6 areas showed no significant differences for treatment group. The treatment interacted significantly with epistemological beliefs. Individuals - with more advanced epistemological beliefs learned more with a constructivist treatment; individuals with less developmentally advanced beliefs learned more with an objective treatment.

Regina (1996) also conducted a study sought to determine the effects of prior knowledge and instructional patterns on academic achievement of 9th grade students (Ausubel, 1960; Tharp and Gallimores, 1988; Flick, Dickinson and Lederman, 2000). The findings of the study were: (i) There was a significant difference in academic achievement found between students with low and high prior knowledge; (ii) There was a significant difference in meta-cognition between students with low and high prior knowledge levels; (ii) There was no significant interaction between prior knowledge levels and instructional patterns on the academic achievement of students in global studies. Related to the above findings, it was also found that during the process of construction of knowledge, there is a change in schema structure. It is explored in the study conducted by Ismael (1999). He investigated the schema structure of students for human evolution, their idiosyncratic conceptual change after visiting a museum exhibition, the role of alternative frameworks during learning, and the function of affect in learning. The research findings provided evidence for museum exhibition developers to embrace a schema-
Richmond and Striley (1996) conducted a study to understand the process by which students solve scientific problems, the difficulties students encounter in developing the requisite pieces of scientific arguments while negotiating their social roles and the ways these roles shape task engagement and the development and articulation of the arguments themselves. The results demonstrated not only that knowledge building involves the construction of scientifically appropriate arguments but that the extent to which this knowledge building takes place depends on students learning to use tools of the scientific community; their expectations about the intellectual nature of the tasks and their role in carrying these tasks out; and the access they have to the appropriate social context in which to practice developing skills.

Henry (1995) conducted the quasi-experimental study to see whether a constructivist-based approach to science instruction could help fifth-grade students improve scientific literacy, revealed that students in classroom that used a constructivist-based approach to science instruction were able to frame research questions, recognize blind alleys, and use science ideas, processes, and inquiry. With regard to creativity, students in the classrooms that used a constructivist-based approach to science instruction demonstrated autonomy, took advantage of serendipitous situations, used local resources and displayed diversity of projects. Students showed independence in conducting projects and positive feelings about science in class and outside of class.

2.3.2 RESEARCHES ON CONSTRUCTIVIST LEARNING:

Abida Khalid (2012) from University of Education, Bank Road Campus Lahore, Pakistan, reported that traditional approach is very common in teaching. It ignores the students and subjects need the context in which the training is progress the mental level of interest of the students. The emerging trends include the constructivist which is moral and more focus on innovative activities and knowledge acquisition. It seems more feasible to follow constructivist approach for the teaching of English at B.Ed. Level and constructivist is more feasible in engaging the students in innovative and creative activities. The purpose of this study is to compare instructional Module based on constructivist approach with the traditional Method in teacher Education at Science college township campus, University of Education, Lahore. This study is delimited to teacher Education at Township campus,
Experiment control groups were equal (32 each). Experiment group was taught with constructivist approach by using a developed module. Pre and post tests were used to see the difference in two groups. T-test was used to check the significant difference between experiment and control group after experiment. It is explored that both the groups were equal regarding their achievement scores in teaching of English communication before the experiment but after experiment both were different in their achievement. It is concluded that this significant performance of experiment group may be due to teaching student teachers of experimental group with constructivist approach.

Serkan Narli (2010) of Dokuz Eylul University, Izmir, Turkey, investigated the long-term effects of instructing Cantor set theory using constructivist learning approach on student knowledge retention. The participants included 60 first-year secondary mathematics preservice teachers. Students were divided into two classes one of which was taught via traditional lecture (n = 30) and the other was taught using active learning approach (n = 30). A pre-test named “minimum Requirements Identification Test” developed by the researcher was used in the determination of the groups. This test involves the concepts such as “set, relation, and function” which were required to be able to learn Cantor set theory. Student retention of Cantor set theory was measured by using a questionnaire which consists of open-ended questions about the topic. The test was administered to all of the students approximately 14 months after the first instruction. In addition, five students from each group were interviewed. Analyses of the data revealed that the students in the constructivist learning environment showed better retention of almost all of the concepts related to Cantor set theory than the students in traditional class.

