EFFECT OF SOCIAL CONSTRUCTIVIST STRATEGIES ON ACHIEVEMENT IN SCIENCE, CRITICAL THINKING AND SOCIAL MATURITY OF SECONDARY SCHOOL STUDENTS

Major Research project Report

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ACHIEVEMENT IN SCIENCE AND CRITICAL THINKING OF SECONDARY SCHOOL STUDENTS

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ABSTRACT

The present study was conducted to examine the Achievement in Science and Critical thinking of Secondary school. Survey method was adopted for the study. Achievement test and Critical thinkingTest, both constructed by the investigator was used for Collection of data. t-test and Pearson Product Moment Correlation Techniques were used for analysis of the data. The result showed that there is no significant difference between male and female students with respect to Achievement in Science and Critical Thinking, A positive but insignificant relationship was found to exist between Achievement in Science and Critical Thinking of Secondary school students.

KEYWORDS: *Survey method , t-test and Pearson Product Moment Correlation Techniques , Critical Thinking.*

1. INTRODUCTION:

In today's rapidly changing global knowledge economy, driven by information and communication technology,a child has to be able to deal with changes quickly. The rapid changes demand logical and critical thinking skills that could help an individual in analyzing information and the credibility of the sources of information and use them to accumulate and accommodate more information to solve problems of life efficiently . Critical thinking helps individuals to justify their value systems.

A citizen of a large democratic country like India should critically think of social issues without prejudice and take well informed, unbiased judgements through critical evaluation of evidences and facts. Hence the educational policies and programmes are channelized towards enhancement of critical thinking skills and to improve the achievement levels of its students. The educational system too, is making attempts to rapidly adopt its Science curriculum and its aims and objectives to accommodate itself to the rapidly changing demands of the knowledge era. In addition to aiming at improving the achievement in science of students it is also aiming at developing higher order critical thinking skills in them.

1.1 Critical Thinking: Critical thinking is purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference as well as explanation of the evidential, conceptual, methodological or contextual considerations upon which that judgment is based. Critical thinking is the ability to recognize problems, to find workable means for meeting those problems, understand the importance of prioritization and order of precedence in problem solving, gather relevant information, interpret data to appraise evidence and evaluate arguments, recognize the existence (or non-existence) of logical relationships between propositions, draw warranted conclusions and generalizations, put to test the conclusions and generalizations at which one arrives and render accurate judgments about specific things and qualities in everyday life.

Critical thinking is "the mental processes, strategies, and representations people use to solve problems, make decisions, and learn new concepts" (Sternberg, 1986, p. 3).

It refers to "Seeing both sides of an issue, being open to new evidence that disconfirms your ideas, reasoning dispassionately, demanding that claims be backed by evidence, deducing and inferring conclusions from available facts, solving problems, and so forth" (Willingham, 2007, p. 8).

Critical thinking encompasses specific abilities like analyzing arguments, claims, or evidence (Ennis, 1985; Facione, 1990; Halpern, 1998; Paul, 1992); making inferences using inductive or deductive reasoning (Ennis, 1985; Facione, 1990; Paul, 1992; Willingham, 2007); judging or evaluating (Case, 2005; Ennis, 1985; Facione, 1990; Lipman, 1988; Tindal &Nolet, 1995); and making decisions or solving problems (Ennis, 1985; Halpern, 1998; Willingham, 2007).

1.2 Achievement in Science:

The main aim of teaching of science at secondary school level is to enhance the understanding of students' about the concepts and processes of science which include four components viz., (a) scientific understanding; (b) scientific investigation; (c) scientific communication; and (d) habits of mind. Achievement in Science refers to the accomplishments of students with reference to the acquisition of knowledge and understanding of students in relation to concepts and processes of science. It indicates to what students know, understand, and are able to do in natural science.

It is a widely known fact that teaching of science in secondary schools aims at improving Achievement in science and critical thinking among its students.

2. NEED AND IMPORTANCE OF THE STUDY

Educators have long been aware of the importance of critical thinking skills in leading an effective work life. Critical thinking is identified as one of several learning and innovation skills necessary to prepare students for post-secondary education and the workforce by the Partnership for 21st Century Skills. Common Core State Standards too reflect critical thinking as a cross-disciplinary skill vital for college and employment. Kennedy, et al. (1991) in their survey of the research literature concluded that, even young children can benefit from critical thinking instruction, though critical thinking ability appears to improve with age.Past research has demonstrated that students' reasoning and critical thinking can indeed be affected by classroom practices and task structures (Ames & Archer, 1988; McKeachie, 1986; Nolen, 1988; Smith, 1977). Cooperative learning and group discussion were found to promote increased use of higher order skills and higher reasoning strategies. Task structures such as focused discussion, student-led seminars, problem-based learning and role play have been shown to enhance critical thinking.

Although individuals with critical thinking ability and those possessing the knowledge and understanding of concepts of science and science processes are proving to be assets of this knowledge driven society, research on developing these abilities in children are far and few. In spite of the persistent attempts being made to enhance achievement in science and critical thinking abilities in children of secondary schools, very few students are found to exhibit and apply them in their life. In this context, it is more urgent and crucial that a systematic baseline study had to be embarked on to investigate the level of critical thinking and achievement in science and whether gender differences contributed to differences in these abilities.

3. STATEMENT OF THE PROBLEM

The study has been entitled as,

"Achievement in Science and Critical thinking of Secondary school students".

4. OBJECTIVES OF THE STUDY

The following are the objectives of the study:

- To find whether there is any significant difference in Achievement in Science of male and female students

- To find whether there is any significant difference in Critical Thinking of male and female students.
- To study the relationship between Achievement in Science and Critical thinking of Secondary school students.

5. HYPOTHESES OF THE STUDY

The following are the hypotheses of the study:

- There is no significant difference in Achievement in Science of male and female students.
- There is no significant difference in Critical Thinking of male and female students.
- There is no relationship between Achievement in Science and Critical thinking of Secondary school students.

6. VARIABLES OF THE STUDY

Main variables: Achievement in Science
Critical Thinking.

Background Variable: Gender

7. METHODOLOGY

Survey method was adopted for the study.

8. SAMPLE OF THE STUDY

The sample of the study comprised of 100 students from secondary school of Mysuru city selected by using simple random sampling technique.

9. TOOLS USED FOR THE STUDY

- **Critical Thinking Test:** Critical thinking test designed and constructed by the Investigator was used to collect the data. The Critical thinking Test consisted of 35 Multiple Choice Questions covering eight areas namely Analysis, Applying standards, Information seeking, Logical reasoning, Transforming knowledge, Inference, Decision making and Discrimination. The correct answer for every item was given a score of one thus making the maximum total score equal to 35.
- **Achievement test in Science:** Achievement test in Science was designed and developed by the Investigator. The Achievement test in Science consisted of 46 Multiple Choice Questions and one short answer question for a total score of 50. The test was constructed based on the content of Ninth standard Science text book covering the concepts related to Matter in our surroundings, Motion, Force and Laws of Motion, Gravitation, Work and Energy, Sound and Natural Resources.

10. COLLECTION OF DATA

Two schools were selected randomly and hundred students from these two schools formed the sample of the study. The investigator personally administered the Achievement Test in Science and Critical thinking Test to the students.Before administering the Tests to the students were informed about the tool and were given clear instructions to answer the tests .

11. STATISTICAL TECHNIQUES EMPLOYED

t-test and Person Product moment Correlation technique were used to analyse the data.

12. ANALYSIS AND INTERPRETATION OF DATA

HYPOTHESIS 1:

There is no significant difference Achievement in Science of male and female secondary school students

Table No.1: Summary table of 't' test of Achievement in Science of male and female students.

Variables		N	Mean	SD	*'t' value*	df	Significance
Gender	Male	50	37.4600	6.96115	1.62	98	NS
	Female	50	39.6600	6.63513			

Table No.1 shows that the obtained 't' value 1.62 is less than the tabled value at 0.05 level. Hence, the null hypothesis 1 is accepted and it is concluded that there is no significant difference between male and female students with respect to Achievement in Science.

HYPOTHESIS 2:

There is no significant difference in Critical Thinking of male and female secondary school students

Table No.2: Summary table of 't' test of Critical Thinking of male and female students.

Variables		N	Mean	SD	*'t' value*	df	Significance
Gender	Male	50	31.3400	1.95469	0.66	98	NS
	Female	50	31.5800	1.66709			

Table No.2 shows that the obtained 't' value 0.66 is less than the tabled value at 0.05 level of significance. Hence, the null hypothesis 2 is accepted and it is concluded that there is no significant difference between male and female students with respect to Critical Thinking.

HYPOTHESIS 3:

There is no significant relationship between Achievement in Science and Critical Thinking of Secondary school students.

Table No 3:Table showing variables, N,df, co-efficient of correlations and the level of significance between mean Achievement in Science and Critical Thinking of Secondary school students.

Variable	N	Df (N-2)	R	Level of Significance
Achievement in Science	100	98	0.05	NS
Critical Thinking				

The data in the above table shows that obtained 'r' value of 0.05 is positive but not significant. Therefore null hypothesis 3is accepted it is concluded that there is positive but insignificant relationship between Achievement in Science and Critical Thinking of Secondary school students.

13. FINDINGS OF THE STUDY

The following are the findings of the study:

- There is no significant difference in Achievement in Science of male and female students.
- There is no significant difference in Critical Thinking of male and female students.
- There is a positive but insignificant relationship between Achievement in Science and Critical Thinking of Secondary school students.

14. CONCLUSION

Today one of the criteria for success in life and academics is the ability to think independently and logically.Thus the vital goal of today's education is to promote critical thinking in students, and not make them retailers of knowledge.Critical thinking promotes effective communication with people and ability to find solutions for complex problems. It is the most valued personal asset in this knowledge era. Hence educational programmes and strategies should aim at training the young minds with critical thinking skills in a tender age.

15. REFERENCES

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CRITICAL THINKING AND SOCIAL MATURITY OF SECONDARY SCHOOL STUDENTS

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ABSTRACT

The present study was conducted to investigate the relationship between Critical thinking and Social Maturity of secondary school students. Survey method was adopted for the study. 100 Secondary school students in Mysore formed the sample for data collection. Critical thinking Test, constructed by the investigator and Nalini Rao's Social Maturity Scale were used as tools for collection of data. t-test and Pearson Product Moment Correlation Techniques were used for analysis of the data. The result showed that male and female secondary school students do not differ significantly with respect to Critical Thinking. No significant difference was found between male and female students with respect to Social Maturity, There is no significant relationship existing between Critical Thinking and Social Maturity of Secondary school students.

KEY WORDS: *Critical thinking and Social Maturity , t-test and Pearson Product Moment Correlation Techniques.*

1. INTRODUCTION

The present education system is aiming at preparing students to live in a modern, technological and globalized world. Educators in this digitalized era are concentrating on enhancing higher order thinking skills in adolescent students. As students move to secondary and higher secondary school, they need to apply the information they have stored on their day to day life. The students as they grow into adults need to solve daily life problems andrequire higher order thinking skills to lead a quality life.Hence the objectives of teaching in secondary school clearly propagates the development of critical thinking among students. Various methods of teaching are being promulgated to enhance critical thinking skills among students.

Since children have to live in the society with other fellow beings, they should learn to communicate and coexist with them. This needs them to acquire social skills and exhibit socially mature behavior and it is the responsibility of our educators to imbibe these social behaviours in children at an early age. This could be conceivable if appropriate strategies of teaching are adopted to teach various subjects in schools. Hence NCERT in its National Curriculum Framework 2005 insists on adoption of social constructivist strategies on secondary schools to develop social skills.

1.1 Critical thinking: is thinking on a level that is higher than memorizing facts or recalling and repeating exactly the information he has stored in his brains without having to think about it. The students need to do understand the facts and information he receives, infer from them, connect them to other facts and concepts, categorize them, and apply them as he seeks new solutions to new problems. Whatever be the area of work, be it education, or day to day activities it is obvious that children need to think critically to solve problems they face in day to day life.

Critical thinking is purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation and inference as well as explanation of the evidential, conceptual, methodological or contextual considerations upon which that judgment is based. Critical thinking is the ability to recognize problems, to find workable means for meeting those problems, understand the importance of prioritization and order of precedence in problem solving, gather relevant information, interpret data to appraise evidence and evaluate arguments, recognize the existence (or non-existence) of logical relationships between propositions, draw warranted conclusions and generalizations, put to test the conclusions and generalizations at which one arrives and render accurate judgments about specific things and qualities in everyday life.*Critical thinking* is, 'reasonable, reflective thinking that is focused on deciding what to believe or do' (Norris & Ennis, 1989).

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1.2 Social Maturity: Socially mature behavior has been the chief determining factor of success in work and personal life of individuals. Social maturity enable individuals to communicate effectively and maintain better interpersonal relationships for a healthy life. Research findings from a Study in Pennsylvania University have stated that youth scoring higher on social skills were four times more likely to graduate. They would have a superior ability to responds and resolve conflicts in social situations.

Social Maturity is taken to be the level of social skills and awareness that an individual has achieved relative to particular norms of the society in which he is a member. It is a measure of the competence of an individual with regard to interpersonal relations, behavior appropriateness, social problem solving and judgment. Social maturity encompasses attainments in several domains, including independent functioning, effective interpersonal communication, interaction and responsibility thatcontributes to the well-being of society.

Gender differences are expected in thinking abilities and social maturity levels of teenage students due to the impact of the differences in their upbringing and stereotyped roles expected of them in the family and society.

2. NEED AND IMPORTANCE OF THE STUDY

The importance of teaching children to think critically and behave in a socially mature way is gaining momentum in this technological era since they have to be prepared to live in the highly competitive 21st century. The citizens of the 21st century need to face a world characterized by high conflict and competition. It is the educator who has to envisagethe role ofteaching higher-order thinking skills to prepare young men and women to live in the future world. Parents and Children concentrating onrote learning and memorizing of information are the cause of concern to today's education system.

Educators are realizing the importance of teaching children to think critically and teaching them to solve problems creatively in a socially acceptable way. Anderson, Krathwohl et al (2001) opine that the important goal of education is to promote retention of what students have learned and to make sense of what they have learned and be able to use what they have learned in new social situations. According to Brookhart (2010) the thinking that applies to life outside of school is characterised by 'a series of transfer opportunities (rather) than a series of recall assignments to be done'. Children with high critical thinking can apply wise judgment in social situations.

Since it is proved that ways of thinking can be taught, the educational curriculum has started concentrating on equipping students to make sound decisions and exercise reasoned judgment by thinking critically in social situations. Each child, with his individual personality needs to interact with others in the outside world. Since teenagers who posses well developed social skills and those who are socially mature are more capable of handling social situations successfully, they are more prone to success in their future life. Hence educationists, psychologists and social workers are devising various strategies for improving critical thinking and social maturity of young individuals.

At this juncture the researcher felt the need to find whether similar strategies could be planned for improving critical thinking and social maturity among both male and female secondary school students. Thus it becomes more important to find if male and female secondary students differ in their critical thinking ability and their social maturity levels. It is all the more significant to find if there exists a correlation between critical thinking and social maturity.

3. STATEMENT OF THE PROBLEM

The study has been entitled as,
"A Study of Critical thinking and Social Maturity of Secondary school students of Mysore city".

4. OBJECTIVES OF THE STUDY

The following are the objectives of the study:

1. To find whether there is any significant difference between male and female students with respect to Critical Thinking.
2. To find whether there is any significant difference between male and female students with respect to Social Maturity.
3. To examine the relationship between Critical thinking and Social Maturity of Secondary school students.

5. HYPOTHESES OF THE STUDY

In pursuance with the objectives of the studyfollowing hypotheses were framed:

- There is no significant difference between male and female students with respect to Critical Thinking.
- There is no significant difference between male and female students with respect to Social Maturity.
- There is no relationship between Critical thinking and Social Maturity of Secondary school students.

6. VARIABLES OF THE STUDY

Main variables: Critical Thinking and Social Maturity.
Background Variable: Gender

7. METHODOLOGY

Survey method was adopted for this study. The sample of the study were administered two tools related to the main variables of the study and the data was collected for analysis.

8. SAMPLE OF THE STUDY

The sample of the study comprised of hundred students of secondary schools in Mysuru city. The students were selected by using simple random sampling technique.

9. TOOLS USED FOR THE STUDY

The following tests were used as the tools to collect the data for the study:

- **Critical Thinking Test:** Critical thinking test was designed and constructed by the Investigator was used to collect the data. The Critical thinking Test consisted of 35 Multiple Choice Questions covering eight areas namely Analysis, Applying standards, Information seeking, Logical reasoning, Transforming knowledge, Inference, Decision making and Discrimination. A correct answer for each item obtained a score of one thus making the maximum total score equal to 35. Thus the total score ranges from 0 to 35.
- **Social Maturity Scale:** Social Maturity scale constructed and standardized by Dr. Nalini Rao was used. The Social Maturity level of the selected secondary school students was measured using this tool. This scale consisted of 90 items including both positive and negative items. Each item was given four preferences i.e, Strongly agree(SA), Agree(A), Disagree(D), Strongly Disagree(SD). Positive items were

given a score of 4,3,2 and 1 respectively. The negative items were given a score of 1, 2, 3, and 4 respectively. Scores of each item were summed up to get total scores of each individual student.

10. COLLECTION OF DATA

The investigator approached the heads of schools and got permission for data collection. The investigator personally administered the Critical thinking test and Social Maturity scales to the students.

11. STATISTICAL TECHNIQUES EMPLOYED

t-test and Person Product Moment Correlation technique were used to analyse the collected data.

12. ANALYSIS AND INTERPRETATION OF DATA

Hypothesis 1:

There is no significant difference between male and female students with respect to Critical Thinking.

Table No. 1: Summary table of 't' test of Critical Thinking of male and female students.

Variables		N	Mean	SD	*'t' value*	df	Significance
Gender	Male	50	31.3400	1.95469	0.66	98	NS
	Female	50	31.5800	1.66709			

Table No.2 reveals that the obtained 't' value 0.66 is less than the tabled value at 0.05 level. Hence, the null hypothesis 1 is accepted and it is concluded that there is no significant difference between male and female students with respect to Critical Thinking.

Hypothesis 2 :

There is no significant difference between male and female students with respect to Social Maturity.

Table No.2: Summary table of 't' test of Social Maturity of male and female students.

Variables		N	Mean	SD	*'t' value*	df	Significance
Gender	Male	50	196.46	2.47609	0.12	98	NS
	Female	50	196.52	2.52530			

Table No.2 reveals that the obtained 't' value 0.12 is less than the tabled value at 0.05 level of significance. Hence, the null hypothesis 2 is accepted and it is concluded that there is no significant difference between male and female students with respect to Social Maturity.

Hypothesis 3:

There is no significant relationship between Critical Thinking and Social Maturity of Secondary school students.

Table No 3: Table showing variables, N. df, co-efficient of correlation and the level of significance between Critical Thinking and Social Maturity of Secondary school students.

Variable	N	df (N-2)	R	Level of Significance
Critical Thinking	100	98	0.16	NS
Social Maturity				

The data in table No. 3 shows that obtained 'r' value is 0.16which is not significant. Hence it is concluded that there is a positive butinsignificant relationship between Critical Thinking and Social Maturity of Secondary school students.

13. FINDINGS OF THE STUDY

The following are the findings of the study:

- There is no significant difference between male and female secondary school students with respect to Critical Thinking.
- There is no significant difference between male and female secondary schoolstudents with respect to Social Maturity.
- There is a positive butinsignificant relationship between Critical Thinking and Social Maturity of Secondary school students.

14. CONCLUSION

Critical thinking has been debated since early Greek philosophers such as Plato and Socrates and is still a subject of debate and discussion even today. Since individuals with critical thinking abilities can reason, learn actively, engage in reflective and independent thinking, identify and solve problems systematically and justify their beliefs and values they are the most sought after in the society today. These abilities need to be unveiled in a world in a socially acceptable manner where he needs to coexist with his fellow beings. In this context, Social maturity becomes more important. In today's technological world where egoism and individualistic pursuits are dominating, children need to be trained to achieve their excellence in life leading to holistic competence. Socially mature individuals can contribute to the establishment of an euphoric society. It is good news for educators that Critical thinking and social maturity can be developed and taught to children at their formal operational stage.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABSTRACT

In view of the importance accorded to adoption of social constructivist strategies to teach science in classrooms at secondary stage, strategies and plans need to be designed and their impact on achieving the objectives of teaching science need to be tested. Hence the study was undertaken to find the effect of social constructivist strategies on achievement in science critical thinking and social maturity of secondary school students. The study was undertaken with the following objectives: (i) To develop lesson plans based on social constructivist strategies for ninth standard science. (ii) To study the effect of social constructivist strategies on secondary school students with respect to their Achievement in science, Critical thinking and Social maturity. (iii)To study the interaction effect of Treatment and Gender on achievement in science of secondary school students.(iv) To study the interaction effect of Treatment and Gender on critical thinking of secondary school students. (v) To study the interaction effect of Treatment and Gender on social maturity of secondary School students. (vi) To examine whether there is significant relationship between critical thinking and achievement in science of secondary school students. (vii) To examine whether there is significant relationship between achievement in science and Social Maturity of secondary school students. (viii) To examine whether there is significant relationship between Critical thinking and Social Maturity of secondary school students. The Independent variable of the study is the Treatment which is Social constructivist strategies of teaching science and Traditional method of teaching science. The Dependent Variables were Achievement in science, Critical thinking, and Social maturity. Gender was the moderate variable. The present study was an experimental study in which pre- test, post- test parallel group design was adopted and was conducted in the following three phases: Phase 1: Development and Validation of lesson plans based on social constructivist strategies for teaching science to the experimental group, Phase 2: Construction and Validation of achievement test in science and critical thinking test, and Phase 3: Experimentation: Implementation of social constructivist strategies to teach science to the experiment group and traditional teaching approach to the control group. The lesson plans for teaching the selected content of science based on SCS for ninth standard syllabus were developed. Lesson were planned based on the "5E Model developed By Roger Bybee of "The Biological science curriculum study" (BSCS) as this model was developed based on constructivist principles of learning. The sample of the study has been selected in two stages. In the first stage the schools were selected and in the second stage

the classes were allotted to experimental and control groups. The research tools that were used to collect the necessary data were Raven's Standard progressive matrices (RPM), Achievement test in science constructed by the investigator, Critical thinking test constructed by the investigator, and Social maturity scale by Nalini Rao. 't' test , Two way ANOVA and Pearson Product moment correlation were the statistical techniques used for analyzing thedata. The findings of the study revealed that Social constructivist strategies are more effective in enhancing achievement in science, critical thinking and social maturityamong secondary school students. Social constructivist strategies were found to be equally effective in enhancing achievement in science, critical thinking and social maturity among male and female students of secondary schools. A positive and high correlation between achievement in scienceand critical thinking and social maturity of students of secondary schools.

CHAPTER-I

INTRODUCTION

"What a child can today do with assistance, she will be able to do by herself tomorrow"

– ***Lev Vygotsky***

INTRODUCTION

Human beings are naturally curious about the happenings in the environment around. The inquisitive human mind has been observing the environment prudently, looking for meaningful relations, constructing and using new tools to interact with nature, and building conceptual models to comprehend the world. This human effort is science.

1.0 Meaning of Science

The origin of the term Science from the Latin word, 'Scientia' is etymologically synonymous with Knowledge. Science is a system of acquiring knowledge which adopts observation and experimentation to explain and make predications of natural phenomenon. It is an organized body of accumulated knowledge of the universe which is accumulated through observation, measurement, experimentation and framing of laws to explain the facts of nature.

Webster's Dictionary defines,

"Science is knowledge attained through study or practice".

"It is the knowledge covering general truths of the operation of general laws, as obtained and tested through scientific method and concerned with the physical world"

Science Council defines it as,

> "the pursuit and application of knowledge and understanding of the natural and social world following a systematic methodology based on evidence"

According to Britannica ,

> "Science is any system of knowledge concerned with the physical world and its phenomena and that entails unbiased observations and systematic experimentation. In general, a science involves a pursuit of knowledge covering general truths or the operations of fundamental laws".

According to Thomas Hobbes,

> "Science is the knowledge of consequences and dependence of one fact upon another".

According to Burnie (2007),

> "Science as the systematic study of anything that can be examined, tested and verified. Science is a branch of knowledge dealing with a body of facts systematically arranged showing the operation of general laws."

From above definitions it is evident that Science is a branch of knowledge or organized body of knowledge acquired through observation, experimentation and inquiry. This indicates that science is both a product and process.

Science as a product: Information or ideas acquired through various processes of science form the product of science whose fundamental components are facts, concepts, principles, theories and laws.

Science as a process: The scientific method makes any hypothesis (or theory) open to be proven against. During the process, the accurate ideas stay (as theories) while the false ideas disappear from mainstream science as historic steps towards the truth. The ways of collecting information, processing it, measuring, thinking and problem solving look into science as a process. Observation,

comparison, classification, communication, measurement, estimation and prediction form the process of science.

American Association for the Advancement of Science has listed observation, classification, inference, predication, measurement, communication, use of space /time relationships, making operational definitions, formulating hypotheses, experimenting, recognizing and controlling variables, interpreting and formulating data as intellectual skills associated with acquiring information on nature.

Science is a dynamic, expanding body of knowledge covering every new domain of experience. Speculation and conjecture also have a place in science, but ultimately, a scientific theory, to be acceptable, must be verified by relevant observations and/or experiments. The laws of science are never fixed eternal truths and the most established and universal laws of science are subject to modification in the light of new observations, experiments and analysis.

With all its limitations and failings, science is unquestionably the most reliable and powerful knowledge system about the physical world known to humans. Science is ultimately a social endeavor. Scientific knowledge, although reliable and durable, is never absolute. This knowledge including facts, theories and laws, is subject to changes. Indeed contrary to common belief, scientific hypotheses, theories and laws can never be absolutely proven irrespective of the amount of supporting empirical evidence (Popper, 1963). So, understanding science is an issue of far reaching concern.

Science Education

Science profoundly penetrates into every activity of the living world and hence there is an ever increasing thrust on science education. This contributes to fulfilling the needs of today'sscientific and technological civilized world. Science, as a school subject has a crucial role in education. Science provides an exhaustible storehouse of knowledge and human thinking when we consider it

from the intellectual point of view. Science helped mankind to expose infinite avenues of nature both living and nonliving. It takes him to the world that is perceivable, as well as to the world beyond human perception. In the course, it satisfies human curiosity and provides him a disciplined intellectual exercise. So, it has disciplinary effect on the minds of people in the civilized society.

Study of science awakens interest in the subject, its pursuit demands persistent efforts - diligence and patience. A simple process of science viz., experimentation - warrants ones careful observation, perseverance, concentration, honesty, impartial logical judgement. These virtues are useful for guiding a child to live as an efficient social individual in the society. Training in science teaches one to think with imagination and seeks productive thinking to find the solution to a problem, and in doing so we see a discipline-the control of ones capacity to make it, do what one wants it to do (Nourse, 1960). Science can bring behavioural change in the learner, which can enrich his personality aspects. It gives opportunity for search of truth, developing problem solving skill, creative thinking, critical thinking, and constructive imagination. An individual's habits, attitudes, literature, art and culture are all affected and influenced by science. Scientific discoveries have bearing upon deepest thought of man.

Science education performs twofold task (Ganguli and Vashishtha, 1991). At individual level, science education gives an individual a strong hold of the concepts and process of science and also imparts the ability to adopt the scientific approach to problem solving and strategies of experimentation in dealing with problems of comprehension in life. It needs cultivation of scientific enquiry, logical reasoning, habit of judging beliefs on obtainable evidence, courage to admit facts, readiness to discard unfounded theories, to recognize limit of reasoning power itself.