Moore, Nancy M (2010) from Capella University, reported that the dynamic workforce today’s students will be entering demands employees with solid mathematical understanding, skills for analyzing and solving problems, communication skills, and the ability to work on flexible and cooperative teams. U.S. students are not leaving school prepared to be successful meeting these requirements. Studies have found that using constructivism increases achievement, intrinsic motivation, and self efficacy. Further student-student interdependence, if structured carefully and appropriately, results in students having a higher value for the subject area, having higher achievement motivation, being more intrinsically motivated, putting forth more effort, persisting longer, using higher level reasoning strategies more frequently, and achieving at a higher level. They also have higher
self-esteem, develop interpersonal relationships with each other, and become more socially skilled. This study used constructivism and extensive interdependent group work using quantitative and qualitative analysis of surveys, self-assessment surveys, interviews, discussions, and observations. Students actively participated in scaffolding activities that culminated in a real world, complex, problem-solving project demonstrating that student achievement, self-efficacy, intrinsic motivation, and group work skills in the middle school mathematics classroom were positively affected. Testing found memory questions improving least while logic and justification questions had significant change. Turnover in the top and bottom 25% of students was high, all those with over 100% growth were quartile 1 or quartile 2 pretest, and the lowest 15 students using Z scores had over 100% change. Other results indicate that student attitude, confidence, and perseverance all increased. They used better cognitive strategies, less avoidance strategies, were willing to do extra work, felt successful, and were involved. They discussed ideas, cooperated, negotiated, encouraged each other, critiqued constructively, asked for and gave help, and made friends. Finally, they focused longer and set goals and deadlines. All these results support current research for using a constructivist learning environment with extensive group work.

Akar, Hanife (2003) the 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 show 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. The conceptual change the learners went through was evident in their metaphorical images which tend to change from a more controlling image to images that depict leadership, sensitivity to individual differences, and student learning. Descriptive findings indicate that retention was fostered through constructivist activities that mainly included reflective writing, critical thinking, and problem solving. Factors such as active learning, meaningful and enjoyable learning environment, and the attitudes of instructors had a positive impact on student learning. Nevertheless, the load of reflective diary writing and portfolio preparation tasks, and
collaborative work could be overwhelming and discouraging and these impacted negatively on learners’ attitudes towards the course.

Sebela, MokgokoPetrus (2003) at Curtin University of Technology, Science and Mathematics Education Centre examined whether teachers in South Africa could use feedback from a learning environment instrument to help them to increase the degree to which they emphasized constructivist-oriented teaching strategies in their classroom. The study also investigated the validity of a widely-applicable classroom environment questionnaire, as well as associations between attitudes and classroom environment. The study involved a combination of quantitative and qualitative research methods and was carried out in two phases. In the first phase of the study, data were collected using the Constructivist Learning Environment Survey (CLES), to assess learners’ perceptions of the constructivist learning environment, and an attitude scale to assess learners’ attitudes towards their mathematics classroom. The instruments were administered to 1864 learners in 34 intermediate (Grades 4 - 6) phase and senior phase (Grades 7 - 9) classes. Data were analyzed to determine whether (a) the CLES is valid and reliable for use in South Africa and (b) relationships exist between learners’ perceptions of the learning environment and their attitude toward their mathematics classes. Descriptive analysis was used to generate feedback information for teachers based on graphical profiles of learners’ perceptions of the actual and preferred learning environment for each class. Analyses of data collected from 1864 learners in 34 classes supported the factor structure, internal consistency reliability (Cronbach alpha coefficient), and discriminant validity of the CLES, as well as its ability to differentiate between classes. The results suggest that researches and teachers can be confident about using the modified version of the CLES in mathematics classes in South Africa in the future. Simple correlation and multiple regression analyses were conducted to examine whether associations exist between learners’ attitudes towards their mathematics class and their perceptions of the learning environment. The results indicated that student attitudes were associated with more emphasis on all four CLES scales used. The posttest graphical profiles indicated that there was a sizeable improvement in teachers’ emphasis on CLES dimensions in their classroom. Apparently, teachers using action research are able to use learners’ responses to the CLES to develop and implement strategies for improving their learning environment. The study suggests that journal writing, as a tool used by teachers on a daily basis, can improve their professional expertise as reflective practitioners.

Fok Po Yan at the University of Hong Kong examined the effectiveness of creating a constructivist environment in learning Economics on the development of a deep approach to
learning among students with different learning abilities. Two experimental groups of students with different learning abilities were taught Economics by a constructivist approach in three months, whereas, one control group of students were taught by a traditional approach. The LPQ and CLES were used to measure the approaches to learning and the perception of the constructivist learning environment respectively. The results showed that the high-ability students were likely to development a deeper motive in learning than the low-ability students in a constructivist learning environment. However, both the experimental groups showed no significant change in the deep strategy in learning. It was encouraging to find out that those students who could perceive a higher degree of constructivist learning environment were likely to develop a deeper approach to learning. There were no significant correlations between the academic results of Economics and the perception of constructivist learning environment and the changes in the deep approach to learning respectively. The traditional quantitative assessment system might be inappropriate to measure the qualitative learning outcomes resulted from a deeper approach to learning under the constructivist learning environment.

2.3.3 RESEARCHES ON PROCESSING SKILLS:

J.N. Ambross(2012) sought to evaluate the implementation and development of basic science process skills by four grade 4-7 educators at classroom level at a primary school in the northern areas of Port Elizabeth. Qualitative data for this evaluation were collected through educator interviews, classroom observation as well as a focus-group interview. Quantitative data were gathered by means of a Science Process Skills Observation Scale and through examining the learners’ assessment activities. An Assessment Activity Science Process Skill Rating-Scale was used to evaluate assessment activities. Data generated from this study were carefully analyzed and on the basis of their interpretation it was concluded that the implementation and development of science process skills were strongly influenced by the educators’ understanding of these basic concepts, the belief held by each educator about their role and how their learners learn, the presence of quality support and effective training programmes as well continuous professional development.

Murat Demirbas and GulsahTanriverdi aimed to determine the science process skills of 2010-2011 academic year Science Teaching Department freshmen students in Turkey who are taking the laboratory course, Phisics-1. Test of Integrated Science Process Skills developed by Burns, Okey and Wise (1985) has been translated into Turkish by Geban, Askar
and Ozkan, (1992), and it consist of 36 multiple-choice questions with four choices per question. It has been administered to 556 freshmen students at total from Science Teaching Department in randomly chosen universities from seven regions of turkey, and it includes the following sections: recognizing the variables in a problem (12), hypothesizing and describing (8), making operational explanations (6), designing required surveys for problem solving (3), drawing a graph and interpreting data (6). After validity and reliability analyses, it has been found that item discrimination (D) is 0.08 and more, and item difficulty (P) is between 0.1 and 0.93. Average difficulty of the test (Pavg) has been calculated to be 0.52. The data from the students’ answer have been analyzed using the SPSS software. The science process skills of the students from seven different universities have been identified separately, then, a generalization has been made on students at Science Teaching Department from the universities in Turkey.

A.M. Rambuda and W.J. Fraser (2010) studies about the teachers’ perceptions of the application of science process skills in the teaching of Geography in secondary schools in the Free State province. A teachers’ questionnaire on the application of the science process skills in the teaching of Geography was constructed and the questionnaire was content validated against the theoretical assumptions supported by the literature and practical applications of the subject. The questionnaires were distributed to 150 respondents and 71 completed questionnaires were returned for further analysis. The responses to the items of the questionnaire were subjected to a principal component factor analysis and a varimax method of rotation. Two prominent factors were identified and investigated. Factor 1 was labeled “basic science process skills” and reaffirmed teachers’ understanding of the basic process skills as autonomous and independent functions. The second factor confirmed the existence of a higher level of advanced and integrated process skills that build upon the basic or foundational process skills. These results confirmed the researchers’ assumption that respondents could distinguish cognitively between these two very prominent constructs. They were comfortable with the science processes applicable to the teaching of Geography could be grouped into two main distinctive clusters or factors. The homogeneous clustering of items also emphasized the understanding that the classical science process skills could easily be applied to the teaching of Geography. This assumption was supported by the empirical investigation and findings. In addition, the result supported the hypothesis that although teachers did not apply integrated science process skills to the teaching of Geography on a regular basis, they were well-acquainted with the fact that these skills remain an important facet in the teaching of Geography in schools.
Nurhan Ozturki, Ozden Tezel and M. Bahaddin (2010) studied to determine the science process skill achievement level of primary school seventh grade students in a Science and Technology lesson and relations among academic background of the parents, monthly income of the parents, having a computer, having own room and students’ science process skill levels. To this end, “Science Process Skills Test (SPST)” was prepared and used as a data collection means by the researchers. The Cronbach Alpha reliability coefficient of the test was found 0.88. The sample of the study consist of 828 seventh grade students from 21 primary schools which are chosen by chance from Kocaeli Province Center (within Turkey). Scanning model has been used in the study. The data were analyzed by using frequency, percentage, arithmetic average, standard deviation values, and t-test and ANOVA analyze techniques. According to the research findings, it was found that students’ science process skill levels were in middle level. As a result, primary school seventh grade students’ science process skills level did display differences according to parents’ academic background, their monthly income, having a computer, having own room, but the students’ SPS do not change in terms of gender.