Aims of Science Teaching

Science Education as a process helps a child to develop his/her potentialities to the maximum and brings out the best from within the child. The aims of science educationare:

- equipthe child with up to date knowledge of Science and technology for the betterment of society
- cultivate inquiring minds and curiosity about the natural world
- acquire knowledge, conceptual understanding and skills to solve problems and make informed decisions in various contexts.
- develop scientific inquiry skills to design and conduct scientific investigations and evaluate empirical evidence to draw conclusions
- communicate scientific ideas, and experiences accurately in different ways
- think critically, analytically, and creatively to solve problems, make judgements of arguments and take decisions in scientific contexts
- appreciate the profits and limitations of science and also application in technological developments
- understand the international nature of science and its interdependence on technology and society, including the limitations imposed by social, economic, cultural, ethical and other factors
- develop attitudes and values of honesty and respect for themselves and their environment
- know the facts and principles of science and its applications
- acquire skills and understand the methods that lead to generation andvalidation of scientific knowledge,

- develop a historical and developmental perspective of science and to view science as a social enterprise,
- relate to the environment andappreciate the issues at the interface of science, technology and society,
- acquire the requisite theoretical knowledge and technological skills to enter the world of work,
- nurture the natural curiosity, aesthetic sense and creativity in science,
- imbibe the values of honesty, integrity,cooperation, concern for life and preservation of environment, and cultivate scientific temper.

The acquisition of the aims and objectives of Science education predominantly depends upon the process of science teaching, and other variables such as context/situation. The traditional methods followed in teaching of science at present are found to fail in developing these abilities and thought process in children.

Science teaching is subject to remarkable change as a consequence of the rapid development in science and technology and the relative changes in innovative out-looks of modern educational and learning theories. The teaching – learning process of science is more centralized in classroom instruction, where the core interactive sessions takes place between teacher and pupil. The class room instructional activities of science are conducted with intent of modifying student's behaviour. Yet, the traditional methods followed in teaching of science at present are found to fail in developing these abilities and thought process in children. Science education can be considered as predominantly depending upon the process of science teaching, and other variables such as context/situation.

Science teaching is subject to remarkable change as a consequence of the rapid development in science and technology and relative modifications expressed in the form of innovative out-looks of modern educational theories. The teaching – learning process of science is more centralized in classroom instruction, where the core interactive sessions takes place between teacher and pupil. The class

room instructional activities of science are conducted with intent of modifying student's behaviour.

The twentieth century pedagogy was based on learning theories dominated by objectivism. A structured educational system, instructional objectives, teacher-centered education, task analysis, reinforcement, remedial teaching with feedback, rote learning for memorization of facts and objective assessmentformedits salient features. The goal of the education was acquisition of knowledge and skills. Teacher was more active and dominant, whereas, the students were passive recipients of information.

The traditional teaching learning strategy was mechanicaland stereotypic and ignored the development of critical and reflective thinking of students. But in the later part of the 20^{th} century and the beginning of the twenty first century, educationists started to criticize the teaching-learning practices that were based on behaviorist outlook of individualized learning. Since they argue that those practices and approaches could not develop the ability of a child to independently construct his own knowledge that and also could not develop critical thinking for discovering new knowledge. They did not develop the social skills and maturity to deal with people and ability to work collaboratively with people they come across in the their life. As a result, constructivist pedagogy which believes that learning is knowledge construction by learners either independently or cooperatively when they are actively engaged in social experiences and activitiesemerged.

1.2 CONSTRUCTIVISM

As long as there were people asking each other questions, we have had constructivist classrooms. John Dewey (1916) and Jean Piaget (1926) framed developmental and educational theories that resulted in the emergence of Constructivism."Dewey views learners as active participants in knowledge acquisition as they engage in restructuring, manipulating, reinventing and experimenting with knowledge to make it meaningful, organized and permanent.

Learning is an internal process influenced by the learners' personality, prior knowledge and learning goals" (Davidson, 1995).

Realizing the importance of constructivism in education, the National Curriculum framework (NCERT, 2005) has emphasized constructive perspective in which learning is seen as a process of construction of knowledge by the individual child.

Constructivism, the study of learning is about how children make sense of their world. Children actively construct their knowledge as they connect the existing ideas to new ideas on the basis of experiences provided to them. Constructivism is a phenomenonthat is as old as thinking of people.From the past decade, educational research too has been concentrating on the ideology of constructivist approaches to learning. Constructivism has roots in Philosophy, Education and Psychology. Constructivism holds the view that the only reality a human can know is that which is represented by his thought. According to constructivism, while learning, children actively participate in acquisition of knowledge and restructure, manipulate and experiment so that make meaning of the new experience that lead them to new learning.Cognitive development theories form the basis for constructivist learning approaches.Kant(1724-1804), Dewey(1859-1952), Montessori(1870-1952), Piaget(1896-1980), Vygotsky(1896-1934), Bruner and Glaserfeld (1917-2010) are the major exponents of Constructivism.

Piaget's approach to the development of children's cognition is being known as constructivism. Essentially, Piaget's work is about the development and understanding and he described himself as an epistemologist that is someone who is interested in how humans acquire knowledge. For Piaget thought is internalized action (Piaget, 1950). Actions form the processes of reasoning and its actions and interplay between the experience of action and thought that form the basis of the way in which a child constructs a view of the world. He saw children as actively constructing their own understanding largely through the process of self-

discovery. His image of the world was that of a young scientist, an individual thinker. The role of the adult is to act as a guide and facilitator to the child's development, providing an appropriate environment in which children can hypothesize and themselves questions. These raises some important questions for practice, including the extent to which children should be left to themselves and what would be the role of adult support and interaction.

According to Piaget cognition is an example of the adaptation between organism and environment seen through the living world. It is driven by the need to anticipate events in order to survive (Thornton, 2002). For Piaget development precedes learning and we develop in order to learn. It happens and begins with the idea of Scheme or Schema. He describes the process of modification through Assimilation, Accommodation and Equilibration. 'These three processes work together from birth to proper development forward' (Siegler et al., 2003).

According to Piaget's views humans possess mental structures that keep assimilating external events and converting them into mental events and thoughts.We accommodate our mental structures to new and unusual aspects of the mental environment. These two processes, assimilation and accommodation, represents two complementary aspects of the general process of adaptation.The processes of assimilation and accommodation are held together by process of Equilibration. This process of equilibration is the keystone of developmental change, with long term implications whereby the child'smodel of the world comes increasingly to resemble reality. Essentially, when children encounter new experiences their existing schemas have to adjust. This creates a state of disequilibrium or cognitive conflict, which acts as a motivation to learning until a state of equilibrium is restored.

Educational Implications of Piaget's Theory

- The aim of education is to encourage the child to ask questions, try out experiments and speculate rather than accepting information unthinkingly. (Smith et al. 2003).

- Attention to children's different ways of thinking at different ages will need to be considered in making decisions about how they are best educated (Siegler et al. 2003). Children have to be'ready tolearn'.

- Learning is a process of active involvement of children. They learn by doing the things.

- Learning is a process of self constructionof knowledge by the individual child with the process being emphasized over product.

- Child initiated activities; exploring the world and testing ideas without any external pressure are emphasized.

- The child is intrinsically motivated to engage in activities.

- The environment is organized to support the open ended self-discovery learning.

- The role of adult is to observe and facilitate children's learning rather than direct instruction. The educators should create the right environment for learning but then allow the child to solve the problem and through their own active discovery. The adult attends to the unfolding of these structures and provides social and physical environments that encourage a child's normal development. (MacNaughton, 2003).

- "Asking children to explain both why correct answers are correct and why incorrect answers are incorrect produces greater learning than only asking them to explain why correct are correct (Siegler, 2000)" and can lead to the adaptation of new strategies.

Vygotsky differs fundamentally from Piaget and majority of approaches in the information processing models. His views, like Piaget's, that the children are actively constructing their understanding as a result of experiences and in the sq1ense of his idea can be described as constructivist. For Vygotsky this construction of knowledge occurs in the context of children's interaction with

those around them. So he is considered a Social Constructivist. As a social constructivist he opines that language has a vital role in constructing any kind of knowledge. In highlighting the importance of language, Wells (1987) says that children will actively construct their own knowledge, and what they need is only evidences, support and guidance. Parents and teachers help their children to talk and enable them to discover how to learn through the talk as they treat their children as equal partners in conversation by following the lead given by them and negotiate meaning and purpose.

Educational Implications of Social Constructivist theory of Vygotsky:

- Learning is to be seen as a socialprocess, and collaborative learning with others is prioritized.
- Children's learning is maximized when they are regularly working at the upper levels of their competence (MacNaughton and Williams, 2004), which is their Zone of Proximal Development (ZPD).
- Language is important both as a way in which a child develops his thinking and understanding and also as a means for sharing his thoughts and understanding with others.
- The role of adult is interventionist, to extend and challenge the learner to go beyond where they would otherwise have been (Sutherlend 1992).
- Adult support is contingent upon children's behavior: more help is given when children experience difficulty, with this being gradually withdrawn as children as children succeed in an activity (Wood and Wood, 1996). In the early stages the help provided is more elaborate and explicit; later it is less explicit and less frequent, focusing on hints rather than instructions (Meadows, 1993).
- Children can learn from each other as well as from adults, provided that one is more knowledgeable about the activity than the other. The gap

between their understandings need not be great, however, as then the 'expert' is more likely to understand the problems the 'novice' faces (Smith et al. 2003).

- The problems posed should be stimulating the child to solve them.
- The resources or physical tools which children use in their play are important supports for their intellectual development (Broadhead 2004).

Jerome Bruner was influential in promoting Vygotsky ideas. He lies between Piaget and Vygotsky in his ideas as he emphasizes action and problem solving in child's learning as Vygotsky does. He also highlights the importance of language and social interaction in development of thinking. His early work involving the study of adult reasoning had an important impact on his views on development of thinking in young children, emphasizing culture and growth as central factors. He suggests three categories of the representations, namely, Enactive, Iconic and Symbolic representations.

The central idea of the Bruner's which has received most attention is Scaffolding, which is making connection between the previous ideas of particular concept to the present ideas to understand the idea better and may draw the future conclusions about the idea. It is connecting previous knowledge of the learner to know something advanced related to that knowledge in present. 'Highlight critical features and information, buffer the learner's attention against distractions, and channel the learner's activities so that there is freedom to succeed and too much freedom to go wrong. Errors are turned into opportunities to learn, procedures are commented on and explained, efforts are praised and responsibility for doing the task is gradually transferred to the learner, contingent on his or her having demonstrated an ability to succeed (Meadows, 1993).

TYPES OF CONSTRUCTIVISM

Constructivism asserts two principles that have influential consequences for teaching-learning.In general the first principle states that knowledge is to be

actively built by learners and not to be passively received by them. Information is imparted on the learners and they have to absorb that information as they just cannot be communicated. The second principle states that the function of cognition is adaptive and serves the organisation of the experiential world, not the discovery of ontological reality (Glaserfeld, 1992), thus we don't find truth but construct viable explanations of our experiences. Though many of the educational practices are contrary to the first one ,those accepting only first principle are called *trivial or weak constructivism* and those who have accepted both principles are called *radical constructivism*. Trivial constructivism views cognition as the process in which learners construct mental structures from their environment whereas radical constructivism considers cognition as that which helps in organizing the learner's experiential world.

Constructivism, propounded by Vygotsky, emphasizes context and environment (Chen, 2003), and is termed as *social constructivism*. It is based on the principle of social interaction. Vygotsky opined that learning occurs through his interaction with the environment and the people there. Vygotsky's socio historical development psychology concentrates on the dialectic of the individual with the society and the impact of social interaction, culture and language on learning.*Psychological constructivism* is another face of constructivism which evolved from Piaget's model of individual development which believes that a child enters the classroom with ideas and opinions that have to be modified by the facilitation of the teacher by creating dilemmas for the child through tasks and questions.

Social constructivism considers the central role of the society in individual's development. The social world for a student includepeople who affect him like his friends, teachers, family members, administrators and partners in all his activities. The social interaction with the more learned member of the society promotes learning. An experienced partner provides the scaffolding of subject matter to support his understanding. Scaffolding supports learning by prompting the learner to move further from his current levels of performance to develop new

abilities. This could be through an external support provided by the peers, teachers or tools that assist the learner to construct his knowledge.

Animportantaspect of Vygotsky's theory is the "Zone of Proximal Development" (ZPD)."The zone of proximal development is the distance between the actual independent development level and the potential development level under the guidance of or in collaboration with peers" (Vygotsky, 1978). ZPD indicates the area that the student is cognitively prepared for exploration but with social interaction and help of the more mature person. Vygotsky believes mental activity is a social experience and hence the mechanism of social experience has to be understood to understand human thinking. Role of social interaction in learning is emphasized. Cobb (1994) followed by Salomon and Perkins suggested that "*acquisition* and *participation*, the two metaphors of learning interrelate and interact in synergistic ways". "Teaching strategies using social constructivism as a referent include teaching in contexts that might be personally meaningful to students, negotiating taken-as-shared, meanings with students, class discussions, small-group collaboration, and valuing meaningful activity over correct answers" (Wood, Cobb &Yackel 1995).

Vygotsky's theories stress the fundamental role of social interaction in the development of cognition (Vygotsky, 1978; Wertsch, 1985), as he believed strongly that community plays a central role in the process of "making meaning". Vygotsky(1978) claimed, "learning is a necessary and universal aspect of the process of developing culturally organized, specifically human psychological function". In his words social learning precedes development.

If Vygotsky's theory of social cognitive development has to be understood then two of his concepts have to be looked into: the More Knowledgeable Other (MKO) and the (Zone of Proximal Development).

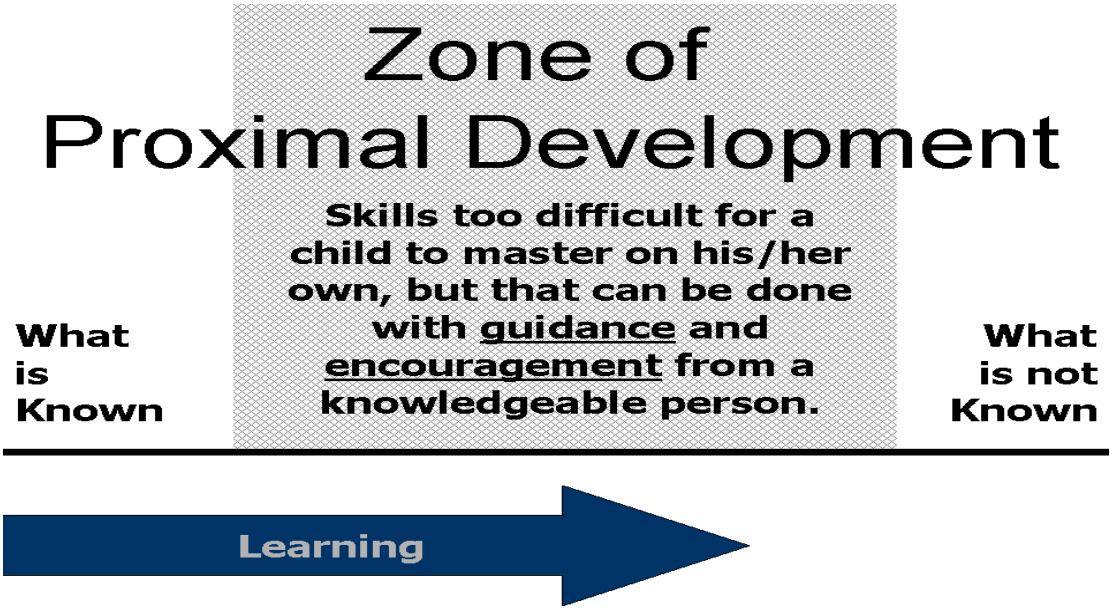
The More Knowledgeable Other (MKO): MKO is someone who possesses a higher knowledge of the learning task, concept, process or ability than the learner. The MKO is normally the teacher or an older adult and sometimes

could be peers with more experience with respect to the learning aspect. Today the MKO could be an electronic support system that could scaffold the learning. Computers and learning software programmed to facilitate the child in the learning process by possessing more knowledge than the learner about the content to be taught.

ZONE OF PROXIMAL DEVELOPMENT:

The second principle given by Vygotsky is the Zone of Proximal Development. The MKO and the ZPD together provide the scaffolding needed for constructivist learning. He defines ZPD as, “the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers”. The scaffolding provided to the student when he is at the ZPD will give a boost to attain the task. "Scaffolding refers to the way the adult guides the child's learning via focused questions and positive interactions." (Balaban. N, 1995)

After the student masters the task the MKO can withdraw the scaffolding and yet the student will be able to complete the task on his own. If the child doesnot have the readiness and the task is not within their ability, even when assistance is provided, then an attempt to teach him the task would be waste of time. The MKO has to wait till the child further matures and develops the ability to learn the task with assistance.



Principles of Constructivism

Brooks and Brooks (1993) suggests the following five principles as basis for a constructivist class:

1. Problems which are relevant to the students have to be posed.
2. Learning has to be structured primary concepts and ideas
3. Student's point of view has to be sought and valued
4. The curriculum has to be applied to address the suppositions of students
5. The students have to be assessed in the context of learning.

Characteristics of aConstructive Classroom

Jonassen (1994) identified the following characteristics of constructive learning environment:

1. The reality has to be presented with the help of multiple representations
2. The complexity of the outside world has to be represented

3. Knowledge construction has to be emphasized
4. Stress authentic tasks in meaningful context
5. Provide real life settings
6. Encourage reflection on experience
7. Encourage collaboration and social negotiation among learners.

Based on the principles of constructivism,few more features drawn are:

- Active learning is preferable to passive learning.
- Learning would be better when it happens in social situation or in a group
- The tasks presented to the learners have to be concrete and not abstract, which means that the tasks should be real, authentic and be a hypothetical one.
- New information should be bridged to what is already known to the learners.
- The new material learnt should be reflected upon and thought over by the learner
- Teachers facilitate the acquisition of the information rather than just presenting it.
- Teachers need to provide the needed scaffolding assistance needed for their progress.
- Students are expected to resolve what they thought they knew with new understandings.
- Construction of collaborative meaning is an important goal orientation of the classroom.

- Close monitoring of students' thinking by the teacher
- The teacher and student both learn and teach.

TEACHER'S ROLE IN A CONRUCTIVIST CLASS

In the constructivist classroom, the teacher has to prompt and facilitate discussion. The teacher should ask questions that lead them to making their own conclusions and thus guide the students. David Jonassen identified, Modelling, Coaching and Scaffolding are the three major roles of the facilitators to support students in a constructivist learning environment.

According to Vygotsky, instructors have a vital role inassisting students develop in the ZDP. The assistance received must have certain features:

1. **Intersubjectivity:** This process describes event where the learner begins a task with others. As they engage each other, they go from having their own understanding of the object to having a shared understanding of the object.

2. **Scaffolding:** Scaffolding is an effective technique used to support learners in their gradual understanding of the object or concepts. Teachers should be available and present while the learner is actively working to understand the object, providing feedback and information in response to the learners grasp of the object.

3. **Guided participation:** Encompassing Scaffolding, guided participation refers to the shared interactions between expert and students

Characteristics of Social Constructivism

The following need to be kept in mind while adopting social constructivist strategies :

- The students make a construct and not just present information, they also apply and use the information.

- The students process the information at the higher levels like evaluation, analysis and synthesis levels.
- The students participate in learning and are accountable for their own learning
- The learning results in a product made by the students and that is used to diagnose learning errors.
- The learning errors of oneself and that of the others are self checked and corrected on their own.
- The whole learning experience is enjoyed by the students.

SKILLS REQUIRED FOR SOCIAL CONSTRUCTIVIST TEACHER

Unlike a traditional classroom, a teacher in a constructivist class should take the role of a facilitator of learning. To play this role effectively, the teacher has to be warm, understanding, attentive listener, and be self controlled. The teacher has to observe the responses of the students and accept their feelings and ideas. The teacher must pose a problem or a question to the learners and it is necessary for her to praise and reward them fairly. Even if the teacher has to criticize the student the reason for it has to be explained clearly. The teacher has to be imaginative and motivating while adopting strategies like discussion, lecture when necessary, demonstration, illustrations, and question answer sessions for presenting the subject matter. The learning method and materials have to be selected in accordance with the instructional objectives and student characteristics, so that students achieve higher. The teacher has to provide a classroom environment which offers freedom and emotional security to students.

Social constructivist teaching strategies

The Social constructivist classroom is an environment where students build or construct their own knowledge. Many activities are hands-on and involve

building on the work of others. Various strategies incorporate the principles of social constructivism and provide a social environment for children to construct their knowledge. They are:

- Cooperative learning
- Collaborative learning
- Situated learning
- Anchored Instruction
- Problem solving
- Concept mapping
- Inquiry based learning
- Casebased instruction
- Games and simulation
- Synectics Model of Teaching
- Advanced Organizers

Cooperative learning

"Cooperative learning is a structured form of small group learning. It is based on two key assumptions, positive interdependence and individual accountability" (Cottell& Millis, 1994). Cooperative learning strategies include practices that will create opportunities to learn in small groups. Children learn in small groups cooperatively and together succeed in their learning tasks. Group of students are so structured that they act together to learn and also assume responsibility for the learning of their team mates too. Cooperation wins over competition among the group members while students actively engage in learning in small structured groups.In a traditional classroom social interaction among

students is often considered a distraction for learning. But in a cooperative learning classroom social arrangement is put to positive use, where cooperative learning enhances the communication skills of students, thereby increasing their chances to be successful in their work and social life.

The type of talk that happens between the students determines the learning. If students talk about a question it creates meaning and understanding about the aspect. Research studies have revealed explaining and discussing solutions to problems and phenomena to their peers to clarify actually enhances the individual's understanding.Every member in the team would assume responsibility not only for his own learning but also for assisting his team mates to learn. As students are engaged in the learning task until every team member is successful in understanding and completing the assignment, an atmosphere of collective achievement is created. In a cooperative learning class students would gain from each other's attempt and efforts as their success in learning benefits every other team mate. Every member of the group is aware that each has a share in the outcome and they know that they either sink or swim together. They are also aware that the performance is a result of both individual and team effort. Each member has the feeling that every member of the team is important and a feeling of pride for identification with the group exists in every member. The accomplishment and recognition of achievement of a single member is celebrated jointly. Research has found that cooperative strategies when adopted to teaching-learning are highly effective in enhancing learning achievement and also in developing values and morals. Johmson and Johnson in his study has found that cooperative leaning improves social and communication skills in addition to learning.

In a cooperative class high achieving students can help slow learners better than their teacher as they can communicate easily with their peers. Gillies (2003) stated, "When children work cooperatively together, they learn to give and receive help, share their ideas and listen to other students' perspectives, seek new ways of clarifying differences, resolving problems, and constructing new understandings

and knowledge. The result is that students attain higher academic outcomes and are more motivated to achieve than they would be if they worked alone". When students work collaboratively, they could achieve a better understanding of knowledge. Cooperative learning strategy makes students more productive in solving problems rather than to be competitive with others.

The main elements of cooperative learning include positive interdependence, social skills, heterogeneous grouping, group interaction, and individual accountability. *Positive Interdependence:* Students know that they have to work cooperatively with team members to complete the task assigned to their group. They understand that the key to successful completion of the learning task lies in structuring the group and understand that every member can succeed only if the other members in the group also do well. Positive interdependence may be promoted if the teacher establishes mutual goals where each student in the team learns and also makes sure that the other members also learn. The teacher has to provide resources that need to be shared by the members and assign individual roles to every student in the group. The students could be made to name their group so that they get a feeling of 'shared identity' and make them realize that the efforts of all members of the group have to put in their efforts and make their unique contribution and share his resources and assume task responsibilities for group success. Each member has to establish is role in the group such as – Facilitator, Scribe, Reporter, Illustrator, Messenger/collector.

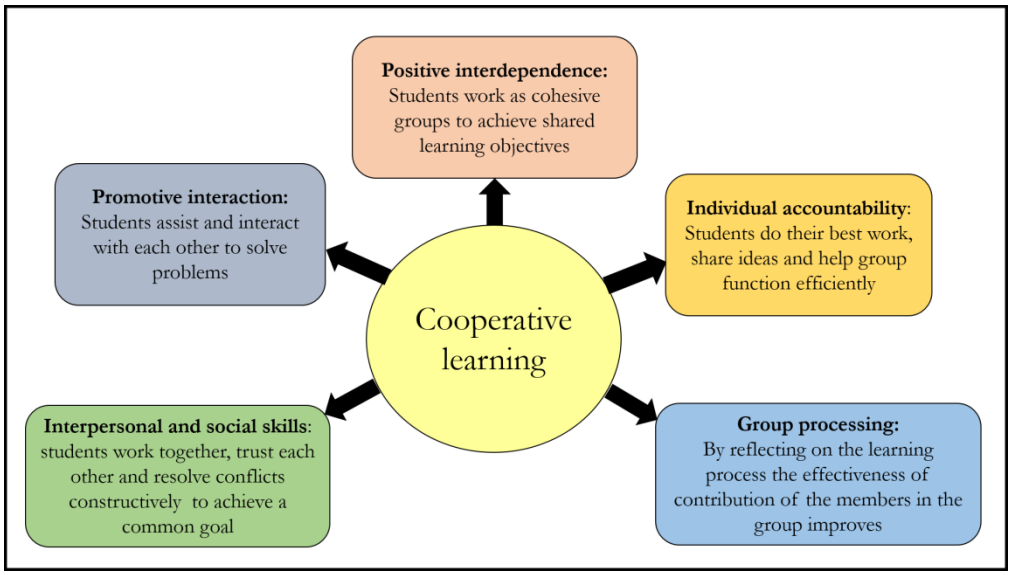
Social Skills: the teacher should create opportunities for students to praise each other, listen to each other, act patiently, explain the method of solving problems, share and communicate one's knowledge with other members, promote each other's success, discuss and connect the present learning with that of the past. Thereby the teacher would be able to develop cooperative social skills in students.

Processing group interaction: The teacher should encourage students to reflect on each other's work in the team while they discuss the extent of their

achievement of goals and maintenance of effective work relationships. The members should be encouraged to describe helpful actions of the members and take decisions on what behaviours should be continued and what behaviours need to be changed.

*Heterogeneous grouping:*the teacher needs to change the members of the group for different learning tasks so that it creates a dynamic environment for enhancing their social skills. Criteria like their past achievement level, gender, age, ethnicity, religions, diligence levels may be kept in view and student of diverse backgrounds and abilities may be assigned to the groups to bring in mixed ability grouping. Random assignment of members to a group also is one method of creating a mixed ability group.

Individual Accountability: The most commonly faced objection in a group work is that a few students end up in doing all the work and others donot work nor learn and some may be idle and disruptive too. This may be avoided if individual members are made accountable by making them take individual quiz, write an essay or complete a given task individually after the learning is completed. Individual student may be randomly called to answer a question. The teacher can also assign different responsibilities and designate individual roles to be performed to complete the task in the group and these roles could be rotated for different tasks.



Co opeative learning has its own advantages as it increases academic learning, critical thinking ability, active learning, student retention, motivation to learn, and satisfaction in the learning experience. It also reduces disruptive behavior, develops peer relationships, promotes self-esteem, improves social skills and develops positive attitude towards learning. It also improves the skills of oral communication and develops the mindset to share information and consider other's point of view.

Collaborative learning

In a Vygotskian classroom, learning happens through collaboration among students themselves and between students and teacher. The basic assumption is that learning is naturally a social act. As students share their knowledge and participate in collaborative activities, they are actually negotiating meaning. Collaborative approach to teaching and learning makes students work in groups to solve a problem or complete a task or end up with a product According to (Gerlach 1994), "Collaborative learning is based on the idea that learning is a naturally social act in which the participants talk among themselves. It is through the talk that learning occurs."

According to Smith and McGregor (1992),

"Collaborative learning is an umbrella term for a variety of educational approaches involving joint intellectual effort by students, or students and teachers together. Usually students are working in groups of two or more, mutually searching for understanding, solutions or meanings, or creating a product.Collaborative learning activities vary widely, but most centre on students' exploration or application of the course material, not simply the teacher's presentation or explication of it".

Collaborative learning adopts Vygotsky's principles of social nature of learning. Collaborative learning encompasses a variety of approaches that involve collective intellectual effort of students themselves and that of students and

teachers. Students work together to understand new concepts, laws, solutions or to create an artefact or to produce an outcome of their learning. These activities may be in the form of collaborative writing, collective projects, joint problem solving, study teams, debates where learning can occur through active engagement among peers. According to Lejeune, (1999), "the main characteristics of collaborative learning are: a common task or activity; small group learning, co-operative behaviour; interdependence; and individual responsibility and accountability".

Since collaborative learning is adopted tohelp students learn more effectively it is important to consider teaching strategies that concentrate not merely on mastery of content but those which go beyond it. Collaborative learning promotes: involvement,cooperation and teamwork, active constructive process, rich contexts, diversity and inherent sociability. Research has shown that student involvement makes a significant difference in student performance and subsequently student retention. The differences they encounter demands that they recognize these differences and deal with them which helps in developing cooperative and team skills and a community feeling. Habits of participation and responsibility to a subject/classroom community can help them work in broader communities. It develops sensitivity to the views and opinion of other team members who come from diverse bakgrounds and possess diverse learning styles and aspirations. In a collaborative setup students are creating something new by integrating new material with what they previously know or to reorganize their knowledge in the light of their new learning. Since collaborative learning begins with problems the student takes over as a participant from being a distant observer. This rich context develops higher order thinking skills like reasoning and problem solving in them. It also creates intellectual synergy of all the minds working on a problem and engagement in a common endeavour.

Collaborative learning approach is closely related to cooperative learning but is not the same. It divides the task horizontally where the members engage in different aspects of a task sequentially, whereas cooperative learning divides the task vertically where members engage concurrently on different aspects of the

task. Various strategies under collaborative learning include Computer supported collaborative learning, Think pair-share where at first students think silently about the problem posed by the teacher, later pair up and exchange their thoughtsand at last, pairs share their responses with the whole class, and Jigsaw strategy where each student of a group take up a different topic, research on it with members of other group having the same topic and come back to the own group to explain about their topic. These strategies reflect the socio-cultural perspective where the students are expected to build the knowledge through interaction between peers and also teachers as facilitators.Advantages of collaborative learning include:Development of higher order thinking skills, Promotion of familiarity among students and faculty through interaction, increased retention of students, Enhancement of their self-esteem,and Promotion of positive attitude towards the subject matter.

Situated learning

This instructional approach proposed by Jean Lave and Etienne Wenger in 1990s emerged from the work of Dewey and Vygotsky who believe that students learn more by active participation.Situated learning essentially is a matter of creating meaning from the real activities of daily living (Stein, 1998) where learning occurs relative to the teaching environment. Few of the activities for situated learning can be,involvement in Field trips in an unfamiliar environment, internship immersion in actual work environment, and activities in laboratories and centers replicating actual work settings. When the student addresses real world problems being actively involved in it, he is situated in the learning experience and acquires knowledge while being a part of it. The social interaction and active involvement of students are key to the success of situated learning. It is often unintended contextual learning where the role of student moves from a beginner to being an expert once they are actively immersed in the social community where learning takes place. The social community matures and learns through collaboration and "sharing of purposeful, patterned activity" (Oregon Technology in Education Council, 2007, citing Lave & Wenger).Situated learning

involves students in cooperative activities where they are challenged to use their critical thinking and kinesthetic abilities. These activities should be applicable and transferable to students' homes, communities, and workplaces (Stein, 1998). In a situated learning situation, students challenge other's assumptions and reflect upon their previous knowledge while they are actively immersed in the learning activity while solving problems. Stein (1998) has given a few guidelines to organize situated learning activities. According to his guidelines if learning is grounded in everyday situations, knowledge will be acquired situationally and transferred to other similar situations. Learning results from social processes that encompass ways of thinking, perceiving, problem solving and interacting. Learning exists in robust and complex social environments.

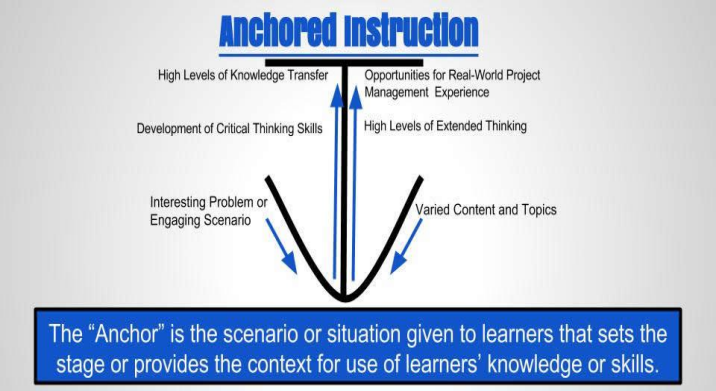
Situated learning is advantageous because it provides children an authentic context that shows the way knowledge will be used in real life. It provides access to expert performances for coaching and scaffolding at critical times. It supports collaborative construction of knowledge. It provides assessment of learning integrated in the task itself.

Anchored Instruction

Anchored Instruction is a teaching-learning approach which makes learning within a meaningful and problem-solving context. It is a type of situated learning which uses contexts like stories to situate learning and application of the learnt material so that learning is contextualized to offer students realistic roles that promote learning process. It stresses on problem solving in integrated learning contexts which draw realistic connections for meaningful learning making connections between and within the content domains. These activities support learning opportunities that extend thinking to other content areas.

The activities are designed such that an "anchor" that may be a story, incident , situation that has an issue to be resolved and is interesting to students. Anchoring means the bond between the content in a realistic context. Anchored modules have in them all the information embedded within and can be used for

scaffolding so that managing in limited time and resources becomes easier. Anchored learning can be Problem based Learning or Case based learning where presented stories are explored to resolve the dilemma created in students. The story is the anchor to which the child's initial ideas are linked, strategies to solve are formulated and also acts as a source of information.



Anchored instruction is designed by introducing the anchor which may be a story or situation that has information for students to identify and solve a problem and is presented through a flexible and interesting medium like videos and hypertexts. Students are made to feel that solving the posed problem by them will add to the story line. The second stage is to develop a shared experience around the anchor where students are to revisit the story to familiarize with it. At this stage the teacher provides guidance in acquiring the concept initially but the students take control of the application of the conceptto resolve the problem in the story line. The next stage is to expand the anchor where students gain more autonomy to locate hidden information to solve the problem. In the next stage, the students use knowledge as a tool to solve the problem. They used the hints in the anchor and plan to resolve the problem by asking sub-questions to extract information that help to complete the task. The teacher has to challenge the students reasoning and scaffold the process of problem solving. In the next stage the students have to work on projects that are related to the anchor by reading more about the subject or exploring a related story or a related simulation so that they deepen their understanding of the concept and connect their knowledge to other disciplines. In the last stage they share what they have learnt and present the

findings on the problem and their extended learning. They also share the strategies used to solve the problem among different groups to synthesize and broaden their understanding.

CONCEPT MAPPING:

Joseph D. Novak and his team at Cornell Universisty developed this technique of concept mapping in 1970s to represent science knowledge of students which later was used for meaningful learning of all subjects. Concept mapsoriginated from the constructivist movement. They are based on Ausbel's cognitive assimilation theory that stressed on the significance of prior knowledge in learning new concepts. They can also be used as advance organizers to review and visualize the relationship among different concepts by creating a visual map of the connection indicated by labelled arrows and linking phrases. They are powerful to help students reach high levels of cognitive performance. They offer a method to represent information visually. It is also called a mind map. It organizes information like an outline in which connections are made between pieces of information in different areas. A concept map harnesses the power of an individual'svision to comprehend the whole information at a glance. Spider, Hierarchical, Flowchart and System concept maps are the four major categories of concept maps.

Concept mapping as a visual learning technique helps students as it gives clarity by depicting how ideas are connected and organized. When students recreate and organize what they have learnt they absorb and internalize new information. Concept maps help students to integrate the new knowledge with the previously learnt knowledge.

When students are asked to prepare concept maps of what they have learnt, they can be used to get an insight into the way students have understood or misunderstood the topic. Teachers can use concept maps to organize their ideas for instruction and use it as a graphic organizer in class. It can be a handy way of

taking notes during the lecture. It is not only a learning tool but also forms an ideal evaluation tool to teachers to assess student learning.

Problem Solving

Teachers in various subjects make students solve problems by applying what is learnt by them previously with stress on critical thinking and decision making skills. Problem solving is the process in which the student applies a method, unknown to him before, to solve a problem and obtain a satisfactory solution. It refers to the desire to reach a definite goal and needs complex logic to find the missing conditions or steps to reach the goal. This process also includes problem finding and problem shaping. Problem solving is a higher order cognitive functioning that requires the modulation of fundamental skills. Problem solvingas a method of teaching-learning is often done within cooperative groups, and the tasks are meaningful to the lives of the students. Proponents of this approach to teaching, stress the importance of relating what is new to what is known. Learning is emphasized more than teaching. After converting this to Piagetian jargon, the student is given opportunities to assimilate and accommodate in a continuous process of achieving equilibrium and building schema. Problem solving strategies develops critical thinking ability, ability to analyze problems and find appropriate learning resources.

Inquiry based Learning

This approach to teaching-learning focusses on students' questions and observations. Educators play an active role throughout the process by establishing a culture where ideas are respectfully challenged, tested, redefined and viewed as improvable, moving children from a position of wondering to a position of enacted understanding and further questioning (Scardamalia, 2002). Both the teacher and the student have to share the responsibility for learning. Inquiry based learning begins with open-ended investigation to a problem or a question and then requires the student to engage in evidence based reasoning and creative problem finding to creative problem finding and solving. The educators have to be

responsive to the learning needs and should know when and how new ideas should be presented to students.Together, educators and students co-author the learning experience, accepting mutual responsibility for planning, assessment for learning and the advancement of individual as well as class-wide understanding of personally meaningful content and ideas (Fielding, 2012).

Inquiry- based learning is advantageous because students themselves identify the real questions or problems for creating learning opportunities and teachers guide the subsequent inquiry. It is flexible in approach and provides positive reinforcement be it physical, emotional and cognitive. It also suits the social collaborative learning environment and could be adopted to any grade, though higher grade students are able to engage in more sophisticated questioning. It validates the knowledge that all the students bring to the learning process.

Case based Instruction

A case is a summary of an activity, event or process either written or in video format. A case may be a video of soil erosion, solar activity, volcano, Transmission of sound waves, Acid rain etc. While establishing a cause and effect of a phenomenon the teacher may identify a case describing an event and discuss the points after students study the case. Case –based instruction have been used since a long time in professional training programmes like law, medicine and business education. Social constructivist theories strongly believe in the potential of case methods to cause effective learning.

Games and Simulations

Games and Simulations provide students with interesting experiences since they are fun and pose challenges to them. Many of the games require collaborative group action and thus create highly engaging environments. They have brought in a revolutionary change in teaching styles by moving them towards a constructive approach. They are constructive when they are flexible to allow students to make decisions of their accomplishments.

Game playing is found to have positive impact on acquisition of cognitive and intellectual strategies. Since games provide an experiential exercise and employ multimodal communication, movement they work upon the principles of social constructivism. The students devise strategies and employ tactics while acquiring a skill or knowledge which develops higher order thinking skills in them. The subject matter is presented through intelligent tutoring systems based on the principles of learning.

Information Processing Models of teaching like the Synetics model of teaching, Advance Organizer Model and the Concept Attainment model, Group discussions also incorporate the principles of social constructivism and are grounded on this theory.

Many studies argue that discussion plays a vital role in increasing student ability to test their ideas, synthesize the ideas of others, and build deeper understanding of what they are learning (Corden, 2001; Nystrand, 1996; Reznitskaya, Anderson &Kuo, 2007; Weber, Maher, Powell & Lee, 2008). Large and small group discussion also affords students opportunities to exercise self-regulation, self-determination, and a desire to persevere with tasks (Corden, 2001; Matsumara, Slater &Crosson, 2008). Discussion increases student motivation, collaborative skills, and the ability to problem solve (Dyson, 2004; Matsumara, Slater &Crosson, 2008; Nystrand, 1996). Increasing students' opportunity to talk with one another and discuss their ideas increases their ability to support their thinking, develop reasoning skills, and to argue their opinions persuasively and respectfully (Reznitskaya, Anderson &Kuo, 2007). Furthermore, the feeling of community and collaboration in classrooms increases through offering more chances for students to talk together (Barab, Dodge, Thomas, Jackson, &Tuzun, 2007; Hale & City, 2002; Weber, Maher, Powell & Lee, 2008).

Learning is an active and continuous process involving the students in construction of meaning from whatever comes in the purview of their senses. New learning is to a large extent influenced by existing knowledge. A compassionate

relationship among teachers and students, student involvement in goal setting and decision making, clear role clarity and expectations and occasions for collaborationare prominentfeatures of social constructive strategies that result in better student outcomes in the form of improved Achievement in Science, Critical thinking abilities and social maturity.

1.3 ACHIEVEMENT IN SCIENCE:

Achievement is the act of acquisition of knowledge, ideas, and skills on those existing already. Achievement is an addition of skills and ideas, or involves reordering of ideas or acquisition of concepts. The learners are involved in three distinctive processes when they are involved in the act of achievement. First among them isinternalization, which is a process in which new knowledge and ideas come to the mind from an external source. The second being the internal process in which the mind compares, contrasts and integrates the acquired knowledge and ideas with the existing ones. Finally the externalization process enables the mind to reorganize the knowledge or skills he possesses.

Achievement in science is the act of acquiring or accomplishing knowledge of scientific concepts and ideas and skills of science. They are accomplished successfully by means of exertion, practice and perseverance.

1.4 CRITICAL THINKING

Critical thinking skills have gained significance from educators as an outcome of teaching-learning since the beginning of the twenty first century. The Partnership of 21st Century Skills has identified critical thinking as an innovation skill necessary to gear up students for post-secondary education and for their work life.

Bailin (2002) defines critical thinking as,

"thinking of a particular quality—essentially good thinking that meets specified criteria or standards of adequacy and accuracy."

It involves the components of analyzing, making inferences, adopting inductive and deductive reasoning, evaluating, taking decisions and problem solving. Critical thinking involves cognitive skills and dispositions. It includes characteristics like open-mindedness, inquisitiveness, reasoning tendency, flexibility, desire to be informed, and respect for diverse viewpoints.

The cognitive-psychological approach has given rise to a few definitions of critical thinking.

Sternberg (1986) defines critical thinking as,

"mental process, strategies and representations people use to solve problems, make decisions, and learn new concepts".

Halpern (1998) considers critical thinking as,

"the use of those cognitive skills or strategies that increase the probability of a desirable outcome"

Evaluation, synthesis and analysis which are placed at the higher side of the hierarchy of Bloom's taxonomy of information processing skills also represent critical thinking. Researchers of critical thinkingtypically agree on the specific abilities which include:

- analyzing arguments, claims, or evidence (Ennis, 1985; Facione, 1990; Halpern, 1998; Paul, 1992);
- making inferences using inductive or deductive reasoning (Ennis, 1985; Facione, 1990; Paul, 1992; Willingham, 2007);
- judging or evaluating (Case, 2005; Ennis, 1985; Facione, 1990; Lipman, 1988; Tindal &Nolet, 1995); and
- making decisions or solving problems (Ennis, 1985; Halpern, 1998; Willingham, 2007).

Answering questions for clarification, defining terms, identifying assumptions are behaviours identified by Ennis(1982) as being relevant to critical thinking. Facione (1990) identifies interpreting and explaining as a part of critical thinking ability. Halpern (1998) recognises verbal reasoning in relation to concepts of likelihood and uncertainty and Tindall and Nolet (1995) identify predicting, whereas Willingham (2007) recognize ability to see both sides of an issue as abilities related to critical thinking.

Kennedy, et al (1991) reviewed the research literature and found that critical thinking ability appeared to improve with age, yet young children benefit from instruction designed to develop critical thinking. All instructors and particularly Scienceteachers insist on providing explicit instruction in critical thinking by teaching them to transfer what is learnt to new contexts, and by using cooperative, collaborative and constructive approaches thereby placing the student at the centre of the teaching-learning process.

1.5 SOCIAL MATURITY

An adult gradually emerges from extreme individualism of an infant and dependency to an outgoing member of a social group who then relies upon its members. Hence, during the last few decades, schools have become increasingly concerned with the problem of aiding children in the development of social maturity. Social maturity plays a large part in the attainment of the "seven cardinal principles of education", that are formulated by National Education Association (1918). Social maturity also plays a crucial part in the four major groups of educational objectives proposed by Educational Policies Commission of the National Education Association (1938). Educators have come to realize that intellectual maturity cannot be attained independent of social maturity and that the intellectual content of the curriculum cannot be taught in a vacuum but must be related to the social aspects of life. Much of what we try to teach in schools today has been included in the curriculum because we feel that it will help individuals to

cope with the problems of life. Hence it follows that the need to develop social maturity is to a large degree the basis of education.

Social maturity refers to the social skills which enable an individual to deal tactfully and understandingly with others.

According to Henry Clay Lindgren, " the relationship an individual maintains with others can be used as a rough measure of emotional and social maturity".

According to Hurlock (1964) " social maturity is an indication of willingness and ability to orient oneself in the various activities and costumes of the group, to make appropriate contribution to the work to adjust oneself to the inevitable limitations and reasonable amount of responsibility of community life without waste of energy or loss of satisfaction".

The total process of the social maturity may be viewed in three major aspects, which are inter related. Social behaviour develops in the form of habits of routine life and capability of interacting with persons and in small groups in a simple way during the latter half of childhood. While establishing the habits the child slowly learns to live with other people by sharing responsibilities in the group and thus, develops social competency. The child learns the cultural ways and develops social competency.

An individual, to function effectively requires information that is necessary for him to grow in a normal environment. Several investigators have accorded a pivotal role of the concept of Social competence as a criterion for adaptation and adequacy (Bower 1966, Gladcoin – 1967, Gold friend D'Zurilla 1969).

Teaching and learning of science by adopting social constructivist principles has the potential to expedite the achievement of outcomes which are not normally known to be that of science. It allows the development of personal and social abilities of learners that will enable them to function more effectively in the wider society. A strong criticism of science teaching is that it fails to develp

social skills in children. Social constructivist strategies of teaching may be an answer to this criticism.

2. NEED AND IMPORTANCE OF THE STUDY:

Teaching aims at development and expansion of new ways of thinking that reveals in increased skills to solve problems of life and to development of new habits with desirable attitudes. The broader outcome of teaching is to result in increased capabilities of students to learn more efficiently in future caused by the knowledge and mastery learning skills acquired by the students. The main aim of teaching is to bring out desirable behavioral change in students, both cognitive and social. This aim could be achieved by teaching science using social constructivist approaches effectively.

In India efforts have been made to study different methods of teaching with a view to identify teaching effectiveness and teaching methods to attain the objectives of teaching Science. Attempts are also made to find out teaching patterns which are conducive for developing cognitive and social abilities and affective behavior in children.

It is generally agreed that the objectives to achieve through the teaching learning process are multidimensional in nature. It is also known that no one particular method or technique is appropriate to achieve all these multi-dimensional objectives. This led researchers to explore various methods, techniques in an integrated fashion which resulted in the development of new social constructivism strategies.

The National Curriculum Frame work for school education (2000) by the National Council of Educational Research and Training (NCERT) stressed on considering the child as constructor of his own knowledge. Learning experiences for the construction of knowledge has been stated as a salient feature of National Curriculum Frame work-2005. The NCF-2005 emphasizes on social constructivist

approaches where the learner must develop his/her own knowledge based on the experience that he/she has got while learning.

The core of teaching process is the arrangement of environment within which students can interact and study how to learn. (Dewey, 1916).But in the present traditional classroom, the teaching learning process is usually dominated by “teacher talk” and is highly dependent on the text books for structuring the course. The teachers act as tunnels who just transfer their meaning and thoughts to the passive students giving an occasional chance for students to initiate questions and to express their independent thought and a rare chance for them to interact between themselves and the teacher.

It has been often seen that even the students who score well are unable to achieve and formulate real life applications outside the school room (Yager, 1991). An interesting finding of research studies reveal that academic knowledge and practical application of this knowledge at present are mutually exclusive. Students also view very little connection between what they experience in their real life andwhat they learn in their classroom.

An important solution proposed for this issue is to prepare students to be adaptive social learners, who can self-learn from the situation he comes across in life and then apply that learning to overcome the issues that he comes across. Evidently, the conventional teacher is an information-giver, dependent on the textbook and the one who fails to create a guided classroom that brings about the desired outcomes of teaching science. Hence science teaching has to change its focus in the classroom from transmission of knowledge to construction of knowledge by adopting constructivist approaches.

Today Critical Thinking and Social Maturity are much valued entities. This could be fostered by collaborative learning within the group. Social constructivism influences the ability to work in team, and thus may have a positive influence on their social maturity.

A commonly and widely held criticism about teaching of science is that it does not develop social skills which are essential for living in this society of humans. Hence this study is a modest venture to find whether use of social constructivism strategies in teaching of science has an impact on their social maturity.

The elaborate review of empirical research studies revealed that there have been no efforts made to study the effect of social constructivist approaches on achievement in science, critical thinking ability and social maturity of students of secondary school. Hence in this context the researcher was motivated to take up the present study to improve upon the present practices in pedagogy of science.

CHAPTER - II

REVIEW OF RELATED LITERATURE

2.0. Introduction

In the previous chapter the theoretical background pertaining to the study was presented. This chapter deals with the review of related literature. The study of the related studies is a crucial aspect of the study. This review situates the current study within the body of literature and provides context for the reader.

A detailed review of both Indian and foreign studies have been presented under the following headings in four sections namely:

2.1. Studies related to Constructivism and Social Constructivist strategies

2.2. Studies related to Achievement in Science

2.3. Studies related to Critical Thinking

2.4. Studies related to Social Maturity

2.1. Studies related to Constructivism and Social Constructivist Strategies:

The literature on Constructivism and Social Constructivist Strategies has been reviewed under this section:

Pandey &Ameta (2017) in their study focused on effect of constructive based training approach on teachers' attitude and students' achievement. The study which adopted a quasi-experimental pre-test and post-test design comprised of eighty students from class sixth of two Nagarpalika Girl's middle school, New Delhi. The experimental and control group comprised of fifteen teachers each. The experimental group was trained for 200 hours for constructive teaching and the control group was trained on conventional teaching. A pre and post -test design was applied on students and teachers, learning and teaching Hindi subject. Teacher-made test with multiple-choice objective type questions was used to assess the learners' achievement in pre-test, and post-test. Post-test was administered after two months of the experiment. Teacher's attitude scale of S.P.Ahluwalia (1990) was administered before the training of teachers and also after

completion of the training. The obtained t-values revealed that constructivist method enhances the academic achievement and problem solving ability of the pupils. It was also found that both the group of teachers differed significantly on teaching attitude.

Alshehri (2016) aimed to investigate the impact of using 5E's Instructional Model on achievement of mathematics and retention of learning among fifth grade students. Semi-experimental method was adopted and pre-test and post-tests were administered. It was concluded that the significant performance of experimental group was due to teaching them with the 5E's instructional model. There were no significant differences in the experimental group attributed to the post and delayed post-test which showed the retention of learning among experimental students.

Chowdhury (2016) took up a study to find the effectiveness of constructivist learning approach on achievement in mathematics. The researcher applied 5E's learning (Engage-Explore-Explain-Elaborate-Evaluate) strategy to experimental group and Traditional method of teaching to control group of students. Pre-test post-test quasi experimental design incorporating both qualitative and quantitative techniques was adopted for the study. Firstly, it was found that Constructivist learning approach significantly improved student's achievement in mathematics as compared to using traditional teaching. Secondly Constructivist learning approach was equally effective for boys and girls in improving their achievement in mathematics. Finally students taught in constructivist learning environment had significantly enhanced their understanding and application abilities as compared to other abilities like knowledge and skill.

Ahme O.Qarareh(2016) investigated the effect of using constructivist learning model in teaching science on the achievement of eighth-grade students and their scientific thinking. content related to the topic, light: its nature, mirrors, lens, and properties, was selected. The study sample consisted of 136 male and female eighth graders chosen from two basic schools in Tafila in the scholastic year 2015/2016. The four-class sample was divided into two groups (controlled experimental). The researcher prepared lesson plans using constructivist learning model, achievement test and scientific thinking test, for which validity and reliability were checked. Means, SD, ANOVA and ANCOVA were used to determine the differences in means of the groups of the study. The results show that there was statistically significant difference at (α= 0.05) for the effect of the constructivist Learning model on the achievement and scientific thinking in

favor of experimental group, and there was no statistically significant difference at (α= 0.05) for the constructivist Learning model on the achievement and scientific thinking attributed to gender. No statistically significant difference at (α= 0.05) for the dual interaction between teaching method and gender on the achievement and scientific thinking was found. In the light of the study results, the researcher presented a number of recommendations including: extra attention to be given to employ constructivist learning model within science courses, and conducting further studies about the effect of the Constructivist Learning Model on various learning outcomes.

Geçit (2016) studied the opinion of 246 pre-service geography teachers with regard to the constructivist approach in three Turkish state universities. An attitude scale was used for data collection. The average attitude of the 246 pre-service geography teachers was calculated to be 3.51 points with regard to this approach. This average score suggested high level of attitude. No significant differences were found in attitude with respect to the grade levels of the participants and the type of high school from which they graduated. On the other hand, significant difference was found in pre-service teachers' attitudes towards this approach in terms of gender and teaching experience.

Singh &Yaduvanshi (2015) in their study discussed the historical background of constructivism and its importance; the role of mentor and learner in constructivist science classroom. They have prepared lesson plans for science teachers based on 5E's model -one of the model of constructivism, on the topic 'Images formed by concave lenses'. Lesson plans facilitated the science teachers in the implementation of constructivism in their classroom.

Mrayyan (2014) attempted to know the effect of using constructivist learning model as a teaching model based on the constructivism theory on academic achievement and mathematical reasoning outcomes. He has opined that constructivism is increasingly influential in the organization of classrooms and curricula in schools, and that its principles appeal to modern views of learning and knowledge, but conflict with traditional academic practices. Constructivism is basically a theory, based on observation and scientific study about how people learn. He found that people construct their own understanding and knowledge of the world, through experiencing things and reflecting on those experiences.

Mishra (2014) studied the prevailing pedagogic practices of social science at

school level in India with the help of interviews with social science teachers. In this descriptive study the researcher adopted the theoretical underpinnings of Socio-cultural approach to learning and tried to design and execute constructivist pedagogic setting for teaching social science. The study establishes the argument that for moving deficit model of teaching-learning, knowledge should be viewed as co-constructed, negotiated and situated entity. The knower should have agency and the voice in process of knowing and that process learning should be dialogic.