Phramaha Charoen Buntod, PaitunSursringam and AdisakSingseevo (2010) aimed to investigate and compare effects of learning environmental education by wises of two approaches: The 5 E-Learning cycle with meta cognitive techniques and the teachers’ handbooks, on learning achievement, basic science process skills and critical thinking of 75 Mathayomsuksa 3 (grade 9) students with different learning achievements. They were assigned to an experimental group with 38 students who learned using the 5 E-Learning cycle with met cognitive techniques and a control group with 37 students who learned using the teachers’ handbook approach. Instruments used in the study included (1) 6 plans of learning organization using the 5 E-Learning cycle with 3 met cognitive techniques: Intelligibility, plausibility and wide applicability, 6 plans of learning organization using the teacher’s handbook, approach; each plan for 3 h of learning in each week; (2) the learning achievement test with 40 item; (3) the test on basic science process skills with 8 subclass and 40 items and (4) the critical thinking test with 5 subclass and 54 items. The data were analyzed by the uses of a percentage, mean, a standard deviation, the paired t-test and the f-test (two-way MANCOVA). The whole students, The high achievers and the low achievers in the experimental group showed gains in learning achievement, basic science process skills in general and in 3-6 subclass and critical thinking in general and in 4-5 subclass from before learning at the 0.05 level of significance. The experimental group indicated more learning achievement, basic science process skills in general and in 2 subclass: Process skills in
general and in 2 subclass: Measuring and predicting and critical thinking in general and in 1 subclass: interpretation, than the control group at the 0.05 level of significance. The high achievers showed only higher basic science process skill in general and in 3 subclass: Using space-time relationship, classifying and predicting, more than the low achievers at the 0.05 level of significance. The statistical interactions of learning achievement with learning model on learning achievement and critical thinking were not found to be significant. Whereas, the interaction of these two variables on basic science process skills in general and in 3 subclass: Measuring, classifying and predicting were found to be significant at the 0.05 level. The 5 E-Learning cycle with met cognitive techniques could develop efficiently learning achievement, basic science process skills and critical thinking of the students. The teachers, therefore, should be encourage and supported to implement this approach in teaching and learning environmental education in all grade levels.

2.3.4 RESEARCHES ON META-COGNITION:

Mir Mohammad Seyedkalan (2012) at Department of Humanities, Germi Branch, Islamic Azad University, Germi, Iran compared the effectiveness of cognitive and metacognitive strategies teaching on the amount of using ICT among Payam Noor university of Ardabil province. The research hypotheses were as following: cognitive strategies instruction has an influence on the value of using information communication and technology, ICT; and metacognitive strategies teaching exerts an effect on the value of using ICT. Sixty participants who were randomly selected and divided into three conditions of cognitive, metacognitive and control group, involved in the entire students (both men and women) of Payam Noor university of Ardabil province, Iran. The design of the study was quasai experimental multi group pretest and posttest. The instrument applied was a researcher made test which was composed of seven IDCL skills. First all three groups were given a pretest then were trained some cognitive and metacognitive strategies ending up with a posttest. ANOVA and ANCOVA statistical tools were used to analyze the data. Result indicated a meaningful relationship between cognitive strategy teaching and the students’ application of information technology and communication. There was no meaningful relationship between metacognitive strategy teaching and the application of information technology and communication. No remarkable difference was seen between the results of pretest and posttest of control group.
Fazalur Rahman, Allama Iqbal (2010) Open University, Pakistan studied the impact of metacognitive awareness on students’ performance has been examined in the present study. 900 students of grade X participated in the study. Metacognitive awareness was measured using inventory, while performance of students was measured with the help of researcher made test in the subject of chemistry. Results indicated that metacognitive awareness was significantly correlated with the performance of students. The highly metacognitively aware science students performed well on the test. Results further indicated that there was no significant difference in the metacognitive awareness of male and female students.