Mahesha S J. (2014) investigated the effect of Social Constructivist Strategies on Achievement in Geography and Group Cohesiveness among secondary school students. The study also aimed to find out the correlation between the dependent variables of the study. Students studying in eighth standard in schools of Mysore city formed the sample and consisted of 120 male and female students from two schools drawn using Random sampling technique. Data was collected using two tools: (1) Achievement test in Geography which was used to measure Achievement of eighth standard students in Geography. (2) Group Cohesiveness Scale used to measure the level of Group cohesiveness. The collected data was analyzed using independent samples 't' test, 2 way ANOVA and Pearson's Product Moment Correlation. The findings of the study revealed that the Social constructivist strategies of teaching had contributed significantly for enhancing Achievement in Geography and fostering Group Cohesiveness of secondary school students. However, the findings indicated that there was no significant differential effect of the treatment in male and female in Achievement in Geography and Group cohesiveness. The results also indicated that there was high positive relationship between Achievement in Geography and Group cohesiveness.

Beyhan (2013) based his study on the perceptions of second year students in secondary schools about the extent to which the learning environments in classes are appropriate for constructivist learning. It was found that the participants agreed that a constructivist learning and teaching environment is created in their classes. The difference between the mean scores of the males and females in the sub-dimension of reflection on constructivist learning environment was found to be significant, while the difference between the total mean scores was not.

Sridevi K.V. (2013) took up a quasi-experimental study to find whether constructivist approach to science instruction could help eighth standard students of

Mysore, India to improve the Science achievement and Attitude towards Science. The sample included thirty seven boys and thirty one girls in total. The experimental group consisted of thirty six eighth standard students, of which were twenty one were boys and fifteen were girls and the control group consisted of thirty two eighth standard students, which included sixteen boys and sixteen girls. Purposive sampling was employed to select the schools for the study. An Achievement test in Science and an Attitude towards Science scale was developed by the researcher. The students were tested on the above tools before and after the treatment. Analysis of Covariance test was performed to control the initial variance. The results showed that Constructivist teaching was more effective than traditional teaching in terms of Achievement in Science and Attitude towards Science among 8th standard students. It was found that constructivist approach was equally effective for both boys and girls in improving Achievement and Attitude towards science. A constructivist environment was preferred to a traditional classroom by the students. The results confirmed research supporting the positive effect of constructivist learning practices and view that constructivist approach to teach science is a viable alternative to traditional modes of teaching.

Madu B. C and Ezeamagu M. U (2013) investigated the efficacy of the constructivist strategies based on the 5Es viz., Engagement, Exploration, Explanation, Elaboration and Evaluation at the primary school level. 134 fourth standard primary pupils formed the sample of the study. Seventy two pupils were taught the concepts of fraction in fourth standard primary mathematics using the 5Es, while sixty two pupils were taught content comparable unit on fraction using the regular conventional method. It was found that pupils in the treatment group made significantly greater gains on fraction achievement test than the comparison group. Results of the study showed promising occasionally robust trends on numbers and numeration outcomes thus contributing to the growing body of evidence suggesting that 5Es approach not only facilitated pupils' mathematics learning outcomes, but were also found to support pupil's number and numeracy development.

Richard O. Ongowo (2013) conducted a survey to investigate the teachers' perceptions of actual and preferred constructivist biology learning environment.. Data were collected from a sample of forty one biology teachers from Gem District, Kenya using a twenty-item Teacher Perception Questionnaire (TPQ) which was a modified version of Constructivist Learning Environment Survey (CLES), the teachers' version.

The TPQ consisted of two forms which were "Actual" and "Preferred". While the actual form assessed the current biology learning environment, the preferred form assessed the teacher perception of a constructivist learning environment. The data were analyzed using paired t-test. The results showed that the teachers' scores on the preferred form of some scales (Personal relevance, uncertainty and student negotiation) were significantly different from the actual form ($p< 0.05$). On the other hand the teachers' scores for scales of critical voice and shared control scales of actual and preferred forms of TPQ were not statistically significant. The implications of the study for practice and further research were discussed.

Olubunmi Omoniyi (2013) conducted a study to test the effect of a constructivist based learning strategy namely the Learning Cycle Approach (LCA) on male and female student's misconceptions on selected concepts in chemistry. The students' reasoning ability on how to solve problems in chemistry and the students' practical skills in solving scientific problems were tested. The sample included fifty five Nigerian Secondary Students (30 males and 25 females) from a semi urban area of Nigeria. The findings showed that the female students performed significantly better than their male counterparts in the test of reasoning ability. The subjects' were found to possess low understanding of manipulative skills. The female (57%) students responded better than males (43%) at formal operational levels while the greater proportion of males (62%) responded at the concrete levels as against 38% of females at concrete level respectively.

Bogar& et.al. (2012) examined academic achievement, retention of knowledge and attitudes towards science course in matter of structural and characteristic subject with constructivist education version students. Achievement test were given to both the groups three months after intervention as retention test. Students in the control group were taught by traditional teaching method (narrative, discussion, question and answer). The experimental group was taught by constructive strategies besides traditional teaching method. The study showed a significant difference in favour of the experimental group taught by constructive education version over the control group with respect to averages of academic achievement scores. Achievement test scores of experimental group were found to be higher than the control group after instructional intervention. The study showed no meaningful difference in attitudes towards science course of the experiment and control group. Since students in experimental group scored higher in the

achievement test for retention it was concluded that constructivist teaching methods used for experimental group was more successful.

Hussain (2012) aimed at exploring the significance of constructivist approach at higher education level. The study also examined its effects on social learning of students. The researcher used constructivist approach and designed activities to involve students in the process of learning. On the basis of observation, the researcher concluded that students enjoyed working on collaborative and cooperative projects and tasks. They were found to be keen on constructing knowledge by involving themselves in activities and showing their readiness to embrace constructivist approach. Constructivist approach played a significant role in the process of learning by constructing knowledge. Similarly, collaborative and cooperative work developed contribution spirit among students, overcoming their shyness and introversion. Students became independent and capable of taking initiatives in conducting research projects; also learnt ethics, social skills and etiquettes in groups. However, some culture related problems like working of female students with their counterparts and shyness of rural students were noted.

Lisa Kindleberger Hagan and Aaron S. Richmond (2012) conducted an experimental study to investigate the effect of teaching constructively an educational psychology course. It also aimed to develop and share a methodology for teaching future educators about constructivism. Over an eight week period, thirty four pre-service educators were taught constructivism through constructivist techniques and administered pre and two post measures of knowledge and perceptions of constructivist teaching methods. Results indicated that using a constructivist approach to teaching constructivism in educational psychology helped pre-service teachers to make significant gains in their academic and self-reported knowledge of constructivist theory. In addition, students reported that they enjoyed being taught constructively.

Erdal Bay, BirsenBagceci and Bayram Cetin (2012) investigated the difference in learners' problem solving skills and meta-cognitive levels when the authentic task-based social constructivist approach was used in an experimental group and a traditional approach was used in a control group. In this research, semi-experimental design with pre test-post test control groups was adopted. The experimental group was taught by constructivist approach (task based collaborative learning process) on the other hand, the control group was put in learning environments based on

meaningful learning approaches. Eighty nine teacher trainees formed the experimental group and forty eight teacher candidates formed the control group. Problem Solving Scale of Heppner and Peterson was adapted and used for acquiring data on problem solving skills. Meta cognitive awareness scale was developed by the researcher and used for obtaining the data on meta-cognitive levels. It was found that the experimental group teacher trainees significantly scored higher in problem solving skills and meta-cognitive levels than the control group. It was concluded that the task-based social constructivist approach had positive effects on teacher trainees' problem solving skills and metacognitive levels.

OludipeBimbola and Oludipe I. Daniel (2010) examined the effectiveness of constructivist-based teaching strategy on academic performance in integrated science of Junior Secondary School students in South-West Nigeria. Quasi-experimental research design was adopted for this study. 120 Junior Secondary School Students were randomly selected from four out of the twenty five co-educational Junior Secondary Schools in Ijebu-ode local government area of Ogun state of South-west Nigeria. The findings revealed that the constructivist instructed students had higher scores on the post test and the delayed post test, compared to those exposed to conventional method of teaching. The study concluded that if integrated science teachers could incorporate constructivist-based teaching strategy into their teaching methods, there would be an improvement in academic performance of Junior Secondary School Students in integrated science.

Cuhadar&Kuzu (2010)investigated ways to improve interaction through blogs in an information technology course, in which a constructive approach was employed. They found that participants' needs regarding information sharing, instructional support and communication played an important role to improve interaction among participants and with the course instructor. Furthermore, it was observed that blogs could be used as tools to develop interaction in discussions and group works.

Powell, Katherine C. Kalina, and Cody J. (2009) conducted a study on Cognitive and Social Constructivism. It aimed at developing tools for an effective classroom and found that an effective classroom, where secondary teachers and students are communicating optimally, is dependent on using constructivist strategies, tools and practices. (1) Cognitive or individual constructivism based on Piaget's theory, and (2) Social constructivism based on Vygotsky's theory were the two major types of

constructivism used in the classroom:. Similarities included inquiry teaching methods and students creating concepts built on existing knowledge that were relevant and meaningful. Differences include language development theory where thinking precedes language for cognitive constructivism and language precedes thinking for the theory of social constructivism. It was concluded that understanding communicative tools and strategies help teachers to develop individual learning methods such as, discovery learning, and social interaction to develop peer collaboration.

Michele Stears (2009) conducted a study on Social and Critical Constructivism to improve Science Curriculum Designsin South Africa. It was found that the introduction of a new National Curriculum in post-apartheid South Africa heralded a different approach in education. This curriculum not only advocated the development of knowledge and skills, but also emphasized education for democracy and citizenship. It sought to balance central control (and a single curriculum) with local design, which required educators to design curricula according to central guidelines and set outcomes. A science curriculum informed by principles of social, as well as critical constructivism, was thought of as more likely to meet the criteria as set out by policy makers. They probed learners' responses to a science curriculum formed by social and critical constructivist principles, and discussed the possible implications of such curricula for science education. Grade six classes of 45 isiXhosa-speaking learners aged 11 to 12 from a former black township in the Western Cape of South Africa were purposely selected for the case study. Most of them came from disadvantaged backgrounds. One class of learners were taught science lesson series by the researcher while the class teacher acted as an observer in the classroom. The lesson series was based on the principles of social and critical constructivism. The lesson series was taught over four days for three hours every day. Data were collected as the series was taught. The entire lesson series was video-taped and focus group interviews were conducted with five different learners at the end of each day. In this small scale, qualitative study, pupils' responses suggested that this approach allowed for greater participation by learners, as they had considerable input with regard to the chosen theme. Activities were learner-centered and drew on learners' everyday experiences. Although this was a series of science lessons, it was clear that the social issues also needed to be addressed in the lessons. The strategy allowed learners to take ownership of their learning, as they could make choices regarding the curriculum. The response of the learners to the science

curriculum formed by social and critical constructivist principles raised questions about curriculum design, the nature of science and the purpose of science education.

Jamie et al.(2009) in their research study focused on the theory of Constructivism and Scaffolding to implement a Blog system environment which allowed users to create their own personalized Blog for individual, group, and organization practice. The blog system formed a platform for client to exchange their ideas and thoughts in order to achieve the goal of knowledge sharing and then enhance learning effects of the students. The study revealed that the learner's learning style has no significant influence on their learning effects and that the teaching strategy based on Constructivism and Scaffolding can improve learner's learning effects. It also revealed that due to the interaction of teaching strategy and learning style, the experimental group showed better learning effects.

Christina Solomonidou & Dimitrios Kolokotronis (2008) examined the role of multimedia software package 'Interactions between Objects' on students' learning of mechanical interaction forces and Newton's laws. They designed and developed this software adopting social constructivism on the basis of 226 students' initial conceptions (categorized in six categories), in order to help students construct appropriate knowledge about the subject. Thirteen primary, lower secondary and upper secondary school classes were taught with the software. 226 students (aged 11–16) and 13 teachers of the classes participated in the software's evaluation research. Data analysis showed students' substantial learning gains with respect to their initial alternative conceptions of the six conceptual categories. The students' incorrect answers to the post-test questionnaire were found to have perceptibly decreased (a mean of 65%). In contrast, their correct answers to the questions had reached high percentages, from 60% to 90% depending on the question and the students' age. The contribution of the software's specific characteristics on students' learning was discussed along with implications for designing constructivist science learning tools.

Oguz (2008) focused on effects of active learning methods based on constructivist approach on the prospective teacher's achievements, attitudes towards the subject matter and perceptions about the learning process. Experimental design and qualitative method were used in this study. Constructivist learning methods were employed on the experimental group, were as traditional learning approach was followed

to the control group. The findings revealed a significant difference between the achievement levels of the experimental and control groups in favor of the experimental group. No significant difference was found in their attitudes. It was concluded that constructivist learning activities enabled the students to become more prosperous and was effective in developing positive perceptions in them.

Vickneasvari. A and P. Krishnasamy (2007) examined the effects of a multimedia constructivist environment on Form Four students' achievement and motivation in the learning of "Chemical Formulae and Equations". Multimedia Constructivist Instruction (MCI) and Multimedia Objectivist Instruction (MOI) courseware were developed. The MCI was assigned to eighty students whereas the MOI was assigned to eighty nine students. Students' ability levels (high-ability, HA or low-ability, LA), cognitive styles (field-independent, FI or field-dependent, FD) and gender were considered as the moderator variables. The study found that, the MCI students performed significantly better and were significantly more motivated than the MOI students. The HA students were found to perform significantly better and were significantly more motivated than the LA students. The FI students did not perform significantly better but were significantly more motivated than the FD students. The male students did not perform significantly better but were significantly more motivated than the female students. HA students performed significantly better and were significantly more motivated than the LA students in MCI. HA students using MCI performed significantly better but were not significantly more motivated than the HA students using MOI. The LA students using MCI did not perform significantly better but were significantly more motivated than the LA students using MOI. The FI students performed significantly better and were significantly more motivated than the FD students in MCI. The FI students using MCI performed significantly better but were not significantly more motivated than the FI students using MOI, and the FD students using MCI did not perform significantly better but were significantly more motivated than the FD students using MOI, whereas the male students did not perform significantly better but were significantly more motivated than the female students in MCI. The male students using MCI performed significantly better but were not significantly more motivated than the male students using MOI, and the female students using MCI also performed significantly better but were not significantly more motivated than the female students using MOI. The study concluded that multimedia constructivist environment

fostered the learning of "Chemical Formulae and Equations".

Kim, K. (2005) aimed at finding the effect of constructivist approach in relation to academic achievement and self concept of sixth standard mathematics students. Students' feedback in relation to constructivist teaching was also obtained. It was found that Constructivist teaching was more effective than traditional teaching in terms of academic achievement. Constructivist teaching was not found to be effective with respect to self concept but was found to have some effect on motivation, anxiety towards learning and self motivation. It was also found that the students preferred constructivist environment to a traditional classroom.

Chin-Chung Tsai (2005) took up a study to develop a questionnaire to explore students' preferences toward constructivist Internet-based science learning environments. The questionnaire included eight scales: ease of use, relevance, multiple sources, student negotiation, cognitive apprenticeship, reflective thinking, critical judgment and epistemological awareness. The sample included 853 high school students (438 males and 415 females) from ten high schools in Taiwan. Through factor analysis, these scales revealed highly satisfactory validity and reliability in assessing students' perceptions for Internet-based science learning environments. The students' responses also showed that they strongly preferred the Internet-based learning environments that could connect scientific knowledge with real life situations. Female students were found to place more emphasis on the instructional guidance offered by the Internet-based environments for science learning. Presentation of scientific knowledge was found to be more authentic by female students than the male students.

Ambrose Hans G. Aggabao (2005) compared the effectiveness of three teaching approaches based on constructivist learning philosophies on achievement as well as retention of learning of students. The study focused on comparing new teaching approaches that were designed based on constructivist learning philosophies to current traditional teaching. Interactive small-group learning was used as a social constructivist approach while individualized self-engagement was used as radical constructivist approach. Both were supported with instructional materials and instructional protocol consistent with constructivist philosophies. Equivalent-Groups-Pre test-Post test Experimental Design was adopted for the study. The experiment was conducted on ninety two math students of a college of teacher education. Results of this study showed

that radical constructivist approach had significant advantage over the other two approaches, while the social constructivist approach showed better gain scores than the traditional teaching approach.

Dara Celeste Dozier (2004) took up a study to determine what relationship existed among interactivity, social constructivism, and satisfaction with distance learning in the target population of U. S. Army Infantry soldiers participating in college Distance Learning (DL) courses. 131 Infantry soldiers at Fort Benning, Georgia formed the sample. Statistically significant relationships were found between DL satisfaction and demographics like; prior experience with web-based learning, computer and Internet expertise, and number of media used for student instructor interaction. The findings supported the use of highly interactive social constructivist instructional approaches in computer-mediated and other learning environments.

Uzuntiryaki (2003) compared the effectiveness of instruction based on constructivist approach over traditionally designed chemistry instruction on ninth standard students' understanding of chemical bonding concepts. In addition, the effect of instruction on students' attitude towards chemistry as a school subject and the effect of gender difference on understanding of chemical bonding concept were investigated. The result indicated that instruction based on constructivist approach caused a significantly better understanding of scientific conception related to chemical bonding and produced significantly higher positive attitude towards chemistry as a school subject than the traditionally designed instruction. It was also found that science process skill was a strong predictor in understanding the concepts related to chemical bonding. No significant effect of gender difference was found on understanding the concept about chemical bonding and students' attitude towards chemistry as a school subject.

Laura Azzarito & Catherine D. Ennis (2003) investigated how teachers used social constructivist strategies to encourage student construction of knowledge and meanings, and how students constructed knowledge and meanings in two middle school physical education classrooms. A qualitative naturalistic design was used to collect data over a five-month period with two experienced middle school physical education teachers. Data included eleven weeks of observational field notes and interviews with teachers and students. Data were analyzed using cross-case and inductive analysis. Findings indicated that the teachers' strategies created a learning environment in which

students actively constructed knowledge and meanings by making connections to their peers and by connecting physical education to their lives, their communities, and the real world. Students were found to share information, assume leadership and responsibility, and make decisions. By connecting to their peers, students felt supported in their learning. The findings also supported seventy seven social constructivist strategies in physical education to encourage individual growth and social awareness among learners.

AkarHanife (2003) conducted a study to find the impact of constructivist learning process on pre-service teacher education students' performance, retention, and attitudes in Classroom Management Course. 144 third year pre-service teachers formed the sample. Data were collected through qualitative and quantitative methods. The findings indicated that retention was fostered through constructivist activities like 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 were found to have a negative impact on learners' attitudes towards the course.

Kate Hawkey (2003) took up a case study to find the effect of using asynchronous text-based discussion. The study considered the role of the tutor and discussed the extent to which online discussions can facilitate social constructivist approaches to instruction and the creation of knowledge. Seventeen trainee teachers studying in a post graduate teaching courseparticipated in the study. The asynchronous text-based discussion (using e-blackboard) focused on planning for progression in children's learning in history and culminated in the trainee teachers writing individual assignments on the topic. The study analysed the different types of contributions made and reports on the trainees' evaluations of the benefits and limitations of using e-blackboard.

Pooran (2000) examined the use of approaches to teaching science based on two contrasting perspectives in learning viz., social constructivist and traditional, and their effects on student's attitudes and achievement. It was found that students who were taught through constructivist-based teaching, showed more favourable attitude towards science as a subject. They were found to have obtained higher scores in class

achievement, total achievement and achievement on the knowledge and application test. It was also found that students in the traditional group showed more favourable attitude towards school. Females were found to have developed more positive attitude towards the importance of science and obtained significantly higher scores in class achievement. No significant interaction effects were obtained between method of instruction and gender.

2.2. Studies related to Achievement in Science

Thompson, Benika J. conducted a quantitative correlational research study to examine the degree of relationship among the predictor variables of fifth-grade science teachers' personal science teaching efficacy and science teaching outcome expectancy to student achievement in science. Fifth-grade elementary science teachers (N = 31) from a large urban school district in North Carolinawere surveyed using the STEBI to collect data on personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE).For each fifth-grade teacher, classroom composite scale scores were determined by calculating mean scale scores on the North Carolina End-of-Grade Test of Science Grade 5 as evidence of student achievement. A positive correlation was found between PSTE scale scores and science classroom composite scale scores with a resulting r value of 0.302. No statistically significant correlation (r= -0.053) existed between STOE and science classroom composite scale scores.

Chris and Kellogg, Ann T,(2016) presented findings from the Early Childhood Longitudinal Study, Kindergarten Class of 2010-2011 that demonstrated significant gaps in science achievement in kindergarten and first grade by race/ethnicity. They estimated the Black-White science gap in kindergarten at -0.82 SD but found only a small gender gap by first grade. Large disparities between Asian student performance in science as compared to mathematics and reading were documented. Student background characteristics and school fixed effects were found to amount for nearly 60% of the Black-White and Hispanic-White science achievement gaps in kindergarten.

Abdi, Ali, (2014)investigated the effects of inquiry-based learning method on students' academic achievement in science lessons. Forty fifth grade students from two different classes selected through purposive sampling formed the sample of the study. The group which was assigned as experimental group was instructed through inquiry-based learning method whereas the other group was instructed traditionally. The experiment lasted for eight weeks. The effectiveness of inquiry-based learning method over traditional instruction was determined by an achievement test consisting of 30 items on sciences administered as pre-test and post-test to students both in the experimental and control groups. Analysis of Covariance (ANCOVA) was usedfor statistical analysis. The results showed that students who were instructed through inquiry-based learning achieved higher scores on academic achievement in sciencethan the ones who were instructed through the traditional method.

Nwafor, Chika (2015)explored the effect of self-regulated learning approach on junior secondary school students' achievement in basic science. Quasi-experimental design was used for the study.Two co-educational schools were selected through simple random sampling technique. One school was assigned to the treatment group while the other was assigned to the control group randomly. Basic Science Achievement Test (BSAT) was used to collect data. The data for the research questions were answered descriptively using mean and standard deviation, while the hypotheses were tested using the analysis of Covariance (ANCOVA) at an alpha level of 0.05. The findings of the study revealed that self regulated learning strategy enhanced higher students' achievement in basic science than the conventional method.

Areepattamannil, Shaljan (2012)investigated the effects of inquiry-based science instruction on science achievement and interest in science. 5,120 adolescents from 85 schools in Qatar formed the sample of the study. Hierarchical linear modeling was used for analyses of data. The analysis revealed substantial positive effects of science teaching with a focus on model or applications and interactive science teaching and learning on science achievement and interest in

science. In contrast, science teaching and learning using student investigations and hands-on activities were found to have substantial negative effects on science achievement in the context of other variables.

Alpaslan, Muhammet Mustafa, (2017)conducted a research study to determine the level of the relationship among Turkish elementary school students' personal epistemologies, motivation, learning strategies, and achievements in science. A total of 322 fifth-grade students formed the sample of the study. Results from the structural equation modeling showed that students' personal epistemologies influenced both their motivation and metacognitive strategies in science learning. Viewing scientific knowledge as constructed by the learner was found to contribute to the students having high motivations, high science achievement, and the ability to engage meta-cognitively in learning tasks.

Therrien, William, et all., (2017)discussed the use of explicit instruction in the curriculum area of science where non-explicit approaches (e.g., discovery learning) are often used. They pinpointed the relative paucity of research on explicit instruction in science classrooms, They argued that explicit instruction, particularly when it is embedded within an inquiry approach aligned to the Next Generation Science Standards, had the potential to increase achievement in science for students with Learning disability. Based on previous research, they provided potential ways to implement the five core instructional components of explicit instruction in present inquiry-based science classrooms.

Widiana, Wayan and JampelNyoman, (2016) conducted a classroom action research aimed to improve the students' creative thinking and achievement in learning science. They implemented multiple intelligences approach with mind mapping approach and described the students' responses. The subjects of this research were the fifth grade students of SD 8 Tianyar Barat, Kubu, and Karangasam. The objects of this research were multiple intelligence, achievement in science and students' response. The research was conducted in two cycles and every cycle consisted of planning, action implementation, observation, and reflection. The data of students' creative thinking were collected by performance

test; the data of students' achievement in learning science were collected through questionnaire. The collected data were then analyzed descriptively and quantitatively. The results of the study showed that (1) the implementation of multiple intelligence approach improved the students' creative thinking and achievement in learning science. The improvement in the students' creative thinking from cycle I to cycle II is 16.56%. (2) The improvement of the students' achievement in learning science from cycle I to cycle II is 11.46%. (3) The students' response to the implementation of multiple intelligence with mind mapping fell into the positive category. The students were found to feel happy in learning science through the implementation of multiple intelligences with mind mapping.

Johnson, Carla, et all., (2016)examined the ability of Transformative Professional Development (TPD) to transform science teacher quality and associated impact on science achievement, including particular focus on English Language Learners (ELL). TPD was implemented in a large, low-performing, urban district in the southwest with predominantly Latino ELL populations. Findings revealed TPD enabled significant growth in teacher quality and participants in TPD experienced gains in student science achievement on state assessments. Most importantly, ELL student achievement in science Grades 4 to 8 was improved. Challenges to implementation of TPD are discussed along with implications for future research.

Caglak, Serdar (2017) investigated the influence of use of hands-on science activities on students academic achievement in science. Review of literature revealed several research studies focusing upon such aim and thus, a meta-analysis of these researches was carried out to obtain an overall effect size estimate of hands-on science activities on science achievement. Of the available studies, 15 with multiple outcomes satisfied the pre-determined inclusion criteria. In addition to the estimation of overall effect size using fixed- and random-effects models, subgroup analyses were also run through a mixed-effect model to determine whether heterogeneity in effect size estimates was due to the influence

of moderator variables. Results showed that the estimated effect size was statistically significant ($Z = 8.57$, $p < 0.01$). The magnitude of the overall effect size estimate indicated that the hands-on activities had a very large impact on students science achievement (Hedge`s g = 1.55, 95% CI = [1.20-1.91]). The effect size estimates for each moderator variable was also statistically significant at alpha level of 0.01, but no difference was found within sub-categories of moderator variables.

Topcu, Mustafa Sami et all., (2016)explored the factors predicting differences in science and mathematics achievement by students in Turkey and the Republic of Korea on the 2011 TIMSS assessment. While these countries are similar with regards to population size, cultural beliefs about education, and public expenditure on education, students in each country had different levels of achievement in science and mathematics. This study investigated how aptitude, instruction, and environment related factors predict Turkish and Korean students' achievement in science and mathematics. In both countries, some factors, such as student aptitude (e.g., science self-efficacy) and environmental (e.g., parental educational level) factors significantly predicted students' science and mathematics achievement. Some differences were found between the two countries regarding certain classroom environmental variables, such as bullying and student sense of belonging at school.

Adamuti-Trache et all., (2013)employed the data of 2004 School Achievement Indicators Program (SAIP) to examine whether academic effort manifested by greater investments in school and homework does result in higher literacy scores in science for Canadian students. The study compared four gender-immigrant profiles: Canadian-born males, immigrant males, Canadian-born females, and immigrant females on their scores on teacher-assigned grades in science and on the SAIP science literacy test, and across a range of dispositions, beliefs, and behaviors suggested in the literature as predictive of achievement in science. The Study found that Canadian-born students, particularly boys, had higher performance in the science literacy test despite their lower achievement in

the science classroom and the least investments of time in doing science homework. In contrast, immigrant female students demonstrated the highest academic effort and achievement in science courses. The results were attributed to different socialization experiences with science and technology that limit female and immigrant students' abilities to transfer knowledge to new situations that have not been learned in the classroom.