Fatemeh Takallou (2008) at Payame Noor University, Iran suggested that if learners have an important role in new teaching methodologies, raising their awareness of learning strategies and helping them utilize these strategies is a crucial aim of teachers. One type of these learning strategies is metacognitive strategies including planning, self-monitoring and self-evaluation. The present study aimed at examining the effect of metacognitive (planning and self-monitoring) strategy instruction on EFL learners’ reading comprehension performance (on authentic and inauthentic texts) and their metacognitive awareness. To this end, two tests (TOEFL and a reading comprehension test) and Strategy Inventory for Language Learning (SILL) were administered to 93 male and female EFL learners in four phases of this study. At the first phase, TOEFL was administered to all the students both to homogenize students reading language proficiency and to validate the reading comprehension test. At the second phase, SILL was administered to two experimental and one control groups before strategy instruction. SILL assesses the frequency with which the subjects use a variety of techniques for foreign language learning. At the third phase, two experimental groups received five sessions of instruction on metacognitive strategies, one on planning and the other on self-monitoring strategy based on the Cognitive Academic Language Learning Approach (CALLA). Both experimental and control groups worked on authentic and inauthentic texts (some articles from Readers’ Digest and Skillfully III). At the forth phase, after completion of instruction, the reading comprehension test and SILL questionnaire were administered to all groups. Data analysis revealed that two experimental groups which received instruction on ‘planning’ and ‘self-monitoring’ outperformed the control group on the reading comprehension test. Moreover, text type played an important role in the subjects’ reading comprehension. The subjects performed better on authentic texts. In addition, the results showed that experimental groups’ awareness to metacognitive strategies significantly
increased after instruction. The findings of the present study have implications for learners, teachers, and textbook writers in the realm of TEFL in particular and education in general. ZhengxiaoBian at Central China Normal University (2007) studied about the feasibility study of metacognitive strategy used in the teaching and learning of English reading in the senior middle school on the basis of the literature review. According to the theory put forward by Chamot and O’Melly(1994), the author presents a suggested framework for the training of the reading strategy in the daily English teaching, namely, to teach the students to learn the metacognitive knowledge gradually, develop the metacognitive awareness of the senior school students, enrich the metacognitive experiences, put the metacognitive supervision in effect and enhance the use of metacognitive strategy in everyday teaching, aiming at making the students independent learners. The situation of teaching and learning of reading in this research came from an interview. In the experiment, two classes are set, in which there are 60 students in the experimental class while there are 57 students in the controlling class. Training of reading strategy is done in the experimental class while the controlling class is given the class in the usual way. At the end of the term, the author collects the data and compares the scores of reading comprehension of the two classes. The result shows that explicit training metacognitive strategy can improve the students’ reading ability. Allowing for the disadvantages of the research, the thesis offers three suggestions with the hope of improving the credibility and validity of the following research: 1. The relevant department should provide the teachers with the training of the metacognitive strategy. 2. The government should provide enough policy and fund to support the teachers’ training. 3. In the teaching of English reading, teachers will be always acting as a good source of guidance.

Hwa Tee Yong and Lau NgeeKiong of Mara University of Technology Malasiya (2005) stated that if students are to excel on both the routine mathematics skills and problem-solving skills, teachers must place emphasis on both the mathematical contents and the mathematical processes in the teaching and learning of mathematics. This paper presents the theoretical rationale and the importance of metacognition to the learning of mathematics. A project was conducted on students of around sixteen years of age and the findings indicated that students did employ the four phases of problem solving emphasized by George Polya. However, students fared better when they regulated their thinking process or employed metacognitive skills in the process of solving mathematics problems. This paper also suggests the strength of a mixed methodology in doing research by expanding an understanding from one methodology to another, and converging findings from different data sources.
Claudia Amado Gama of University of Sussex (2004) puts forth a metacognition instruction model, named the Reflection Assistant (RA), that focuses on the following metacognitive skills: (1) problem understanding and knowledge monitoring, (2) selection of metacognitive strategies, and (3) evaluation of the learning experience. The RA automatically builds a metacognitive profile of the students based on two measures: knowledge monitoring accuracy (KMA) and knowledge monitoring bias (KMB). The KMA measures the accuracy student’s knowledge monitoring. The KMB detects any systematic bias the students might exhibit in her knowledge monitoring, enabling us to categorize students as pessimistic, optimistic, realistic or random. We tested the RA model by implementing a full ILE for algebra word problems called MIRA. The experimental version of MIRA included an implementation of the RA while the control version did not. An empirical study conducted with 27 undergraduate students showed that students who performed the reflective activities spent more time on task and gave up on fewer problems. Moreover, this group answered significantly more problems correctly than the control group. Evidence of a positive effect of the RA model on the students’ metacognition was observed. These results suggest that the RA model was beneficial for the learning process.