T Ma, Xin et all., used data from the 2011 (Chinese) Student Academic Achievement Evaluation, and examined whether within-school socioeconomic gaps in science achievement exist across science subjects. Multivariate multilevel analyses indicated that for both fathers and mothers within-school socioeconomic gaps in science achievement existed among schools but did not vary much across schools. Schools were strongly consistent in within-school socioeconomic gaps in science achievement across science subjects, and this consistency was found to be independent of student and school characteristics. The relationships between school average science achievement and within-school socioeconomic gaps in science achievement were found to be weak among schools across science subjects.

Ogonnaya (2016) investigated the effects of concept mapping on students' achievement in basic science. The study employed a quasi-experimental designviz., pretest posttest non-equivalent control group research design and was carried out in Ebonyi State of Nigeria. 122 students were selected by a simple random sampling from two secondary schools drawn from the population. One school was used for treatment and the other for control. The treatment group was taught basic science with concept mapping approach while the other was taught with conventional method. Mean, standard deviation and the Analysis of Co-Variance (ANCOVA) were used to analyze data. Results showed that concept mapping fosters students' achievement in basic science than conventional methodin both male female students. In addition there no interaction effect was found between gender and teaching methods on students' achievement in basic science.

Lee et all., (2017)investigated teacher learning and teacher beliefs in a two-year technology professional development (TPD) for teachers and its impact on their student achievement in science in the western part of the United States. Middle-school science teachers participated in TPD focused on information communication technologies (ICTs) and their applications in science inquiry pedagogy. Three self-reporting teacher measures investigating technological literacy, ICT capabilities, and pedagogical beliefs about science inquiry pedagogy and Student achievement scores on the end-of-year state-science-test were used to collect the data. Descriptive statistics, t-tests, and Pearson's correlations were used for analysis. Teachers' technological skills and ICT capabilities was found to increase over time with significant gains each year. Teachers' pedagogical beliefs were found to change to become more science inquiry oriented over time; but, the gains were not significant until after the second year of TPD. Students' performance was found to be correlated to teachers' pedagogical beliefs about science inquiry.

2.3. Studies related to Critical Thinking

Enabulele, Augustine, (2011) examined the effectiveness of the dialectical journal as a tool for teaching critical thinking skills, and middle school teachers' perception of critical thinking. Two groups of middle school students were split into control and experimental group. Critical thinking test was administered as a pre test to both the groups before the experimental group was instructed on how to use the dialectical journal for two weeks. Critical thinking test after the instruction was given to both the groups as post test. Also, middle school teachers responded to survey questions and indicated their perceptions of critical thinking. Results demonstrate that the experimental group performed poorer than it did in the pretest group. Similarly, the control group performed poorer than it did in the pretest. Majority of the teachers were found to have perceptions of critical thinking that are favorable and accurate by virtue of their consistency with research. The dialectical journal was found to be ineffective as a tool for teaching

critical thinking. Since teachers had favorable perception of critical thinking, they were willing to learn more about it and to teach it.

Devika, R.; Soumya, P. R., (2016) conducted a study to investigate the influence of gender, type of management and the optional subject on the critical thinking ability of higher school students using the normative survey method on a sample of 640 secondary school students from schools of Palakkad district. Critical Thinking Ability Test for Higher Secondary School Students was constructed and standardized by the investigators. ANOVA and t-test were used to analyze the data. A significant difference was found to exist in the mean scores of critical thinking ability with respect to gender, type of management and optional subjects of students.

Widyatiningtyas, Reviandari, (2015) took up a study to analyze the influence of problem-based learning approach, school level, and students' prior mathematical ability to student's mathematics critical thinking ability. 140 grade ten senior high school students coming from excellent and moderate school level formed the sample of the study. Post-test control group only research design was adopted for the study. A set of mathematical critical thinking ability test was used as the research instruments. The data were analyzed by using two way ANOVA and t-test. The research found that the problem-based learning approach had a significant impact on the ability of students' mathematics critical thinking in terms of school level and students' prior mathematical abilities. It was also found that there was no interaction between learning approach and school level, and learning approach and students' prior mathematics ability to students' mathematics critical thinking ability.

Arrington, Walter T. Ted, (2017), investigated and analysed the teaching of critical thinking skills in eight public universities in Texas, in History, Education, and Business departments. Document analysis of the universities' mission statements, the departments' stated learning objectives, and two upper level undergraduate syllabi from each department was done. This phase of the study analyzed the maximal keyword and word sequence frequency within the

documents, the search terms having been derived from critical thinking language and Bloom's Taxonomy and standing as proxies for critical thinking skills. A second phase of the study surveyed history professors at seventeen public and private Texas universities for their perspectives on teaching critical thinking skills. Results indicated that no college course in either history or education specifically prepared future teachers to teach critical thinking skills at the secondary level. A concerted effort needs to be made by education departments to provide discipline specific courses, e.g., Teaching History in Secondary Education, which include as part of that preparation the teaching of critical thinking skills to high school students.

Kwan, Yee Wan; Wong, Angela F. L., (2014) investigated-secondary school students' perceptions of their constructivist learning environment in Liberal Studies, and whether their perceptions were related to their critical thinking ability. A convenience sample of 967Secondary students studying Liberal Studies in Hong Kong participated in this research by completing a self-administered questionnaire which included the Constructivist Learning Environment Survey (CLES), Cornell Critical Thinking Test Level X, and demographic information on age and gender. Students were found to perceive their learning environment to be moderately constructivist in nature. Both age and school banding differences were identified in that younger students and students in band 1 schools tended to perceive a higher degree of constructivist characteristics in their learning environment. Multiple regression analyses indicated that three of the five scales of CLES were predictors of critical thinking ability. Shared Control was the strongest predictor and negatively associated with critical thinking ability, while Personal Relevance and Critical Voice were positively related to critical thinking ability. Findings of the study are discussed with reference to developing students' critical thinking ability in Liberal Studies classrooms.

Kettler, Todd (2014), investigated the critical thinking skills of fourth-grade students from a school district in Texas, including 45 identified gifted students and 163 general education students. Identified gifted students were found to

outperform general education students on both the Cornell Critical Thinking Test and the Test of Critical Thinking. There was no evidence of main effects or interaction effects for gender in measures of critical thinking within these samples. Critical thinking scores of were not found to differ significantly, nor were differences in scores associated with length of exposure to the gifted education program. The association of higher ability with advanced critical thinking skills, and the lack of evidence of an effect of the gifted education programs not focussing specifically on critical thinking skills suggested that differentiation of curriculum and instruction for gifted or advanced learners might fruitfully include deliberate differentiation of instruction in this area.

Kurniati; Kusumah, (2015), examined the effect of the application of contextual teaching and learning (CTL) approach to the enhance of mathematical critical thinking ability (MCTA) of Primary School Teacher Students (PSTS). This research is an experimental study with the population of all PSTS who took algebra subject matter of one university in the city of Bogor. The results showed: (1) the increase of MCTA of student who receive CTL better than students who receive TTL; (2) There are differences in the increase MCTA between students in groups of high MPA, medium MPA, and low MPA, both the student who received the CTL and TTL; and (3) There is no interaction between learning factors (CTL and TTL) with MPA (high, medium and low) toward the enhance of MCTA.

Walter, Christel and Walter, Paul., (2018) explored the influence of critical thinking and interests on students' performance at school. The tested students attended German grammar schools ("Gymnasien"). Separate regression analyses showed the expected moderate positive influences of critical thinking and interests on school performance. Structural Equation Model was used for analysis of data. Only a direct effect of critical thinking on school performance was observed. Critical thinking seemed to be a moderator variable, mediating an indirect effect of interest on school performance. An additional analysis of the data showed that the influence of critical thinking could exclusively be observed in the subsample of students who had a family background without a migration history. In the

subsample with migration history critical thinking and interests did not have an effect on school performance. Since the students with migration history did not differ in school performance from their fellow students without migration history, the result gives rise to the assumption that those students in German grammar schools may have chosen other ways of motivation and learning style to school performance.

Gurcay, Deniz and Ferah, HaticeOzturk, (2018), examined the relationship between ninth grade students' metacognitive self-regulation skills and physics self-efficacy beliefs and their critical thinking., 162 students of ninth grade formed the sample of the study. Critical thinking scale, metacognitive self-regulation scale and physics self-efficacy scale were used as tools. Data were analyzed by descriptive statistics, Pearson product moment correlation analysis, and stepwise multiple regression analysis. The results indicated that the students' critical thinking, metacognitive self-regulation and physics self-efficacy beliefs were high. It also revealed that the students' metacognitive self-regulation and physics self-efficacy belief scores were significant predictors of their critical thinking scores, explaining 55% of the variance of critical thinking scores. The main variable found to explain critical thinking was metacognitive self-regulation, explaining 53% of variance.

Dilekli, Yalçin, (2017) investigated the relationship between critical thinking skills and learning styles of mentally gifted students. The participants were 225 gifted students in Turkey attending Science and Art Centres which are after-school activity centers for mentally gifted students. Participants were 9-15 years old and were attending secondary schools and high schools. The data were gathered using the Kolb Learning Style Inventory and the Critical Thinking Scale and analyzed using Chi-Square, t test, ANOVA and regression analyses. The findings revealed that gender was not a significant variable for learning styles but it was a significant variable for critical thinking skills. Gifted students were found to have higher scores on the Critical Thinking scale. Relationships were also found between gifted students' learning styles and their critical thinking skills

except in the analysis dimension of the Critical Thinking scale. Gifted students who achieved the highest scores were found to possess assimilating and converging learning styles.

2.4. Studies related to Social Maturity

Suchow (2016) integrated 3D printing into the learning environment, incorporating complex design projects that embody the highest ideals of service for others following a sequence in a Catholic secondary school. First, he described the initial year of implementation, including best practices derived from the experiences. Next, he described efforts in the second year to expand the program goals to include designing and printing for others in need. These descriptions were paired with a discussion of outcomes and lessons learned through the 3D printing endeavors. Lastly, and most importantly, he made a series of recommendations for educators to introduce a 3D printer into their faith-based curriculum, to see their students develop the skills and vision needed to become the protagonist artisans of the future.

Suchow, R. (2016). 3D Printing & Service Learning: Social Manufacturing as a Vehicle for Developing Social Awareness. Journal of Catholic Education, 20(1), 292-300.

Vibha (2011)took up a study on a sample of 500 B.Ed. teacher trainees from School of Education, Lovely Professional University. The independent variables viz., Self Esteem and Emotional Maturity were varied at two levels-Low and High. The results of ANOVA showed that Low and High Self Esteem groups exhibited significant differences on the variables of Transcendence, Interconnectedness, Expansion of Self, Extrasensory Perception and Total Spiritual Intelligence in favour of High Self Esteem group, whereas no differences were exhibited between two groups of Low and High Self Esteem on the variable of Existential Enquiry. In relation to Emotional Maturity groups-low and high, significant differences were found on the variables of Transcendence, Expansion of Self, Extrasensory Perception and Total Spiritual Intelligence in favour of Low

Emotional Maturity and no significant differences were found on the variables of Interconnectedness and Existential Enquiry. The double interaction effects of the variables of Self Esteem and Emotional Maturity were not found to be significant on Spiritual Intelligence and all its dimensions.

Singhpuar (2013)took up a study to investigate the non-cognitive variables like anxiety, emotional maturity and social maturity and their relationship with academic achievement. The study also aimed studying the locale-wise differences in anxiety, emotional maturity and social maturity. It was found that there existed a significant relationship between social maturity and academic achievement as well as between anxiety and academic achievement. No significant relationship was observed between Emotional maturity and academic achievement. It was found that Rural and Urban high school students differed significantly in their level of anxiety whereas no significant difference was found between them on the variables of Emotional and Social Maturity.

Kalagbor (2016)examined factors that positively influence students' academic performance in public and private secondary schools in Rivers State-Nigeria. The instrument used for the collection of data was the "Students' Academic Performance Questionnaire" (SAPQ), structured on the 4-point Likert scale measurement. The findings revealed that public secondary students were better influenced by the quality of teaching manpower than their counterparts in private secondary schools. The researcher recommended the need for the government to pay adequate priority attention to educational system, particularly, in the areas of making the public secondary schools satisfy the minimum education establishment standards and prosecuting proprietors of unapproved private schools to sustain minimum educational standards in Rivers State.

Alzboon (2013)explored the level of social adaptation and its relationship with achievement motivation of the secondary school students in Jordan. The sample consisted of 495 secondary school students in the province of Jerash. Two tools were developed to collect the data for the study, one measuring social adaptation and the other measuring achievement motivation. The study found that

the level of social adaptation and achievement motivation among secondary school students in the province of Jerash were high.Statistically significant positive relationship was found between social adaptation and achievement motivation among the secondary school students in the province. Therefore, in light of the results, the researcher recommended conducting further studies exploring the relationship of social adaptation to other variables.

Nagra& Kaur (2013) took up a study with the objective of identifying the social maturity ofteacher educators in relation to locality and subject stream. A sample of 200 teacher educators from different locality and subject stream formed the sample. Results of the study revealed that teacher educators possessed a high level of social maturity. No significant difference was observed in social maturity of teacher educators in relation to locality and subject streams. The analysis of variance results were also insignificant highlighting that there was no interaction effect of locality and subject stream on social maturity of teacher educators.

Kumar &Ritu (2013) in his study highlighted that social maturity is knowing what to do and striving for it by following role models to reach the desired level of acceptable social behavior. It also highlighted that Personality comprised of pattern of feelings, thoughts, and activities that distinguishes one person from another. The study aimed at finding the relationship between social maturity and personality of senior secondary school students. It was hypothesized that no relationship existed between social maturity and personality of senior secondary school students. It was found that no significant difference existed between social maturity and personality of male and female senior secondary school students. A sample of 100 (50 male and 50 female) senior secondary school students studying in class XII of senior secondary schools were selected through simple random sampling method. Social maturity scale developed by Dr. R. P. Srivastava and DPI (Dimensional personality Inventory) by Dr. Mahesh Bhargava were used to collect the data. The study found that a positive relationship exists between social maturity and personality of senior secondary

school students. No significant difference was found between social maturity and personality of male and female secondary school students.

Astha& et al. (2017) took up a study to assess the social maturity of adolescents. They viewed social maturity as the ability to function in an appropriate responsible manner and the process of establishing a satisfactory relationship between individual and his environment. Two colleges Stella Marrys Convent College and KNIC College were selected from Sultanpur city. A sample of 60 students were selected randomly. Vineland social maturity test (1992) developed by Dr. A.J. Malin and Dr. J. Bharath Raj was used in this study. It was found that most (66.66%) of the male respondents had high social maturity and most of the girls i.e (70%) of the respondents had high social maturity. Girls were found to posses high social maturity than boys.

Gupta (2014)examined Social Maturity among male and female M.Ed. Students. 100 male and female students of M.Ed. from Science and Arts streams from Himachal Pradesh formed the sample. Comprehensive scale of Social Maturity prepared by Roma Pal was used to collect the data. The reliability was found to be 0.834 and the validity was found to be 0.831. After the analysis of the data, it was found that all M.Ed. students, irrespective of the group they belong to, whether science or humanity were social mature. No significant difference was found in social maturity level among female arts and science students. There was no significant difference in the social maturity level among male and female students. There was no significant difference in the social maturity level among male arts and science students; among male and female science students; and among male and female arts students.

Anand et al (2014). studied social maturity and personality of secondary and higher secondary school students in relation to their socio-demographic variables. The sample of 220 students of IXth, Xth, XIth and XIIth class, out of which 110 were boys and 110 were girls were selected from co-educational English medium schools of Kanpur district using multistage random sampling technique. Self-designed socio-demographic questionnaire was used to study the

socio-demographic characteristics of respondents. Social maturity of the respondents was assessed by using Rao's Social Maturity scale developed by DrNalini Rao. Recreation was considered as a factor in social maturity of adolescents. Factors of social maturity of adolescents of co-education schools were found to be affected by family and peer group. Social maturity of 50.9% boys and 40.0% of girls were affected by their neighborhood and school.

Choudhar & Madhuri (2014),undertook a study to assess and compare the Social Maturity of Adolescents in relation to their Gender and Locality. In their view social maturity is the ability to function in an appropriate responsible manner. They took up this study since adolescence is the age for an individual to express mature behavior and Social Maturity is an essential aspect for an individual. The sample consisted of 500 adolescent students studying in 11th and 12th standards from rural,(250(125 female and 125 male)) and Urban, (250 (125 female and 125 male)) areas. Rao's Social Maturity scale was used to assess their social maturity. Thus obtained data was analyzed using means, S.Ds, and 't'-test. The research revealed significant gender difference on the basis of social maturity and also reported that adolescent students belonging to rural areas possess higher social maturity than those belonging to urban area. The study has implications for the parents, teachers and policy makers.

Hasnain& Adlakha (2012)investigated the differences in the levels of self-esteem, social maturity and well-being between adolescents with and without siblings. They also investigated the percentage of variance counted by social maturity and self-esteem in the well-being of adolescents with and without siblings. For this purpose a total sample of 100 students studying in 10th to 12th grades were selected on purposive basis from the schools of Delhi and National Capital Region (NCR) of India. In order to collect the data Self-esteem Inventory by Coopersmith, Social Maturity scale by Rao and PGI Well-being measure by Verma&Verma were administered to the participants. Non-significant differences were obtained between adolescents with and without siblings on self-esteem and well-being. However, significant difference was found between adolescents with

and without siblings on social maturity showing that adolescents without siblings had higher mean social maturity score than adolescents with siblings. The study of regression analysis showed significant contribution of social maturity and self-esteem together in well-being of adolescents without siblings, but independently they were not found to contribute significantly to their well-being. The total contributions of self-esteem and social maturity in the well-being of adolescents without siblings was 13%. However, in the case of adolescents with siblings social maturity and self-esteem neither together nor independently were found to contribute significantly to their well-being.

Manju (2016) investigated the Social maturity of B. Ed Student teachers. A sample of 150 B.Ed student teachers from Mysore City was selected adopting Stratified random sampling technique giving representation to different types of B.Ed colleges and streams. B Ed student teacher's social maturity was assessed with the help of social maturity scale developed by Nalini Rao. Descriptive survey method was adopted for the study. The data, which was obtained from the survey, was analyzed using percentage analysis, t-test and one-way ANOVA. It was found that a majority (45%) of the B. Ed student teachers in Mysore city possessed average level of Social Maturity and (26 %) were found to possess low level of Social Maturity. Only (29 %) of the B.Ed students were found to possess high level Social Maturity. It is found that the female student teachers possessed higher Social Maturity than their male counterparts. No significant difference was found between Arts and science B. Ed student teachers in their Social Maturity. It is found that student teachers from aided B. Ed college possessed significantly higher Social Maturity than their counter parts from Government and Unaided Colleges.

Sethu Madhavi & Amuthavalli (2014) investigated the social maturity of visually impaired high school students. The sample consisted of 400 visually impaired high school students, 200 boys and 200 girls from two government and two private schools for visually impaired, selected purposively. The data was analysed by the computation of mean, SD and t-test. The findings revealed that the visually impaired high school students stand on above average level of social maturity. Boys were found to be more socially mature than girls and government

school students were found to be more socially mature than private school students.

Shah & Sharma (2012) aimed at studying the relationship between Social Maturity, School Adjustment and levels of Academic achievement among residential school girl students. The study was conducted on a sample of 347 girls from class IX to XII at an all girls residential school of North India. Dr. Nalini Rao's Social Maturity Scale (RSMS) was used to measure social maturity, Sinha & Singh's Adjustment Inventory for School Students (AISS) was used to measure school adjustment and aggregate score of the students in the year end final examination was taken to assess the level of their academic achievement. The findings indicated a significant relationship between social maturity and school adjustment. Also, significant difference was indicated between the school adjustments of the three groups of students i.e. low, high and average levels of academic achievement.

Pan (2014) conducted a study to find out the adjustment ability and social maturity level among the secondary school students in relation to their gender, strata, and socioeconomic status. and also measures the relationship between two variables through correlation. The samples were drawn through random sampling technique from secondary schools of West Bengal and were categorised based on gender, strata, and socioeconomic status. Two standardised tools were used for data collection and the collected data were analysed through descriptive statistics (mean, median, and SD) and inferential statistics (t-test and product moment correlation). The study showed that there is a significant difference in adjustment ability and social maturity in relation to gender, strata, and socioeconomic status and that there is a significant correlation between the adjustment ability and social maturity. This research helps all the institutional units especially the teachers to understand how institutional adjustment increases student's social maturity.

Alam (2016) investigated social adjustment and social maturity as

predictors of academic achievement among adolescents. Descriptive survey method of research was used for collecting the data using Adjustment Inventory for School Students (AISS) by A. K.P. Sinha and R.P. Singh (1993) and Social Maturity Scale (RSMS) by Nalini Rao (1986). The sample included 200 randomly selected students of 10th class from government high schools of Darbhanga District (Bihar).Descriptive, correlational and inferential statistics were used to compute correlations and to compare the means between the groups. The findings revealed that (1) there is significant relationship between social adjustment, social maturity and academic achievement of students across total and sub samples (2) there is significant difference between boys and girls in respect of their social adjustment and social maturity, however they do not differ significantly on academic achievement (3) there is significant difference between rural and urban students in respect of their social adjustment, social maturity and academic achievement. It is recommended that similar research with appropriate methodology and design may be used to ascertain the degree of conformity which this research has on the above said variables, namely, social adjustment and social maturity. Educational planners and curriculum designers are required to consider a course dealing with social skills and the ways to get adjusted with the problems facing the students in different fields particularly in academics.

Punia (2015) studied the social maturity of B.Sc students. Adolescence is an impressionable age or role models replicating stage, they take them from all areas that are close at hand in their society, whether mass media, parents and family or their teachers. An individual's personal and social values and skills is that complex of knowledge, values, attitudes and abilities which contribute to the development of a sound moral character, as a sense of community and competence is responding to the personal, social and cultural aspects of life. Results of present study depict that 63.3 per cent students of 1st year were moderately socially mature against 76.6 percent of 3rd year students. Mean scores of B.Sc. 3rd year on personal adequacy, inter-personal adequacy and social adequacy (76.83, 76.93, 80.00) was found to be higher than 1st year students.

Sadeghi & Niknam (2015)aims to evaluate the relationship between coping skills with social maturity and adjustment in female first graders of high school in Tehran city. The present study is a correlational based study including 370 female students selected by multi stage random sampling method. This study applies Lazarus coping skills, social maturity scale of Vineland and Bell's adjustment Inventory. The results of regression analysis showed that coping skills predict social maturity and adjustment. The study found a positive and significant relation between coping skills (problem-focused, emotion-focused) and social maturity and adjustment.

Naik & Saimons (2014) took up an extensive research linking healthy social and emotional development to effective parenting. Adolescents thrive when parents provide not only affection, but also respectful communication and listening, consistent rules and expectations, and safe opportunities that promote independence. Successful parenting was found to foster psychological adjustment, help adolescents succeed in school, encourage curiosity about the world, and motivate children to achieve.

Athanimath & Yenagi (2011) conducted a study to know the relation between social maturity and depression among second PUC students. The total sample consisted of 463 students drawn from science tutorials in Dharwad city during 2008-09. Social maturity of the students was measured using the social maturity scale developed by Roma Pal (1986).The depression of the students was measured using the depression scale developed by Karim and Tiwari (1986) and the self-structured personal information schedule was used to know the demographic characteristics of the students. The findings of the study reveled that, half of the students were socially matured. 42 percent of the students were found to be high on social maturity and 6 percent of them were low on social maturity. There was no significant gender difference on social maturity followed by low (30%) and highly depressed (16 %) and there was a significant gender difference among the students on depression indicating that boys being more depressed than girls. There was negative but non-significant relation between social maturity and

depression among the students. Age was found to have a positive and significant relation with depression among the students, while parents' education and annual income of the family had negative and significant relationship with the depression. Thus the findings revealed that the students with high social maturity were less depressed.

CHAPTER -III

METHODOLOGY

The previous chapter dealt with the review of related literature. This chapter presents the procedural details of the research methodology followed in this study.

3.1 Statement of the Problem:

In view of the importance accorded to adoption of social constructivist strategies to teach science in classrooms at secondary stage, strategies and plans need to be designed and their impact on achieving the objectives of teaching science need to be tested.

Hence, the statement of the problem is as follows,

"Effect of social constructivist strategies on achievement in science critical thinking and social maturity of secondary school students"

3.2 Objectives of the study:

The study was undertaken with the following objectives:

1. To develop lesson plans based on social constructivist strategies for ninth standard science.
2. To study the effect of social constructivist strategies on secondary school students with respect to their
    - Achievement in science
    - Critical thinking
    - Social maturity
3. To study the interaction effect of Treatment and Gender on achievement in science of secondary school students.
4. To study the interaction effect of Treatment and Gender on critical thinking of secondary school students.
5. To study the interaction effect of Treatment and Gender on social maturity of secondary School students.

6. To examine whether there is significant relationship between critical thinking and achievement in science of secondary school students.
7. To examine whether there is significant relationship between achievement in science and Social Maturity of secondary school students.
8. To examine whether there is significant relationship between Critical thinking and Social Maturity of secondary school students.

3.3 Hypotheses of the study:

In pursuance of the objectives of the study the following null hypotheses were formulated:

1. There is no significant difference in post test scores of achievement in science of experimental and control group.
2. There is no significant difference in the mean gain scores of critical thinking of experimental and control group.
3. There is no significant difference in the mean gain scores of social maturity of experimental and control group.
4. There is no significant interaction effect of treatment and gender of secondary school students with respect to their
    - Achievement in science.
    - Critical thinking.
    - Social maturity.
5. There is no significant correlation between achievement in science and critical thinking of secondary school students.
6. There is no significant correlation between Achievement science and social maturity of secondary school students.
7. There is no significant correlation between critical thinking and social maturity of secondary school students.

3.4 Variables of the present study:

The variables of the present study fall into four categories viz., Independent, Dependent, Moderate and Control variables.

1. Independent variable:

- Treatment:
    - Social constructivist strategies of teaching science.
    - Traditional method of teaching science.

2. Dependent Variables:
    - Achievement in science.
    - Critical thinking.
    - Social maturity.
3. Moderate variable:
    - Gender
4. Control variable:
    - General Mental ability.

3.5 Operational definitions of the key terms:

Some of the key terms that are used in this study are defined operationally as follows:

- **Treatment:** Treatment refers to the two methods of teaching which were adopted to teach science to the ninth standard students the treatment included teaching of science through social constructivist strategies and the traditional method.
- **Social constructivism:** Social constructivism extends constructivism into social settings, where in groups of students construct knowledge for one another, collaboratively creating a small culture of shared artifacts with shared meanings.
- **Social Constructivist Strategies(SCS):**In this study social constructivist strategies of teaching science refer to those teaching learning strategies which encourage students to construct their own knowledge as they work in small groups and those which provide scope for the More Knowledgeable Other (MKO)to facilitate learning. The new learning is planned in line with the Zone of Proximal Development (ZPD). The following social constructivist strategies were adopted to teach content from science through social constructivist principles in this study: Cooperative learning, Collaborative learning, Concept mapping, Situated Learning, Anchored Instruction, Inquiry Based learning, Problem solving, Games and Simulation and Case-based instruction.