2.3.5 REVIEWS OF CONCLUSIONS DRAWN FROM THE STUDIES DONE ON CONSTRUCTIVIST TEACHING:

- The study to measure the interplay between students’ scientific epistemological beliefs and their perceptions of constructivist learning environment showed that teachers needed to complement the preferences during the process of designing learning experiences based on constructivist lessons.
- The study about comparison between constructivist instruction approach and traditional instruction in teaching chemistry chemistry showed that constructivist instructional approach is more effective in learning chemistry.
- The research about building mathematical understanding by using constructivist teaching approach indicated that the teaching and learning process is influenced positively by constructivist approach and collaborative learning supported to built mathematical understanding.
- The study to develop constructivist approach experiments to determine its effectiveness in teaching physics concepts showed that the constructivist approach
experiments were effective in enhancing students’ achievement and in developing a more positive attitude towards the subjects.

- The study to develop sets of materials and strategies to support argumentations was an effective strategy in teaching science.
- The study to verify the feasibility of designing short teaching sequences in teaching and learning science showed that the use of student centered instructional strategies increased students’ motivation and change students’ perceptions in science education.
- Researches on effective teaching practices for students with and without learning difficulties supported constructivist instructional practices.
- The research about effects of constructivist learning activities on trainee teachers’ academic achievement and attitudes stated that constructivist learning activities enabled the students to become more successful and to develop positive perceptions.
- The study about effectiveness of constructivist science instructional methods on middle school students’ achievement and motivation suggested that the best method of science instruction was a constructivist method that potentially increased students’ achievement in science by providing social and scientifically literate work force.
- The study about effect of constructivist teaching strategies on science test scores of middle school student stated that students’ achievement in science improved due to positive social change brought by constructivist approach.
- The study about effect of constructivist instructions on attitude towards democracy among Thai college students stated that significant positive gain in attitude towards democracy in Thai students due to constructivist instructions.
- The research about effect of a Constructivist-Based Mathematics Problem Solving Instructional Program on the achievement of grade five students suggested that the implementation of social constructivist activities in teaching need careful examination of constructivist activities on performance.
- The research about classroom teachers’ perceptions about constructivist curriculum and implementation of constructivist teaching and learning activities revealed that classroom teachers were open to change and often implemented constructivist teaching and learning activities in class.
- The research about implementation of constructivist approach among chemistry students. Result stated that microteaching class is the major factor influencing student teachers to implement constructivist approach in their teaching.
2.3.6 REVIEWS OF CONCLUSIONS DRAWN FROM THE STUDIES ON CONSTRUCTIVIST LEARNING:

- The research project that determined the measurement of learner characteristics, learner perceptions of the classroom constructs of the learners showed that the issues related to the assertion that attainment and retention of knowledge and understanding by students in science classroom could be achieved with the application of constructivist epistemology.

- The research on students learning of science conceptions by providing students with the opportunities to express their own ideas and experiences which could relate to students’ prior ideas helped students to organize creative and effective environments for meaningful concept learning.

- An open ended constructivist project with the aim of fostering critical thinking skills, creating independent and motivated learners showed that students were engaged in the constructivist approach to learning.

- The study about impact of constructivist learning process on pre-service teacher education students’ performance, retention and attitudes in classroom management course indicated that retention was fostered through constructivist activities.

- The study to develop students’ conceptions of L2 reading as an important skill by using constructivist approach showed very useful and positive change in students’ conceptions of L2 reading skill.

- The study to investigate long term effects of instructing Cantor Set Of Theory using constructivist learning approach on student knowledge retention revealed that the students in the constructivist learning environment showed better retention of almost all the concepts related to Cantor Set Theory than the students in the traditional class.

- The study aimed to investigate and compare effects of learning environmental education by using 5-E Learning cycle with meta cognitive techniques and by using teachers’ handbook on learning achievement showed significant gain in learning achievement of students’ who taught by using 5-E Learning cycle.
The comparative study of instructional module based on constructivist approach and traditional approach in teacher education at science college showed that constructivist approach facilitate strong learning environment than traditional instructional approach.