- **Traditional Method of Teaching (TMT)**

  Traditional method of teaching is teacher centered in which teacher imparts knowledge and students receive it. Information is transferred to the students in the form of chalk and talk and lecture. There is less scope for interaction between students themselves and the teacher. Emphasis is on rote memory of the content matter rather than the thinking process.Students are not expected to think in an exclusive manner even though thinking about different scientific issues is highly important.

- **Achievement in science**: Achievement indicates the attainment of the set objectives related to knowledge, understanding, application and skills. Achievement in science is an act of successful accomplishment, especially in relation to the content prescribed in science syllabus. Achievement in science in the present study is the total scores obtained by the students on items representing knowledge, understanding, application and skills in Science achievement test constructed by the investigator.

- **Critical thinking**: Critical thinking is purposeful, self-regulatory judgment which results in interpretation, analysis, evolution and inference, as well as explanation of the evidential, conceptual, methodological, or context considerations upon which that judgment is based. Critical thinking is an individual's ability to recognize problems, understand the importance of prioritization and order of precedence in problem solving, gather relevant information, interpret data to appraise evidence and evaluate arguments, recognize the existence or nonexistence of logical relationships between propositions, draw warranted conclusion and generalization, put to test the conclusion and generalizations at which one arrives and render accelerate judgments about specific ideas in everyday life.

Following are the components of critical thinking considered for constructing the critical thinking test:

- **Analyzing**: refers to the ability of the individual in separating or breaking a whole into parts to discover their nature, function and relationships.
- **Applying standards**: refers to judging according to established personal, professional, or social rules or criteria.

- **Information Seeking**: refers to the ability to search for evidence, facts, or knowledge by identifying relevant sources and gathering objective, subjective historical and current data from those sources.
- **Discriminating**: depicts the ability to recognize differences and similarities among concepts or situation and extinguish carefully to categorize.
- **Predicting:** depicts the ability for envisioning a plan and its consequences.
- **Logical reasoning:** refers to the ability to draw inferences or conclusion that are supported in or justified by evidence.
- **Transforming knowledge**: refers to the ability to change or convert the condition, nature, form or function of concept among contexts.
- **Inference:** is the ability to infer conclusion or opinion that is formed because of known facts or evidence. This conclusion is arrived at rationally and logically based on given facts or circumstances.
- **Decision Making:** refers to the thought process of selecting a logical choice from the available option.

Critical thinking in this study is represented by scores on critical thinking test constructed by the investigator.

Social maturity: Social maturity is the possession of appropriate attitude for personal and interpersonal relationships which are essential for effective functioning in the society.Social maturity in the present study is represented by the scores on Social maturity scale developed by Nalini Rao.

General Mental Ability (GMA): General mental ability is a term which describes the level at which an individual learns, understands instructions, & solves problems &is considered the most important factor, explaining more variation in individual performance than specific abilities. General Mental ability in this study is represented by the total scores obtained by the students on Raven's StandardProgressive Matrices.

3.6. Method of the Study:

The present study was an experimental study in which pre- test, post- test parallel group design was adopted in order to compare the effect of social constructivist strategies & traditional method on achievement in science, critical thinking &social maturity.

The present study was conducted in the following three phases:

a) Phase 1:Development and Validation of lesson plans based on social constructivist strategies for teaching science to the experimental group
b) Phase 2: Construction and Validation of achievement test in science and critical thinking test.
c) Phase 3: Experimentation: Implementation of social constructivist strategies to teach science to the experiment group and traditional teaching approach to the control group. After administering the pretest,the treatment was implemented and later thepost- test was administered for collecting the data and the data was analyzed.

The lesson plans for teaching the selected content of science based on SCS for ninth standard syllabus were developed. The lesson plans were given to experts in the field of education for scrutiny and the suggestion of experts were incorporated. These lessons were tried out and changes were made to suit the classroom conditions and were thus validated.

3.6.1 Social constructivist lesson plans:

Lesson plans were developed for the selected content to be taught using different social constructivist strategies.These lesson plans were based on the background knowledge and experience of the students and follows the principles of social constructivism. Twenty five lesson plans were prepared for the selected units in science syllabus of ninth standard.

Lesson were planned based on the "5E Model developed By Roger Bybee of "The Biological science curriculum study" (BSCS) as this model was developed based on constructivist principles of learning. The 5Es represents the following five stages: Engage, Explore, Explain, Elaborate and Evaluate.

- **Engage**: In this stage the teacher arouses student's interest and curiosity and gets them personally involved in the lesson, promotes questioning and connects learning to real life experiences. The teacher structures tasks, elicits student's prior knowledge and facilitates them to make connections to post learning experiences. Asking a question, defining problem, showing surprising events and problematic situations act as means to engage the students and focus them on the

instructional tasks. Discussions initiated helped to uncover students prior understanding and videos were used to create students curiosity and to encourage them to ask their own questions.

- **Explore:** The purpose of this stage is to get students involved in the topic to provide them with a chance to build their own understanding.In this stage the students have the opportunity to directly get involved with phenomena and materials. As they work together in teams, students build a set of common experiences, which prompts sharing and interaction. The teacher identifies student's conceptions and challenges their misconceptions. The teacher also assists student to expand their perspectives and reflect on their learning. The teacher is mindful of the learning requirements of the task attentive to student responses and intervenes accordingly.

- **Explain:** At this stage students are provided with an opportunity to communicate what they have learned so far and figure out what it means. The teacher provides opportunities for students to demonstrate their current levels of understanding through verbal and non-verbal means. They explicitly reveal the relevant knowledge, Concepts and skills which is represented in multiple ways. The teacher provides strategies to enable students to connect and organize new and existing knowledge. They assist students to represent their ideas, using language and images to engage them in reading, writing, speaking, listening and viewing. In this stage communication occurs between, peers, with the facilitator, and through the reflective process these segmented introduce vocabulary in context and correct or redirect in is conceptions. Teaching progressively asses students understanding and structure opportunities for students to practice new skills.

- **Elaborate:** In this stage students are allowed to use their new knowledge and continue to use explore its implications. The teacher engages students in dialogue continuously. They support students to identify and generate principles or rules. At this stage students expand on the concepts they have learned, make connections to other related concept, and apply their understanding to the world around them in new ways. The teacher supports students to create and test

hypotheses and to justify decisions. The teacher monitors student understanding by providing explicit feedback and adjusts instruction accordingly.

- **Evaluate:** This stage helps both students and teachers to determine how much learning and understanding has taken place. The final "E" is an on-going diagnostic process that allows the teacher to determine if the learner has attained understanding of concepts and knowledge. Evaluation and assessment can occur at all points along the continuum of the instructional process. Rubrics, teacher observation, student's interviews, portfolios, project and problem-based learning products, video segments are used as tools to assist the evaluation. They are used to determine student's depth of understanding. Students will be excited to demonstrate their understanding through journals drawings, models and performance tasks.

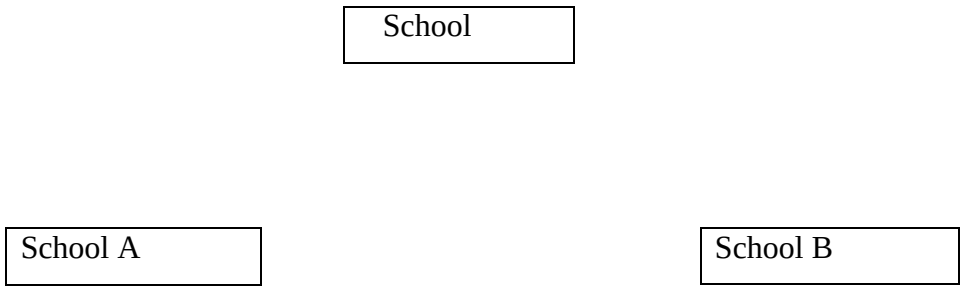
3.6.2 Design of the Experiment:

Pre-test Post-test matched group design was adopted as the research design for the present study. The main advantages of this design lies in matching the subject on their general mental ability (GMA) and the random assignment of subjects at initial stage assure equivalence between groups prior to experimentation. Table 3.1 represents the Pre-test Post –test matched Group Design.

Table No.3.1: Experimental design: Pre-test Post –test matched Group Design.

Group	Pre-test	Treatment	Post-test
Experimental group	Critical thinking test and Social maturity scale	Teaching through social constructivist strategies	Achievement test,Critical thinking test and Social maturity scale
Control group	Critical thinking test and Social maturity scale	Teaching through traditional method	Achievement test,Critical thinking test and Social maturity scale

The diagrammatic representation of experimental method is shown in Fig.3.1



[Note: SCS-Social Constructivist Strategy. TMT- Traditional method of teaching]

Students from two schools were administrated Raven's Progressive Matrices to measure their GMA. The GMA scores, were converted to Standard T scores. Students who scored nearly the same on GMA were assigned to the two groups of thirty students each in both the schools. These matched groups were randomly assigned as experimental and control groups of thirty students each in two schools were matched on their GMA and were randomly assigned to the experimental and control groups.

Pre-test on critical thinking and social maturity was initially administered to both the experimental and control groups in each of the schools before starting the treatment. The two experimental groups in both the schools were taught by adopting SCS for a period of three months simultaneously and the two control groups in both the schools were taught by the traditional method.

Critical thinking test and social maturity scale were administered as posttest to both experimental and control groups. The significance difference between post scores of achievement in science of experimental and control group were found to compare the effectiveness of SCS and TMT in enhancing Achievement in science. The significance of difference between the mean gain scores of critical thinking and social maturity of the experimental and control groups were found to compare the effect of SCS and the traditional methods of Teaching science in enhancing critical thinking and social maturity of secondary school students.

Pre-test

Critical thinking test and social maturity scale was used as pre-test to determine the student's entry behavior. All the 120 students belonging to the two experimental and two control groups in both the schools were administered critical thinking test and social maturity scale as the pre-test.The Pre-test scores of all the four groups have been presented in appendix.

Post-test

The post-tests were administered at the end of treatment to both the experimental and control group to measure their terminal behavior with respect to Achievement in science, Critical thinking and Social maturity. The post-test scores in achievement in science, Critical thinking and social maturity of the four group have been presented in appendix.

3.6.3 Homogenizing the group:

Since the students selected for the treatment were from different schools,the Investigator had to make sure that they would have the same ability before the treatment.In order to obtain parallel groups of experimental and the control groups, the researcher administered Raven's progressive Matrices (RPM) to measure their GMA the students were matched on their general mental ability before assigning to the experimental and control group to assure equivalence between the group prior to experimentation. Students from two schools were administered Raven's progressive matrices to measure their GMA. The GMA scores were converted to T-scores and students who scored nearly the same on GMA were assigned to two groups of 30 students in both the selected schools. These matched groups were randomly assigned as experimental and control groups in school A and school B. Thus two groups of 30 students each in two schools were matched on their GMA and were randomly assigned to the experimental and control groups.

3.7 Sample of the study:

The sample of the study has been selected in two stages. In the first stage the schools were selected and in the second stage the classes were allotted to experimental and control groups.

Stage:-1) Selection of school

Random sampling technique was adopted to select the secondary schools from Mysore city the schools were selected based on the following criteria to ensure that school were comparable;

- Urban school
- Availability of ICT facilities
- Strength and regularity of the students
- Administrative co-operation
- Infrastructure of the classes

Stage:-2) Selection of classes

Since there were more than two sections of ninth standard in both the schools lottery method was used to select the classes for the experiment. Students from these sections were administered GMA test and those students who were matched on their GMA were selected for the experimental and the control group.

Table No-3.2: Number of male and female students forming the sample from the two selected schools.

Schools	**School-A**		**Schools-B**		**Total number of students**
Groups	**Experimental Group**	**Control Group**	**Experimental Group**	**Control Group**	
Male	15	15	15	60	60
Female	15	15	15	60	60
No. of students	30	30	30	30	120

3.8 Tools used for collection of data:

To verify the hypotheses of the study, the researcher needed to collect data using valid and reliable instruments. The research tools that were used to collect the necessary data are as shown in table no. 3.

Table No 3.3 : Tools used for collection of data

Sl No	Variables	Tools used	Standardized /Constructed by	Validity	Reliability
1	General mental ability	Raven's Standard progressive matrices (RPM)	Raven J. C	_	0.80 to 0.90
2	Achievement in science	Achievement test in science	Principal Investigator	• Face • Content	0.82to 0.87
3	Critical thinking	Critical thinking test	Principal Investigator	• Face • Content	0.81 to 0.84
4	Social maturity	Social maturity scale	Nalini Rao	_	0.63-0.98

Raven's Standard progressive matrices (RPM):This tool which is constructed by J.C. Raven (1960) is standardized and the general mental ability of the student was measured using this tool. This tool was administered to the ninth standard students in order to match them on their GMA. The Raven's Progressive Matrices (RPM) is a non-verbal test for measuring the GMA of students above the age of eleven. The test consists of five sets of problems viz., A, B, C, D and E and the test on the whole consists of sixty problems. Each set has twelve problems. Every problem requires the user to select the design that completes the pattern. The problems provide opportunities for grasping the progressive assessment of the person's capacity for intellectual activity. Each set is designed with easy problems and gradually moves on to difficult ones. Each correct response is awarded one mark and the total marks is sixty. The time allotted for the administering of this test is thirty minutes, and every student is given a separate scoring sheet to write their answer.

The correlation of standard progressive matrices with Binet and Wescheler scale range from 0.54 to 0.86. From the Raven's report, the reliability coefficients of the test vary from 0.80 to0.90. The progressive matrix has been described as one of the best of

the available measure of general intellectual functioning ('g'). Factor analytic studies reveal high loading up to 0.83 on 'g' factor. Sample items of Raven's standard progressive matrices are presented in appendix.

Achievement test in Science:

The test for Achievement in science was developed by the principal investigator. The test in Achievement consisted of multiple choice questions and short answer question from the content of ninth standard science text book.

- *Construction of Achievement test in science*: The draft of the Achievement test was prepared with 55 items of which 54 were multiple choice and one was a short answer type. The vocabulary and the language structure for the level of ninth standard students were also kept as a criterion for preparing the items. The test was constructed based on the content of ninth standard science text book of Karnataka state syllabus.

  The weightage given to content and objective are shown in the weightage table

Table No 3.4 : -Weightage of Content.

Sl .No	Chapter	Marks	Weightage (%)
1	Matter in our surroundings	6	12%
2	Motion	2	4%
3	Force and Laws of Motion	6	12%
4	Gravitation	7	14%
5	Work and energy	7	14%
6	Sound	10	20%
7	Natural Resources	12	24%
	Total	50	100%

Table No 3.5 : - Weightage to objectives

Sl. No	Objectives	Marks	Weightage (%)
1	Knowledge	18	36%
2	Understanding	17	34%
3	Application	11	22%
4	Skill	4	8%
	Total	50	100%

Based on these weightage tables the blue print of Achievement in science was prepared. The blueprint of the achievement test in science was developed to guide the proportionateness of measuring the performance of the students who were taught thought the two different methods of teaching. The test covered seven different content areas, each sub-dived into several sub-topics. The blue print reflected the number of questions for each topic and indicated the category of objective tested namely knowledge, understanding, application and skill. The blue print is presented in appendix.

Based on the blueprint the questions of the achievement test were constructed and the draft tool was prepared. The draft of the test constructed was scrutinized by experts in education and secondary school science teachers. They were requested to critically examine the tool on the following criteria:

- Suitability of items
- Appropriateness of alternative for each item
- Language and structure of item or questions
- Ambiguity

For the correspondence to specific behavioral outcome and comprehensibility, the tool was scrutinized by the experts and suggestions were given for refining the items. Their suggestions were incorporated in the draft of the test before the tryout.

- *Try out of the test* : The Achievement test in science was administered to 100 secondary school students of ninth standard. The items were analyzed for their difficulty index and discriminatory power.
  - *Item analysis*: Firstly the scored answer scripts were arranged in descending order of the scores obtained. They were divided into two subgroups of answer scripts i.e upper 27%of students scoring highest marks and lower 27% of students receiving lowest marks. The frequency of response to each item for the chosen group was found out. The sum of the frequencies for the two groups was calculated and them item difficulty and discriminative index were found for each item with the help of the formulas given below:

$$\text{Difficulty value} = (DV) = \frac{R(High) + R(Low)}{2N} * 100$$

Discriminatory power = (DP) =R(High) + R(Low)

2N

where,

R (high) = the number of correct responses to an item in the high group.

R (low) = number of correct responses to an item in the low group.

N = 27% of the total group.

The Difficulty Value (DV) and Discriminatory Power (DP) of each item are given in table

Table No. 3.6 : DV and DP of each item of Achievement test in Science

Item No	DV	DP
1	56	0.40
2	48	0.40
3	67	0.46
4	41	0.48
5	83*	0.12*
6	53	0.54
7	39	0.42
8	43	0.36
9	25	0.48
10	66	0.45
11	10*	0.28
12	40	0.44
13	56	0.40
14	69	0.63
15	74*	0.12*
16	50	0.38
17	59	0.56
18	18*	0.15*
19	68	0.62
20	62	0.48
21	76	0.36

22	26	0.46
23	49	0.28
24	15*	0.13*
25	84*	0.29*
26	58	0.44
27	66	0.38
28	78	0.48
29	54	0.28
30	61	0.44
31	69	0.56
32	45	0.36
33	23	0.42
34	56	0.40
35	48	0.40
36	68	0.64
37	66	0.40
38	60	0.44
39	36	0.28
40	43	0.36
41	13*	0.26*
42	58	0.44
43	53	0.54
44	87*	0.14*
45	78	0.46
46	40	0.44
47	58	0.40
48	24	0.48
49	66	0.44
50	53	0.48
51	56	0.62
52	73	0.38
53	25*	0.16*

54	48	0.40
55	50	0.44

- Note: items indicated by *were deleted for the final tool.

Item selection:

As suggested by Abu-Hashem (2008), the items with a difficulty value in the range 21-80 and discriminating power greater than 0.20 were selected for the final test. Nine items which do not fall in this range were deleted from the test and hence the final tool consisted of forty six items for total marks of 50.

Reliability:

- **Test re-test reliability**

  Test re-test reliability method was adopted to establish the reliability of Achievement test in science. The test was administered to hundred students of ninth standard from two schools. The same test was re-administered to the same set of students after a gap of one month. The consistency co-efficient was calculated for the test and re-test scores using person's product moment correlation technique. The obtained consistency coefficient was 0.82 which indicated a high reliability of the test.

- **Cronbach's Alpha reliability**

  Cronbach's Alpha method was employed to determine the reliability of Achievement test in science and Cronbach's alpha reliability was found to be 0.87 indicating high reliability.

Validity:

Face validity and content validity were established for Achievement test in science.

- **Face validity**

  In order to establish the validity of the tool the researcher established its face validity. The principal investigator and a few experts from the field of education and science teachers approved the newly developed test in terms of its face validity.

- **Content validity**

In order to establish its content validity, the principal investigator sent the final tool to ten experts in the field of education. The experts unanimously approved its appropriateness for the intended purpose. Hence the Achievement test in science possessed content validity. The Achievement test in science possessed content validity. The Achievement test in science is presented in appendix.

Critical thinking test

The researcher thoroughly examined the existing tools of critical thinking ability by reviewing the literature related to critical thinking. From the review it was found that Watson-Glaser critical thinking appraisal for law firms and banking sector(1925,1941,1994) Goodwin Watson andE.M.Glaser, Ennis-weir critical thinking essay test (1985- Robert H Ennis and Eric Weir)- an instrument for testing and teaching of college students were widely found to be used by various research studies. Since there were no suitable tools available to measure the level of critical thinking of ninth standard student's the investigator felt the need to construct a text on critical thinking ability.

Critical thinking skills were assessed on the basis of the following eight components:

- Analyzing
- Applying standards
- Information Seeking
- Logical reasoning
- Transforming knowledge
- Inference
- Decision making
- Discrimination

Construction of items:

The critical thinking test was designed and constructed by the investigator. The draft of the critical thinking test consisting of forty six multiple choice items, constructed on the basis of age, mental ability, grade of the students vocabulary and language structure for the level of ninth standard students was sent to experts from the field of

education. Their suggestions were incorporated and the modified draft of the test was prepared for the tryout.

Try out of the test:

In order to tryout, the critical thinking test was administered to hundred ninth standard students, to identify the clarity, feasibility and the time duration taken for completing the test. The items were analyzed for their difficulty index & discriminatory power.

Item analysis:

Firstly the scored answer scripts were arranged in descending order. Then the two sub groups of answer scripts i.e upper 27% of students receiving highest marks and the lower 27%of students receiving lowest marks of the group were separated. The frequency of response to each items for the chosen group was found. The sum of the frequencies for the two groups was calculated and then item difficulty and discriminative index were found for each item with the help of the formula given below

Difficulty Value = DV = *100

Discriminatory power = DP =

where,

R(high) = The number of correct responses to an item in the high group.

R(low) = The number of correct responses to an item in the low group

N = 27% of the total group.

The difficulty value (DV) & discriminatory power (DP) of each item are given in table.

Table No:3.7- DV and DP of each item in critical thinking test.

Item number	Difficulty value (DV)	Discriminatory power (DP)
1	50	1
2	13*	0.25*
3	22	0.44
4	56	1.11
5	56	1.11
6	57	1.14
7	4*	0.07*
8	4*	0.07*

9	87	1.7
10	59	1.18
11	28	0.55
12	70	1.40
13	9*	0.18*
14	78	1.55
15	46	0.92
16	70	1.40
17	28	0.55
18	70	1.40
19	48	0.96
20	54	1.07
21	55	1.25
22	68	1.37
23	55	1.11
24	4*	0.074*
25	67	1.33
26	63	1.18
27	89	1.177
28	13*	0.25
29	52	1.03
30	46	0.925
31	15*	0.296
32	37	0.74
33	13*	0.25
34	28	0.55
35	31	0.62
36	33	0.66
37	11*	0.22
38	8*	0.14*
39	22	0.44
40	48	0.96

41	85	1.70
42	74	1.48
43	81	1.62
44	50	1
45	10*	0.18
46	20	0.40

- ❖ Items deleted for the final tool

Item selection:

As suggested by Abu Hashem (2008) the items with a difficulty value in the range of 21-80 and discriminating power greater than 0.20 were selected for the final test. Eleven items which do not fall in this range were rejected there by retaining only thirty five items in the test. Each item was given a score of one thus making the maximum total score equal to 35.

Final form of the test on critical thinking consisted of 35 multiple choice questions. The total number of questions in each component of critical thinking is given in table no 3..

Table No. 3.8 : -Item numbers in the critical thinking test according to its components

Sl no	**Components**	**Item number**	**Total of item**
1	Analyzing	4,7,17,20,21,22,20,34,31,33	10
2	Applying standards	25	1
3	Information seeking	34,35	2
4	Logical reasoning	9,12,15,3,31,32	6
5	Transforming knowledge	2,5,6,13	4
6	Inference	10,11,14,18,19,27,26,33	8
7	Decision making	9,16	2
8	Discrimination	1,29	2

Reliability:

This final version was administered to a group of hundred students and reliability value was calculated using Cronbach's Alpha method and Split half method. The Cronbach's alpha correlation co-efficient was found to be 0.84 which indicated a high

index of reliability and the Split half method reliability value is 0.81 which also indicated a high index of reliability.

Validity:

Face validity and content validity were established for Achievement test in science.

- **Face validity**

  In order to establish the validity of the tool the researcher established its face validity. The investigator and a few experts from the field of education and science teachers approved the newly developed test in terms of its face validity.

- **Content validity**

  In order to establish its content validity, the investigator sent the final tool to ten experts in the field of education. The experts unanimously approved its appropriateness for the intended purpose. Hence the Achievement test in science possessed content validity. The Achievement test in science is presented in appendix.

Social Maturity Scale

Social Maturity scale developed and standardized by Dr. Nalini Rao (1984) was used to measure social maturity of students in this study. This scale measures, three dimensions of social maturity namely personal adequacy, interpersonal adequacy, and social adequacy. Personal adequacy measures work orientation, self-direction and ability to take stress. Interpersonal adequacy measures communication, enlightened trust and co-operation and social adequacy measures social commitment, social tolerance and openness to change. Thus the scale is divided into nine sub-scales and contains 90 items, which consists of positive and negative statements. The students are asked to record their responses by encircling the appropriate option. If it is a positive statement values of 4, 3, 2, 1 are given and these values are reversed in the case of negative statements. The sum total of the values of all the statements gives the index of the students score on the scale.

Reliability :

Reliability of this tool was established using test-retest technique (Nalini Rao, 1984). The scores of all sub-scales of the two administrations were correlated and the correlation co-efficient obtained on all the sub-scales were significant at 0.01 level. The lowest correlation co-efficient of 0.63 was obtained on the enlightened trust sub scale and the highest correlation coefficient of 0.98 was on the work orientation sub-scale. All the correlation co-efficient were high enough to establish the reliability of the tool. Internal consistency of the tool was also established.

Validity :

In order to minimize the rating errors by the teachers, all the ninety items of the nine social maturity sub-scales were transformed into behavioural items. Teacher assumed students as mature, immature or moderately mature. Hypothesizing that the students rated mature by teachers differed significantly in their scores on the social maturity rated immature, t-tests were computed. It was found that the 't' values were significant at 0.05 level and beyond for all the sub categories of the scales.

3.9 Statistical techniques used for analysis of data

The following statistical techniques were used for data analysis to verify the different hypotheses formulated for the study.

a) **'t' test :** 't' test was used to find the significant difference between the posttest means of experimental and control groups on Achievement in science and mean gain scores of Critical thinking and Social Maturity.

b) Two way ANOVA

The principle involved in analysis of variance is the comparison of variability between the various groups with the sum of variability found within the groups. As two way ANOVA permits the simultaneous study of two factors as well as interaction between the two, this technique was used for this purpose.

c) Pearson Product moment correlation

The technique was used to find out the correlation between Achievement in science, Critical thinking and Social Maturity.

3.10 Limitation of the study

The study has the following limitation:

- The tool developed by the investigator was not standardized and only the validity and reliability were established.

CHAPTER – IV

ANALYSIS AND INTERPRETATION OF DATA

In the previous chapter the methodology of the study which includes the statement of the problem, the variables, the operational definitions, the design of the study, construction and validation of tools, the sampling procedure, data collection and data analysis procedures were presented.

The present chapter aims at answering the research questions and verifying the hypotheses of this research study. Data collected during the research is analysed and presented under three sections:

- **Section.I:** This section deals with the analysis related to comparison of the effect of treatment on experimental and control group with respect to the dependent variables namely, achievement in science, critical thinking and social maturity. 't' test was used for this purpose.
- **Section. II:** This section deals with the analysis related to interaction effect of treatment and gender on dependent variables namely, achievement in science, critical thinking and social maturity. Two way ANOVA technique was used for this purpose.
- **Section. III:**This section deals with analysis related to correlation between achievement in science, critical thinking and social maturity. Pearson's product moment co-efficient of correlation was calculated for this purpose.

4.1 SECTION.I

This section deals with the analysis related to comparison of the effect of treatment on experimental and control group with respect to the dependent variables namely, achievement in science, critical thinking and social maturity. 't' test was used for this purpose.

HO.1:

There is no significant difference in post test scores of achievement in science of experimental and control groups.

't' value was calculated to test hypothesis Ho.1 The results are presented in table no.4.1

Table No.4.1:showing mean, SD, t-value of experimental and control group with respect to Achievement in Science.

Groups	**N**	**Mean**	**SD**	**df**	**T**	**Significance**
Experimental	*60*	*44.71*	*2.75*	*118*	*17.65*	**
Control	*60*	*32.98*	*4.35*			

** : Significant at 0.01 level

Table No.4.1shows that the obtained 't'value 17.646 is greater than the tabled 't' value 2.63 at 0.01 level. Hence, the null hypothesis Ho.1 is rejected and the alternate hypothesis stating that there is a significant difference in post test scores of achievement in science of experimental and control groups is accepted.

Since, the mean value of experimental group (44.71) is greater than that of the mean value of control group (32.98), it is concluded that social constructivist strategies are more effective in enhancing achievement in science among secondary school students.

Fig No-4.1 Graph showing achievement in science scores of experimental and control groups.

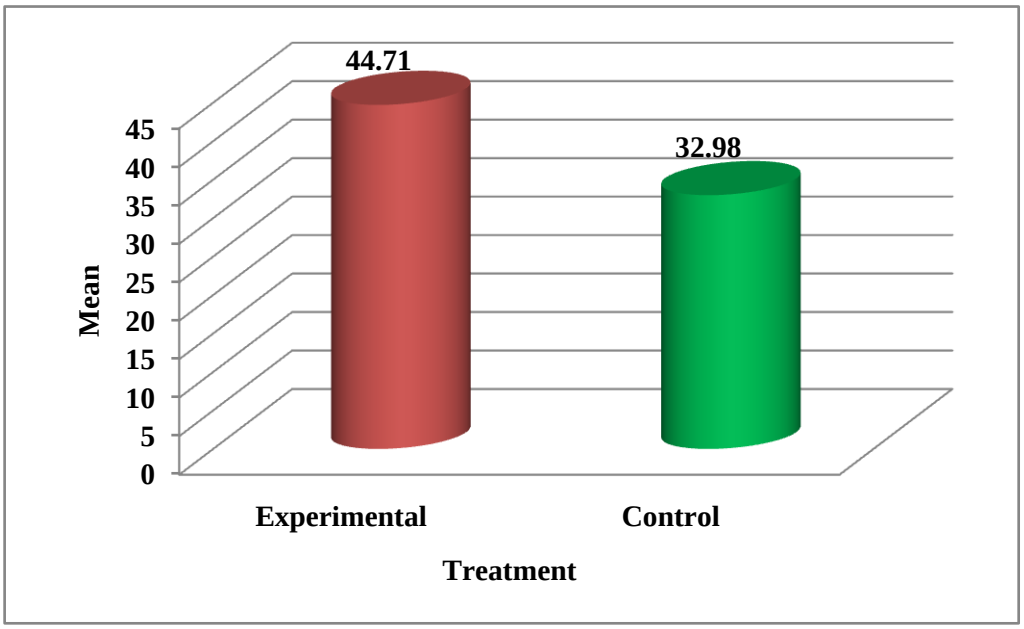


Figure No-4.1 shows that the mean score of experimental group is greater than that of the control group indicating that social constructivist strategies are more effective in enhancing achievement in science among secondary school students.

HO.2:

There is no significant difference in mean gain scores of critical thinking of experimental and control groups.

't' test was calculated to test hypothesis Ho.2 The results are presented in table No.4.2

Table No.4.2 :showing mean, SD, t-value of experimental and control group with respect to critical thinking.

Groups	**N**	**Mean**	**SD**	**df**	**t**	**Significance**
Experimental	60	12.11	1.78	*118*	*34.32*	**
Control	60	1.68	1.53			

** Significant at 0.01 level

Table No.4.2 shows that the obtained 't'value 34.32 is greater than the tabled 't' value 2.63 at 0.01 level. Hence, the null hypothesis Ho.2 is rejected and the alternate hypothesis stating that there is a significant difference in mean gain scores of critical thinking of experimental and control groups is accepted.

Since, the mean gain value of experimental group (12.11) is greater than that of the mean gain value of control group (1.68), it is concluded that the experimental group is benefited more than the control group with respect to enhancement of critical thinking. Social constructivist strategies are effective in developing critical thinking in students of secondary schools.

Fig No-4.2 Graph showing critical thinking mean gain scores of experimental and control groups.

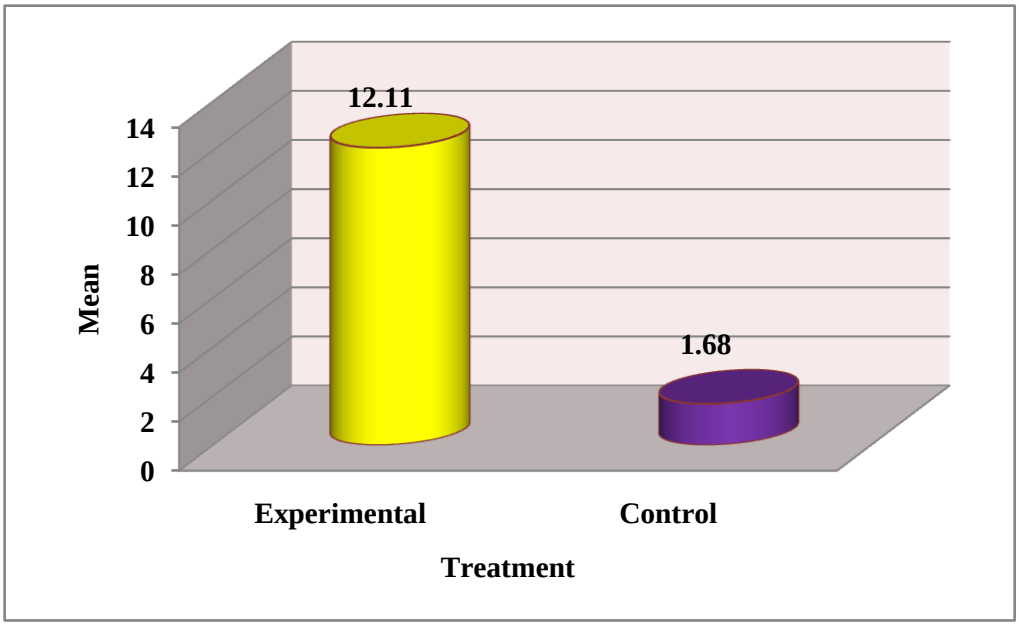


Figure No-4.2 shows that the mean gain scores of critical thinking for experimental group is greater than that of the control group indicating that social constructivist strategies are more effective in development of critical thinking among students of secondary school.

HO.3:

There is no significant difference in mean gain scores of social maturity of experimental and control groups.

't' value was calculated to test hypothesis Ho.3 The results are presented in table no. 4.3

Table No.4.3 :showing mean, SD, t-value of experimental and control group with respect to social maturity.

Groups	**N**	**Mean**	**SD**	**df**	**t**	**Significance**
Experimental	*60*	*99.00*	*11.08*	*118*	*46.9*	**
Control	*60*	*17.00*	*7.78*			

** Significant at 0.01 level

Table No.4.3 shows that the obtained 't'value 46.9 is greater than the tabled 't' value 2.63 at 0.01 level. Hence, the null hypothesis Ho.3 is rejected and the alternate hypothesis stating that there is a significant difference in mean gain scores of social maturity of experimental and control groups is accepted.

Since, the mean gain value of experimental group (99.00) is greater than that of the mean gain value of control group (17.00), it is concluded that the experimental group is benefited more than the control group with respect to enhancement of social maturity. Social constructivist strategies are more effective in enhancing social maturity of students of secondary schools.

Fig No-4.3 Graph showing social maturity mean gain scores of experimental and control groups.

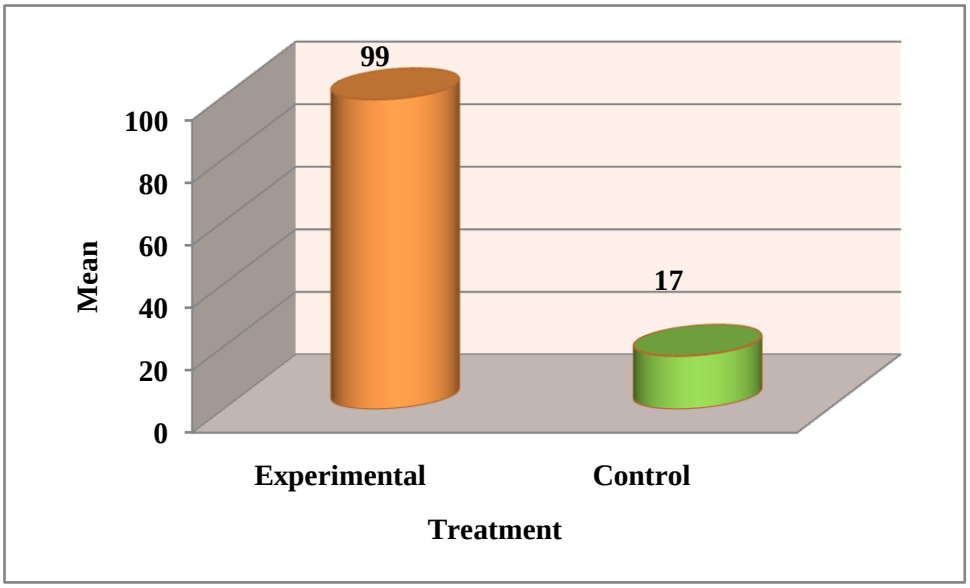


Figure No-4.3 shows that the mean gain score of experimental group is greater than that of the control group. Hence it is concluded that social constructivist strategies are more effective in development of social maturity among secondary school students.

HO.4:

There is no significant interaction effect of gender and treatment on achievement in science among secondary school students.

Table-4.4

Summary table of Two Way ANOVA of gender, treatment and achievement in science of secondary school students.

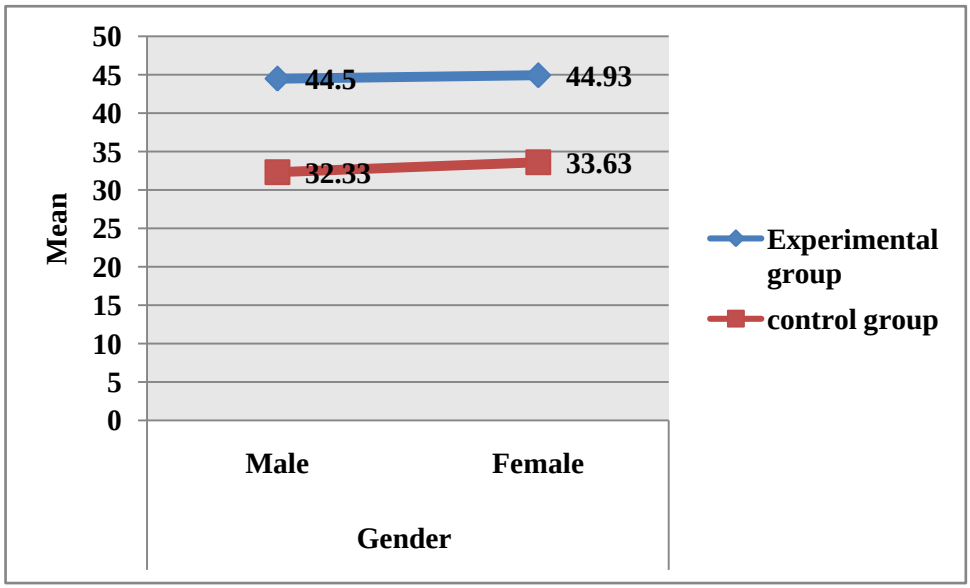
Source of Variance	Sum of Squares	df	Mean Square	F	Level of Sig.
Gender	22.533	1	22.533	1.701	.195
Treatment	4130.133	1	4130.133	311.708	.000
Gender * treatment	5.633	1	5.633	.425	.516
Error	1537.000	116	13.250		
Total	186814.000	120			

Table no-4.4 also reveals that the obtained 'F' value (0.425) for the interaction effect of gender and treatment on the achievement in science of secondary school students is not significant. Therefore, the above stated null hypothesis Ho.4 is accepted and it is concluded that there is no significant interaction effect of gender and treatment with respect to achievement in science among secondary school students. Social constructivist strategies are equally effective in enhancing achievement in science among male and female students of secondary schools.

Table No.4.5*:showing mean scores of male and female secondary school students from experimental and control group with respect to achievement in science*

Group	Gender	
	Male	**Female**
Experimental group	44.5	44.93
Control group	32.33	33.63

Fig No-4.4 Graph showing mean scores with respect to achievement in science of male and female secondary school students of experimental and control groups.



The following interpretation can be made from this graph:

Table no-4.5 and graph no-4.4 indicate an ordinal interaction in which the lines of the graph donot cross. This implies that the improvement in achievement in science of male and female students is in the same direction and social constructivist strategies donot have a differential effect with respect to improvement in achievement in science of male and female students of secondary schools.

HO.5:

There is no significant interaction effect of gender and treatment on critical thinking among secondary school students.

Table-4.6

Summary table of Two Way ANOVA of gender, treatment and critical thinking of secondary school students.

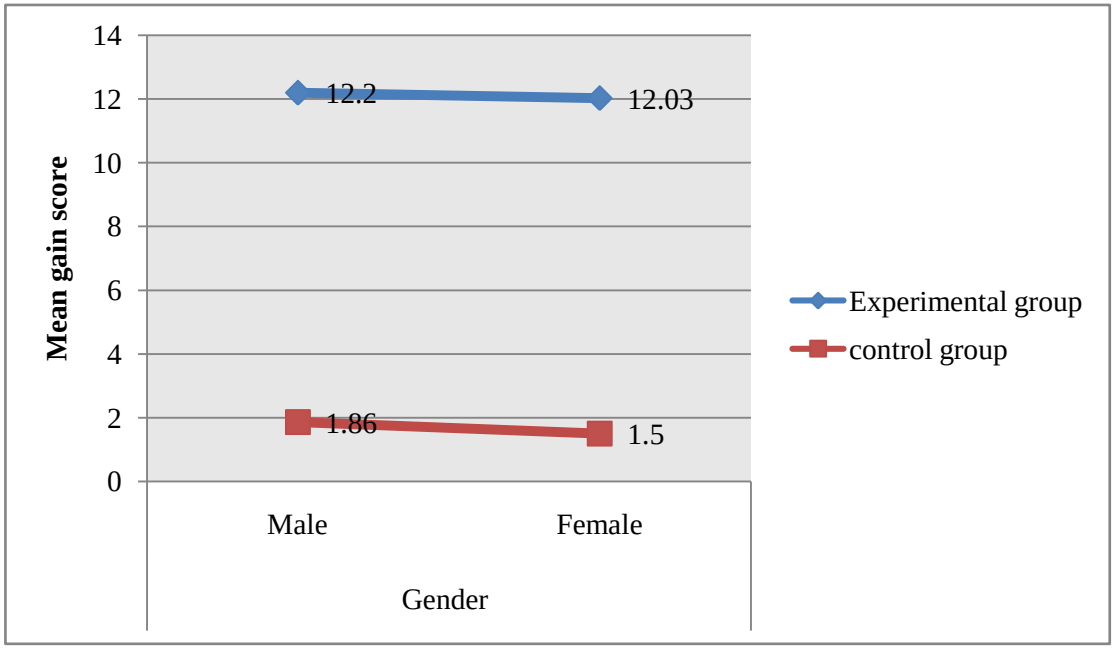
Source of Variance	Sum of Squares	df	Mean Square	F	Level of Sig.
Gender	2.133	1	2.133	.762	.384
Treatment	3265.633	1	3265.633	1.167E3	.000
Gender * Treatment	.300	1	.300	.107	.744
Error	324.733	116	2.799		
Total	9306.000	120			

Table no-4.6 also reveals that the obtained 'F' value (0.107) for the interaction effect of gender and treatment on the critical thinking of secondary school students is not significant. Therefore, the above stated null hypothesis Ho.5 is accepted and it is concluded that there is no significant interaction effect of gender and treatment with respect to critical thinking among secondary school students. Social constructivist strategies are equally effective in enhancing critical thinking among male and female students of secondary schools.

Table No.4.7 *:showing mean gain scores of male and female secondary school students from experimental and control group with respect to critical thinking.*

Group	Gender	
	Male	**Female**
Experimental group	12.2	12.03
Control group	1.86	1.5

Fig No-4.5 Graph showing mean gain scores with respect to critical thinking of male and female secondary school students of experimental and control groups.



The following interpretation can be made from this graph:

Table no-4.7 and graph no-4.5 indicate an ordinal interaction in which the lines of the graph donot cross. This implies that the improvement in critical thinking of male and female students is in the same direction and social constructivist strategies donot have a differential effect with respect to enhabcement of critical thinking of male and female students of secondary schools.

HO.6:

There is no significant interaction effect of gender and treatment on social maturity among secondary school students.

Table-4.8

Summary table of Two Way ANOVA of gender, treatment and social maturity of secondary school students.

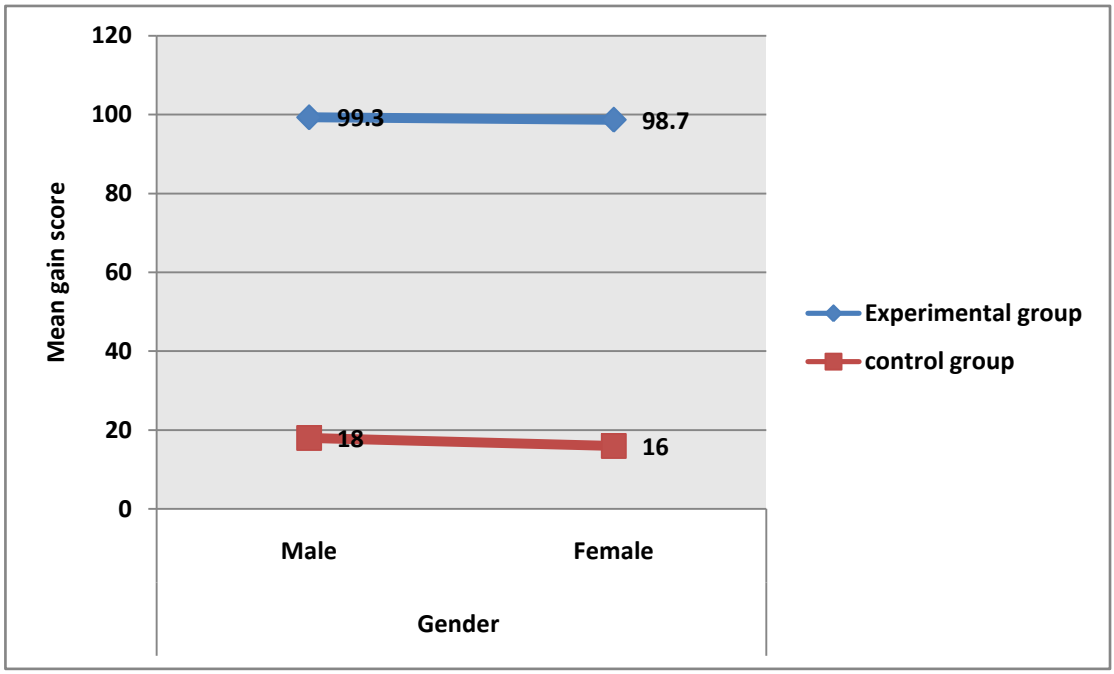
Source of Variance	Sum of Squares	df	Mean Square	F	Level of Sig.
Gender	50.700	1	50.700	.547	.461
Treatment	201720.000	1	201720.000	2.175E3	.000
Gender * Treatment	14.700	1	14.700	.159	.691
Error	10756.600	116	92.729		
Total	616222.000	120			

Table no-4.8 also reveals that the obtained 'F' value (0.159) for the interaction effect of gender and treatment on the social maturity of secondary school students is not significant. Therefore, the above stated null hypothesis Ho.6 is accepted and it is concluded that there is no significant interaction effect of gender and treatment with respect to social maturity among secondary school students. Social constructivist strategies are equally effective in developing social maturity of male and female students of secondary schools.

***Table No.4.9**:showing mean gain scores of male and female secondary school students from experimental and control group with respect to social maturity.*

Group	Gender	
	Male	Female
Experimental group	99.3	98.7
Control group	18	16

Fig No-4.6 Graph showing mean gain scores with respect to social maturity of male and female secondary school students of experimental and control groups.



The following interpretation can be made from this graph:

Table no-4.9 and graph no-4.6 indicate an ordinal interaction in which the lines of the graph donot cross. This implies that the improvement in social maturity of male and female students is in the same direction and social constructivist strategies donot have a differential effect with respect to improvement in social maturity of male and female students of secondary schools.

HO.7:

There is no significance relationship between critical thinking of secondary school students and their achievement in science.

Table-4.10

Showing the Number, Mean, 'r' value between critical thinking of secondary school students and their achievement in science.

Variables	**N**	**Df**	**'r' value**	**Level of significance**
Achievement in Science	120	118	0.798	**
Critical thinking				

Table no-4.10 shows that obtained 'r' value of 0.798 is greater than table value of 0.114 at 0.01 level. Hence, the null hypothesis Ho- is rejected and the alternative hypothesis stating that there is a significance relationship between critical thinking of secondary school students and their achievement in science.

Therefore, it is concluded that there is a positive and high correlation between the critical thinking of secondary school students and their achievement in science.

HO.8:

There is no significance relationship between social maturity of secondary school students and their achievement in science.

Table-4.11

Showing the Number, Mean, 'r' value between social maturity of secondary school students and their achievement in science.

Variables	**N**	**Df**	**'r' value**	**Level of significance**
Achievement in Science	120	118	0.838	**
Social Maturity				

Table no-4.11 shows that obtained 'r' value of 0.838 is greater than table value of 0.114 at 0.01 level. Hence, the null hypothesis Ho- is rejected and the alternative hypothesis stating that there is a significance relationship between social maturity of secondary school students and their achievement in science.

Therefore, it is concluded that there is a positive and high correlation between the social maturity of secondary school students and their achievement in science.

HO.9:

There is no significant relationship between social maturity of secondary school students and their critical thinking.

Table-4.12

Showing the Number, Mean, 'r' value between social maturity of secondary school students and their critical thinking.

Variables	**N**	**Df**	**'r' value**	**Level of significance**
Social Maturity	120	118	0.919	**
Critical thinking				

Table no-4.12 shows that obtained 'r' value of 0.919 is greater than table value of 0.114 at 0.01 level. Hence, the null hypothesis Ho- is rejected and the alternative hypothesis stating that there is a significance relationship between social maturity of secondary school students and their critical thinking.

Therefore, it is concluded that there is a positive and high correlation between social maturity of secondary school students and their critical thinking.

CHAPTER-V

SUMMARY AND CONCLUSION

5.1 Summary of the study:

Human beings are naturally curious about the happenings in the environment around. The inquisitive human mind has been observing the environment prudently, looking for meaningful relations, constructing and using new tools to interact with nature, and building conceptual models to comprehend the world. This human effort is science.

The Social constructivist classroom is an environment where students build or construct their own knowledge. Many activities are hands-on and involve building on the work of others. Various strategies incorporate the principles of social constructivism and provide a social environment for children to construct their knowledge.

Need for the study:

Teaching aims at development and expansion of new ways of thinking that reveals in increased skills to solve problems of life and to development of new habits with desirable attitudes. The broader outcome of teaching is to result in increased capabilities of students to learn more efficiently in future caused by the knowledge and mastery learning skills acquired by the students. The main aim of teaching is to bring out desirable behavioral change in students, both cognitive and social. This aim could be achieved by teaching science using social constructivist approaches effectively.

In India efforts have been made to study different methods of teaching with a view to identify teaching effectiveness and teaching methods to attain the objectives of teaching Science. Attempts are also made to find out teaching patterns which are conducive for developing cognitive and social abilities and affective behavior in children.

It is generally agreed that the objectives to achieve through the teaching learning process are multidimensional in nature. It is also known that no one particular method or technique is appropriate to achieve all these multi-dimensional objectives. This led researchers to explore various methods, techniques in an integrated fashion which resulted in the development of new social constructivism strategies.

The National Curriculum Frame work for school education (2000) by the National Council of Educational Research and Training (NCERT) stressed on considering the child as constructor of his own knowledge. Learning experiences for the construction of knowledge has been stated as a salient feature of National Curriculum Frame work-2005. The NCF-2005 emphasizes on social constructivist approaches where the learner must develop his/her own knowledge based on the experience that he/she has got while learning.

The core of teaching process is the arrangement of environment within which students can interact and study how to learn. (Dewey, 1916).But in the present traditional classroom, the teaching learning process is usually dominated by "teacher talk" and is highly dependent on the text books for structuring the course. The teachers act as tunnels who just transfer their meaning and thoughts to the passive students giving an occasional chance for students to initiate questions and to express their independent thought and a rare chance for them to interact between themselves and the teacher.

It has been often seen that even the students who score well are unable to achieve and formulate real life applications outside the school room (Yager, 1991). An interesting finding of research studies reveal that academic knowledge and practical application of this knowledge at present are mutually exclusive. Students also view very little connection between what they experience in their real life andwhat they learn in their classroom.

An important solution proposed for this issue is to prepare students to be adaptive social learners, who can self-learn from the situation he comes across in

life and then apply that learning to overcome the issues that he comes across. Evidently, the conventional teacher is an information-giver, dependent on the textbook and the one who fails to create a guided classroom that brings about the desired outcomes of teaching science. Hence science teaching has to change its focus in the classroom from transmission of knowledge to construction of knowledge by adopting constructivist approaches.

Today Critical Thinking and Social Maturity are much valued entities. This could be fostered by collaborative learning within the group. Social constructivism influences the ability to work in team, and thus may have a positive influence on their social maturity.

A commonly and widely held criticism about teaching of science is that it does not develop social skills which are essential for living in this society of humans. Hence this study is a modest venture to find whether use of social constructivism strategies in teaching of science has an impact on their social maturity.

The elaborate review of empirical research studies revealed that there have been no efforts made to study the effect of social constructivist approaches on achievement in science, critical thinking ability and social maturity of students of secondary school. Hence in this context the researcher was motivated to take up the present study to improve upon the present practices in pedagogy of science.

Statement of the Problem

"Effect of social constructivist strategies on achievement in science critical thinking and social maturity of secondary school students"

Objectives of the study:

The study was undertaken with the following objectives:

1. To develop lesson plans based on social constructivist strategies for ninth standard science.

2. To study the effect of social constructivist strategies on secondary school students with respect to their
    - Achievement in science
    - Critical thinking
    - Social maturity
3. To study the interaction effect of Treatment and Gender on achievement in science of secondary school students.
4. To study the interaction effect of Treatment and Gender on critical thinking of secondary school students.
5. To study the interaction effect of Treatment and Gender on social maturity of secondary School students.
6. To examine whether there is significant relationship between critical thinking and achievement in science of secondary school students.
7. To examine whether there is significant relationship between achievement in science and Social Maturity of secondary school students.
8. To examine whether there is significant relationship between Critical thinking and Social Maturity of secondary school students.

Hypotheses of the study:

In pursuance of the objectives of the study the following null hypotheses were formulated:

1. There is no significant difference in post test scores of achievement in science of experimental and control group.
2. There is no significant difference in the mean gain scores of critical thinking of experimental and control group.
3. There is no significant difference in the mean gain scores of social maturity of experimental and control group.
4. There is no significant interaction effect of treatment and gender of secondary school students with respect to their
    - Achievement in science.
    - Critical thinking.
    - Social maturity.

5. There is no significant correlation between achievement in science and critical thinking of secondary school students.
6. There is no significant correlation between Achievement science and social maturity of secondary school students.
7. There is no significant correlation between critical thinking and social maturity of secondary school students.