2.3.7 REVIEWS OF CONCLUSIONS DRAWN FROM THE STUDIES ON PROCESSING SKILLS:

- The comparative study of learning environmental education, basic science process skills and critical thinking by 5-E Learning cycle with met cognitive techniques and by using teachers’ handbook indicated that the experimental group taught with 5-E Learning cycle showed significant gain in basic science process skills.

- The study to determine the science process skills achievement level of primary school seventh grade students in a science and technology lesson showed that students’ science process skill levels did display differences according to parents’ academic background, their monthly income, having a computer and having own room.

- The study about teachers’ perceptions of application of science process skills in teaching of Geography in secondary schools in free state province supported the hypothesis that although teachers did not apply integrated science process skills to the teaching of Geography on regular basis, they were well-acquainted with the fact that these skills remain an important facet in technology of Geography in schools.

- The study to determine the science process skills of freshmen students of science teaching department in Turkey by using science process skill test indicated that students who applied hypothesizing, describing etc. skills were show significant gain in achievement in laboratory course, Physics-1.

- The study to evaluate the implementation and development of basic science process skills by four grade 4-7 educators at a primary school on Port Elizabeth concluded that implementation and development of science process skills were strongly influenced by the educators who have basic concepts of science process skills.

2.3.8 REVIEWS OF CONCLUSIONS DRAWN FROM THE STUDIES ON META-COGNITION:

- The metacognition instruction model named as Reflection Assistant prepared to focus on metacognitive skills of undergraduate students showed that students who
performed the reflective activities answered significantly more correctly than the control group.

- The study to present the theoretical rationale and importance of metacognition to the learning of mathematics of students of around sixteen years of age indicated that students employed four phases of problem solving better when they regulated their thinking process or employed metacognitive skills in the process of solving mathematics problems.

- The study about feasibility study of metacognitive strategy used in the teaching and learning of English reading in the senior middle school on the basis of the literature review showed that explicit training metacognitive strategy can improve the students’ reading ability.

- The study aimed at examining the effect of metacognitive (planning & self-monitoring) strategy instruction on EFL learners’ reading comprehension performance (on authentic and inauthentic texts) and their metacognitive awareness showed that experimental groups’ awareness to metacognitive strategies significantly increased after instruction.

- The study to examined the impact of metacognitive awareness on students’ performance showed that metacognitive awareness was significantly correlated with the performance of students. The highly metacognitively aware science students performed well on the test. Results further indicated that there was no significant difference in the metacognitive awareness of male and female students.

- The study to compare the effectiveness of cognitive and metacognitive strategies teaching on the amount of using ICT indicated that there was no meaningful relationship between metacognitive strategy teaching and the application of information technology and communication.

2.3.9 OVERALL REVIEWS OF CONCLUSIONS DRAWN FROM ALL RESEARCHES:

From the overall study of all researches on constructivist teaching it could be concluded that in the ending of 20th century and in the very early years of 21st century most researches done on constructivist approach focused on students’ and teachers’ perceptions about constructivist teaching and learning approach. For the sake of implementation of constructivist teaching approach in the classroom researches done on comparison between
constructivist teaching approach and traditional teaching approach. Now a days researchers focused on implementation of constructivist instructions in the classroom mostly in the science classroom.

The conclusion made from the researches done on constructivist learning indicated that in the beginning of 21\textsuperscript{st} century most researches done to provide such opportunities to students by which they could express their own ideas and experiences in learning. As time passed out researches done to strengthen students’ conceptions about learning in very positive manner and to set up long term learning effect by providing constructivist experiences. The comparative studies were made about constructivist learning and traditional learning environment. Now a days educators’ aimed to develop constructivist learning environment in the classroom.

From the studies on processing skills and meta-cognitive skills conclusion drawn out that processing skills and meta-cognitive skills inculcated in students very positive and effective way if their teaching and learning supported by constructivist approach.

2.4 IMPORTANCE OF THE PRESENT RESEARCH:

From the present research the comparison between traditional teaching approach and constructivist teaching approach was made by the researcher. From the present research the effectiveness of constructivist teaching approach on four phases of learning (information getting, applying, analyzing and creating) in science at primary level was examined. From the present research the effectiveness of constructivist teaching approach on students’ science processing skills like recalling, comparing, classifying and imagining in learning science at primary level was known. From the present research the effectiveness of constructivist teaching approach on students’ meta-cognitive skills in learning science at primary level was examined.