Variables of the present study:

The variables of the present study fall into four categories viz., Independent, Dependent, Moderate and Control variables.

1. Independent variable:
    - Treatment:
        - Social constructivist strategies of teaching science.
        - Traditional method of teaching science.
2. Dependent Variables:
    - Achievement in science.
    - Critical thinking.
    - Social maturity.
3. Moderate variable:
    - Gender
4. Control variable:
    - General Mental ability.

Method of the Study

The present study was conducted in the following three phases:

a) Phase 1:Development and Validation of lesson plans based on social constructivist strategies for teaching science to the experimental group
b) Phase 2: Construction and Validation of achievement test in science and critical thinking test.
c) Phase 3: Experimentation: Implementation of social constructivist strategies to teach science to the experiment group and traditional teaching approach to the control group. After administering the pretest, the treatment was implemented

and later the post- test was administered for collecting the data and the data was analyzed.

Design of the Experiment

Table No-5.1 Experimental design: Pre-test Post –test matched Group Design.

Group	Pre-test	Treatment	Post-test
Experimental group	Critical thinking test and Social maturity scale	Teaching through social constructivist strategies	Achievement test, Critical thinking test and Social maturity scale
Control group	Critical thinking test and Social maturity scale	Teaching through traditional method	Achievement test, Critical thinking test and Social maturity scale

Sample of the study

Table No-5.2: Number of male and female students forming the sample from the two selected schools.

Schools	**School-A**		**Schools-B**		**Total number of students**
Groups	**Experimental Group**	**Control Group**	**Experimental Group**	**Control Group**	
Male	15	15	15	60	60
Female	15	15	15	60	60
No. of students	30	30	30	30	120

Tools used for collection of data:

To verify the hypotheses of the study, the researcher needed to collect data using valid and reliable instruments. The research tools that were used to collect the necessary data are as shown in table no. 3.

Table No 5.3 : Tools used for collection of data

Sl No	Variables	Tools used	Standardized / Constructed by
1	General mental ability	Raven's Standard progressive matrices (RPM)	Raven J. C
2	Achievement in science	Achievement test in science	Principal Investigator
3	Critical thinking	Critical thinking test	Principal Investigator
4	Social maturity	Social maturity scale	Nalini Rao

Statistical techniques used for analysis of data

't' test , Two way ANOVA, Pearson Product moment correlation were used for data analysis to verify the different hypotheses formulated for the study.

5.2 MAJOR FINDINGS OF THE STUDY

The following are the major findings of the study:

- Social constructivist strategies are more effective in enhancing achievement in science among secondary school students.

- Experimental group is benefited more than the control group with respect to enhancement of critical thinking and hence social constructivist strategies are more effective in development of critical thinking among secondary school students.
- Experimental group is benefited more than the control group with respect to enhancement of social maturity. Social constructivist strategies are more effective in development of social maturity among students of secondary schools.
- There is no significant interaction effect of gender and treatment with respect to achievement in science among secondary school students. Social constructivist strategies are equally effective in enhancing achievement in science among male and female students of secondary schools.

- There is no significant interaction effect of gender and treatment with respect to critical thinking among secondary school students. Social constructivist strategies are equally effective in enhancing critical thinking among male and female students of secondary schools.
- There is no significant interaction effect of gender and treatment with respect to social maturity among secondary school students. Social constructivist strategies are equally effective in enhancing social maturity among male and female students of secondary schools.
- There is a positive and high correlation between achievement in science and critical thinking of students of secondary schools.
- There is a positive and high correlation between achievement in science and social maturity of students of secondary schools.
- There is a positive and high correlation between social maturity and critical thinking of students of secondary schools.

5.3 DISCUSSION OF RESULTS

The findings of research studies conducted by Pandey and Ameta (2017), Chowdry (2016), Ahme.O. Qarareh (2016), Mahesha.S.J(2014), Sridevi(2013), Madu.B.C and Ezeamagu.M.V (2013), Bogar et.al.,(2012), Oludigebimbola and Oludige Daniel (2010), Jamie et al., (2009), Vickneaswari.A and Krishnaswamy.P (2007), Kim.K (2005), Ambrose Hans.G.Aggabao (2005), Uzuntiryaki (2003) and Pooran (2000) have revealed that constructivist learning strategies successfully enhance the academic achievement of students and these findings are in line with the findings of this study.

Ahme.O.Qarareh (2016), Mahesha.S.J (2014), Uzuntiryaki (2003) and Pooran (2000) have found that constructivist strategies are equally effective in enhancing the learning of both boys and girls. These findings are similar to the findings of this study.

Hussain(2012), in his study found that constructivist strategies of learning developed the social skills of students. Gupta(2014), Anand et al.,(2014),

Pan(2014), found no difference in social Maturity in relation to gender. This study also found that constructivist strategies were equally effective in developing social maturity of students irrespective of their gender. However, studies by Chouhoudari and Madhuri (2014) and Alam (2016) found a statistically significant difference in social maturity of boys and girls. Social constructivist strategies need the students to work in groups while they are in involved in the learning activity. Since the students learn together and are responsibly involved in their own learning without any gender difference, these strategies may be helpful in developing social maturity without having any differential effect on boys and girls.

5.4 EDUCATIONAL IMPLICATIONS

The following are the educational implications of the findings of the research study:

- Social constructivist strategies are found to be more effective in enhancing achievement in science among secondary school students. Since social constructivist strategies have proved to be successful in enhancing achievement of students which demonstrates their learning, they can successfully be implemented in normal classrooms**.**

- Teachers have to adopt strategies that involve constructivist principles which are student centered. Teachers have to plan their lessons to integrate team work and collaboration among students, promote debates and facilitate discussions.

- Study groups should be set up at schools so that peer tutoring would enhance their learning by making it a joyful experience for the students. Peer assessment has to be practiced as it makes constructivist learning and evaluation a more relaxed experience.

- The teacher should facilitate the construction of new knowledge by placing the new learning in the zone of proximal development which provides the

scaffolding needed for their own learning. The teacher should make the learner to visualize, explain and interpret the new knowledge so that its application to new situations in life becomes more logical.

- It is found that the social constructivist strategies can be fit into the five –E teaching model effectively making teaching-learning more efficient. Hence teachers of secondary schools have to form groups of students and fit in the constructivist strategies to the five –E model to develop critical thinking among their students.
- Information and Communication Technology has to be used by teachers to create online groups of students so that they can share their thinking and assignments on virtual platforms synchronously in real time, irrespective of time and geographical distance.
- The teachers have to create a learning atmosphere which provides the students with maximum opportunity to interact among themselves and with the teacher. This has to be done by posing an open ended question that would help students to solve a specific problem so that they discover the knowledge on their own.
- The teacher should support the learners in a constructivist learning environment by providing behavioural and cognitive modelling. The teacher should provide appropriate coaching by motivating them, analyzing their performance and providing feedback on their learning and evoking a reflection on what is learnt. The teacher, as an expert, should provide the students with the scaffolding required by focusing on the task and providing the support for cognitive activity whenever they are involved in the task together.
- A social constructivist learning environment should be created by posing a question, a case study or a problem in front of the students. Long term projects too have to be given to create a constructivist learning environment to the students to discover their own learning.
- Experimental group is benefited more than the control group with respect to enhancement of critical thinking and hence social constructivist

strategies are more effective in development of critical thinking, analytical thinking and evaluative skills. Evaluation in a constructivist classroom requires the teacher to also assess the process of learning by techniques of observation, oral discussions, mind mapping and assessment of higher order thinking skills like critical thinking in addition to tests of social skills.

- Experimental group is found to be benefited more than the control group with respect to enhancement of social maturity. Social constructivist strategies are more effective in development of social maturity among students of secondary schools. Strategies like Cooperative learning, Collaborative learning, Situated learning, Anchored Instruction, Group Problem solving, Concept mapping, Inquiry based learning should be adopted to place the student in the position of a discoverer who constructs the new knowledge and relates it to new situations in his own life outside the classroom. These strategies provide an invitation to learners from diverse backgrounds in which learners work together to learn thereby developing skills of team work, judgement, decision making and communication skills and respect for views of co-learners from different backgrounds which in turn enhances their social maturity.
- Teachers should be trained in developing curriculum, planning learning activities and developing lesson plans and worksheets that enable the students to create their own knowledge based on their previous learning and those which provide flexibility in learning, guidance and scaffolding and prompts wherever necessary so that critical thinking will be encouraged. The teacher training curriculum should include the theory and practice of social constructivist strategies and the teacher educators should supervise the practice of these strategies by the student trainees during their internship programme.
- There is no significant interaction effect of gender and treatment with respect to achievement in science, critical thinking and social maturity among secondary school students. Social constructivist strategies are

equally effective in enhancing achievement in science, critical thinking and social maturity among male and female students of secondary schools. Irrespective of the gender of the students constructivist strategies can be effectively used in classrooms. Students need not be differentiated on their gender while organizing activities that encourage them to think like scientists, make guesses and anticipate results of their team work.

- A student who is high in social maturity can successfully adapt to his peer group, exhibit group compatibility, show sympathy, adjust emotionally, be polite, dependable, co-operative and cheerful. He will be able to make judgements, take decisions and act pertinently in critical times. He is able to resolve conflicts, take responsibility for his actions, make an objective assessment of his own behaviour, and is well balanced. A socially mature student is willing to fit his own wishes into the pattern approved by the whole group, identify himself with the interest of the group and gives preferences to the benefits of the group above his individual gains. Adults with these qualities are the ones who are seen to achieve success in their professional and personal life. Social constructivist strategies should be adopted in secondary school teaching so that social maturity can be enhanced in students and the above said qualities are integrated into their personality.
- Positive and high correlation is found between achievement in science and critical thinking and social maturity of students of secondary schools. Achievement in science, critical thinking and social maturity go hand-in-hand. Administrators should make provisions and provide the required support to teachers for adopting social constructivist teaching strategies as it is rewarding and beneficial to enhance achievement in science and critical thinking and social maturity of students which in turn enhance their quality of learning and overall quality of social and personal life.

5.5 SUGGESTIONS FOR FURTHER RESEARCH

The following are the suggestions for further research:

- A baseline survey of data regarding critical thinking ability and social maturity of students can be taken up.
- Research studies to find the effectiveness of constructivist strategies at different stages of schooling/education can be conducted.
- Research studies to find the effectiveness of constructivist strategies in different medium of instruction may be undertaken.
- Studies to compare the effect of constructivist strategies with other teaching strategies with respect to other psycho-sociological variables may be conducted.
- Studies to find the effectiveness of constructivist strategies in teaching different school subjects can be conducted.

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APPENDIX -A

Achievement Test in Science

Please fill up the following.

Name:

Gender: Male/Female

Max.Marks:50

Time: 1:30 Hrs

Instructions:

- Please write your name and Gender in space provided on the top of this page.
- This question paper contains Forty sevenobjective type questions. Each question carry one mark .
- All questions are compulsory.
- Each item has four alternative responses A, B, C, D. You have to tick (✓) the answer as indicated below on the correct response against each item.

I. Multiple Choice Questions **46 X 1=46**

1. Identify the correct statement that defines matter.
   a) Anything that occupies space and has mass is matter
   b) Only those which can be seen with human naked eye
   c) Only those having odour.
   d) Anything that occupies space is a matter.

2. When we put a drop of Ink in water taken in a glass, it spreads in the water making it entirely coloured which property of matter does it exhibit?
   a) Particles of matter are very small in size.
   b) Matter consists of large number of particles.
   c) Particles of matter have spaces between them
   d) Particles of matter are continuously moving.

3. A fragrance that is sprayed at one end of the room can spread throughout the room by the process of----------
   a) Osmosis
   b) Diffusion
   c) Transfusion
   d) Sublimation.

4. Which of the following statements are correct?
   a) Solids have a definite shape and definite volume
   b) Liquids have no fixed shape but fixed volume
   c) All liquids are fluids and all gases are non – fluids
   d) Both A and B

5. Sponge is a solid yet we are able to compress it because,
   a) A Sponge is a delicate solid in which oxygen gas is trapped.
   b) A Sponge is a solid that has minute holes in which air is trapped.
   c) A Sponge is a porous substance in which water is trapped.
   d) A Sponge is a hallow solid in which air is trapped.

6. In which state of matter, the distance between the particles is least?
   a) Solid
   b) Liquid
   c) Gas
   d) Plasma

7. Motion under gravity is an example for
   a) Motion with uniform velocity
   b) Non- Uniform Motion
   c) Uniform Motion
   d) Motion with Non-Uniform acceleration.

8. In a Uniform Circular motion, which of the following it true?
   a) Velocity is constant and speed is changing.
   b) Velocity and speed both remain constant.
   c) Speed remains constant and velocity changes continuously.
   d) Neither velocity nor speed remains constant.

9. A ball is moving over a horizontal smooth surface with a constant velocity. What type of force is acting on the ball?
   a) Balanced forces are acting on the ball.
   b) Unbalanced forces are acting on the ball.
   c) Both A & B
   d) None of the above.

10. Inertia is dependent upon which of the following physical features of the object?
   a) Velocity of the body.
   b) Acceleration applied.
   c) Mass of the body
   d) Volume of the body.

11. When a bus starts suddenly from rest, the passengers sitting inside the bus move backwards. This illustrates an example of
   a) Newton's First law of Motion.
   b) Newton's Second law of Motion.
   c) Newton's Third law of Motion.
   d) Both B and C

12. According to the third law of motion, action and reaction
    a) Always act on the same body.
    b) Always act on different bodies in opposite directions
    c) Have same magnitude and directions.
    d) Act on either body at normal to each other.

13. Rocket works on the principle of Conservation of
    a) Mass
    b) Energy
    c) Momentum
    d) Velocity.

14. When a bullet is fired from a pistol, in Which direction the pistol moves?
    a) Opposite to the bullet's direction.
    b) Same as the bullet's direction
    c) It will be in same position as before.
    d) The Pistol will not move.

15. The atmosphere is held to the earth by
    a) Gravitational force of the Earth.
    b) Gravitational force of the Moon.
    c) Gravitational force of the Sun.
    d) Rotation of the Earth.

16. Newton's law of gravitation is applicable to
    a) Bodies on Earth only
    b) Bodies on Planets only.
    c) Bodies in Our solar system only.
    d) All bodies in the Universe.

17. A boy is whirling a stone tied with a string in an horizontal circular path. If the string breaks, the stone.
    a) Will continue to move in the circular path.
    b) Will move along a straight line towards the centre of the circular path.
    c) Will move along a straight line tangential to the circular path.
    d) Will move along a straight line perpendicular to the circular path away from the Boy.

18. The mass of an object ----------
    a) Varies at different locations
    b) Remains constant
    c) Can be measured using Spring balance
    d) Is in the direction of gravitational force.

19. Pressure at a point in a liquid is
    a) Same in all directions

b) Greater in the upward direction
c) Greater in the downward direction
d) None of the above.

20. Identify free fall situation from the following.
    a) A man landing on parachute
    b) An apple falling on moon.
    c) An rocket propelling into space
    d) A block falling from a Cliff.

21. Archimedes Principle used in designing
    a) Spring balance
    b) Lactometer, Ships.
    c) Weighing machines
    d) Both A and C

22. Work done on an object does not depend upon the
    a) Displacement
    b) Force applied
    c) Angle between force and displacement.
    d) Initial velocity of the object.

23. A boy was playing with a spongy ball, compressing and releasing it. The work done by boy on the ball and the ball on the boy respectively at the time of compressing is
    a) Positive, Negative
    b) Negative, Positive
    c) Positive, Positive
    d) Negative, Negative.

24. Which of the following is a form of mechanical energy?
    a) Potential energy and Kinetic energy
    b) Nuclear energy
    c) Solar energy
    d) Both A and B

25. An example of Kinetic energy would be,
    a) A moving car
    b) A charge particle in an electric field
    c) A stretched rubber band just released
    d) All of the above

26. Solar panels are used for harnessing solar energy. This solar energy is then used to charge an electric cell and this electric cell is used to move a toy. What are the energy changes that take place?
    a) Solar energy- Chemical energy- Kinetic energy

b) Kinetic energy- Solar energy- Chemical energy
c) Chemical energy- Kinetic Energy- Solar energy.
d) Solar energy- Kinetic energy- Chemical energy.

27. SI Unit of energy
    a) Joul
    b) Amphere
    c) Kelvin
    d) Calories.

28. An object is falling from a terrace (Heigth-20m). At what point does it have maximum kinetic energy?
    a) 20m Height
    b) 10m Height
    c) Just after touching the ground floor.
    d) Just before touching the ground floor.

29. Sound is produced due to
    a) Friction
    b) Circulation
    c) Vibration
    d) Refraction

30. Frequency of Tuning Fork depends on
    a) Mass of its prongs
    b) Area of its prongs
    c) Stiffness of its prongs
    d) Density of its prongs

31. Sound waves can pass through
    a) Vacuum
    b) Air only
    c) Air and Other States of matter
    d) Vacuum and other sates of matter.

32. Ocean wave is an example of ----------
    a) Longitudinal wave
    b) Transverse wave
    c) Latitudinal wave
    d) Both A and B

33. Arjun and Kushi are two astronauts moving close to each other in outer space. Arjun suddenly feels his oxygen supply is running out and shouts out to kushi, but Kushi cannot hear him. What is the most probable reason for this?
    a) Sound cannot propagate in vacuum.

b) Sound moves very slowly in the outer space.
c) Intensity of sound gets reduced in the outer space.
d) None of the above.

34. The loudness or softness of a sound is determined basically by
a) Amplitude
b) Wavelength
c) Time period
d) Frequency.

35. What is the relationship between wavelength and frequency?
a) Linear
b) Inverse
c) There is no relation between wavelength and frequency
d) Wavelength is always twice the frequency

36. Echoes may be heard more than once due to
a) Multiple reflections
b) Single reflections
c) Refraction
d) Diffraction of waves.

37. Sound waves travels at ----------
a) Same speed in different mediums
b) Different Speed in same mediums
c) Different speed in different medium
d) Highest speed in vacuum

38. SONAR is----------
a) Small Navigation and Random
b) Sky Navigation and Ranging
c) Sun Nuclear Ranging
d) Sound Navigation and Ranging.

39. What are the processes involved in the formation of rain?
a) Evaporation, Condensation.
b) Condensation, Sedimentation
c) Evaporation, Sedimentation
d) Fusion of clouds

40. Most of the water on Earth surface is found in
a) Oceans and Seas
b) Underground
c) Rivers
d) Glaciers

41. Soil Erosion can be prevented by
    a) Afforestation
    b) Deforestation
    c) Overgrazing by animals.
    d) Urbanization

42. The biological oxidation of Ammonia to Nitrite is known as.
    a) Denitrification
    b) Nitrogen fixation
    c) Ammonification
    d) Nitrification

43. Which of the following steps are involved in Carbon cycle?
    a) Photosynthesis, Burning of Fossil fuels
    b) Transpiration, Condensation
    c) Nitrification, Sedimentation.
    d) Transpiration, Evaporation

44. During the winter season, a person sleeps in a closed room with burning firewood. He experiences nausea and giddiness. The emission of which of the following gas is responsible for it.
    a) Carbon dioxide
    b) Carbon monoxide
    c) Nitrous oxide
    d) Sulphur dioxide

45. Oxygen is returned to the atmosphere mainly by----------
    a) Burning of Fossil fuels
    b) Respiration
    c) Fungi
    d) Photosynthesis

46. Ozone layer depletion is caused due to
    a) Carbon monoxide
    b) Sulpher di oxide
    c) CFC’s
    d) Hydrogen

47. Write neat and labeled diagram of Nitrogen cycle. **1X4=4**

Blue-Print of Achievement Test inScience

Objectives		Knowledge	Understanding	Application	Skill	Total
Sl. No	**Topics**					
1	Physical nature of matter	1(1)		-	-	1(1)
2	Characteristics of particles of matter		1(1)	1(1)	-	2(2)
3	States of matter	1(1)	1(1)	1(1)	-	3(3)
4	Uniform &non-uniform motion, Uniform circular motion	-	2(1)	-	-	2(1)
5	Balanced & unbalanced forces	-	-	1(1)	-	1(1)
6	First law of motion & inertia & mass	1(1)	-	1(1)	-	2(2)
7	Third law of motion & conservation of momentum	1(1)	1(1)	1(1)	-	3(3)
8	Gravitation universal law of gravitation	1(1)	1(1)	1(1)	-	3(3)
9	Importance of the universal law of gravitation Archimedes principle	1(1)	1(1)	2(2)	-	4(4)
10	Work &scientific conception of work	1(1)	1(1)	-	-	2(2)
11	Energy &forms of energy	2(1)	1(1)	1(1)	-	4(3)
12	Laws of conservation of energy	-	1(1)	-	-	1(1)
13	Production of sound & propagation of sound	1(1)	1(1)	-	-	2(2)
14	Sound needs a medium to travel &sound waves are longitudinal waves	1(1)	(1)	1(1)	-	3(3)
15	Characteristics of a sound wave	1(1)	1(1)	-	-	2(2)
16	Speed of sound in different media &reflection of sound	2(1)	1(1)	-	-	3(2)
17	Air pollution, water pollution	2(1)	-	-	-	2(1)
18	Biogeochemical cycles, water cycle	-	1(1)	-	-	1(1)
19	The nitrogen-cycle, carbon cycle	1(1)	1(1)	1(1)	1(4)	4(7)
20	Oxygen cycle, ozone layer	1(1)	1(1)	-	-	2(2)
	Total no of questions =47					
	Total Marks =50					
	Total					50(47)

APPENDIX-B

CRITICAL THINKING ABILITY TEST

Student Name:

Gender:

Instructions:
List of items are given below, Read each item carefully and choose the appropriate option out of the four alternatives given below each item.

1. Choose the word which is different from the rest.
(A) Paper
(B) Wool
(C) Wood
(D) Plastic

2. Answer the following question.
EX: Reading : Knowledge : : Work:?
(a)Experience (b)Engagement (c)Employment (d)Experiment
Ans: Experience

Food: Stomach:: Fuel : ?
(A)Plane (B) truck (C) Engine (D) Automobile

3. If you write down all the numbers from 1 to 100, then how many times do you write 3?
(A) 11
(B) 15
(C) 21
(D) 20

4. You are returning home from school. On the way, you find a sealed envelope in a street, fully addressed with unused stamps on it you would

A) You would keep it in your pocket to see what can be done.
B) Ask my parents what to do.
C) Just watch if someone else will take the envelope.
D) Post it at the nearest letter box.

5. Solve the Puzzle.
EX: gaze + away= lookout (*look* = gaze, *out* = away)
not here + set down
(A) greenhouse
(B) Output
(C) Takeover
(D) Warehouse

6. Volume + retail establishment
(A) bookstore
(B) Notebook
(C) Necklace
(D) Friendship

7. In each of the following questions three out of four alternatives contain letters of the alphabet placed in a particular form. Find the one that does not belong to the group.

(A) DFHB
(B) KMOJ
(C) PRTN
(D) GIKE

8. Here are some words translated from an artificial language.
*tamceno*means sky blu
*cenorax*means blue cheese
*aplmitl*means star bright
Which word could mean "bright sky"?

(A) cenotam
(B)mitltam
(C) raxmitl
(D)aplceno

9. In this pyramid number if: 11 22 31: 12 21 32:: 9 12 21 : ?

(A) 2 7 14
(B) 8 13 20
(C) 6 15 18
(D) 10 23 30

10. Critical reading is a demanding process. To read critically, you must slow down your reading and, with pencil in hand; perform specific operations on the text. Mark up the text with your reactions, conclusions, and questions. When you read, become an active participant.

This paragraph best supports the statement that
(A) Critical reading is a slow, dull, but essential Process.
(B) The best critical reading happens at criticaltimes in a person's life.
(C) Readers should get in the habit of questioning the truth of what they read.
(D) Critical reading requires thoughtful and careful attention.

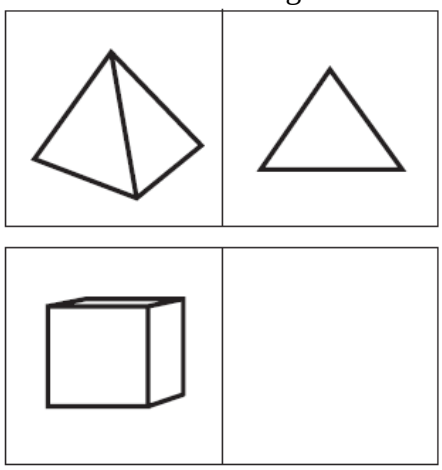
11. The presence of calcium in milk makes it white.Rice,too,is white. Therefore rice also contains calcium

A) False
B) Probably true
C) True
D) Can't say

12. If Z = 52 and ACT = 48, then BAT will be equal to
   A) 39
   B) 41
   C) 44
   D) 46

13. Arrange in a correct sequence.
Rainbow 2. Rain 3. Sun 4. Happy 5. Child
   A) 2, 1, 4, 3, 5
   B) 2, 3, 1, 5, 4
   C) 4, 2, 3, 5 , 1
   D) 4, 5, 1, 2, 3

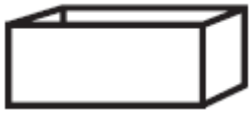
14. Select a suitable figure from the four alternatives.



A) 

B) 

C) 

D) 

15. There was a green house. Inside the green house there was a white house. Inside the white house there was a red house. Inside the red house there were lots of babies. What is it?
   A) Watermelon
   B) Orenge
   C) Banana
   D) Guva

16. The school principal has received complaints from parents about bullying in the school yard during recess. He wants to investigate and end this situation as soon as possible, so he has asked the attender to watch closely .Which situation should the attender to report to the principal?
(A) A girl is sitting glumly on a bench reading a book and not interacting with her peers.
(B) Four girls are surrounding another girl and seem to have possession of her backpack.
(C) Two boys are playing a one on one game of basketball and are arguing over the last basket.
(D) Three boys are huddled over a handheld video game, which isn't supposed to be on school.

17. Find out the missing number.

1, 4, 9, 16, 25, 36, 49, (….)

(A) 54
(B) 56
(C) 64
(D) 8

18. Jaya is taller than Vinod who is shorter than pramod. Usha is taller than Priyanka but shorter than Vinod. Pramod is shorter than Jaya. Who is the tallest?

(A) Priyanka
(B) Vinod
(C) Pramod
(D) Jaya

19. Three pencils cost the same as two erasers.
Four erasers cost the same as a ruler.
Pencils are more expensive than rulers.
If the first two statements are true, the third statement is,

(A) True
(B) False
(C) Uncertain

20. A boy rode his bicycle northwards, then turned left and rode one km and again turned left and rode 2km. He found himself exactly one km west of his starting point. How far did he ride northwards initially?

A) 1 km
B) 2 km
C) 3 km
D) 5 km

21. 7 months have 31 days in them. 11months have 30days in them. How many months have 28 days in them?

(A) 10
(B) 14
(C) 12
(D) 16

22. Four friends in the sixth grade were sharing a Watermelon. They decided that the oldest friend would get the extra piece. Ramesh is two months older than Raju , who is three months younger than Gopi. Swamy is one month older than Raju. Who should get the extra piece of Watermelon?

(A) Ramesh
(B) Raju
(C) Gopi
(D) Swamy

23. If South-East becomes North, North-East becomes West and so on. What will West become?

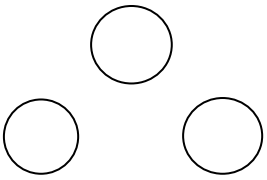
(A) North-East
(B) North-West
(C) South-East
(D) South-West

24. At the baseball game, Sujith was sitting in seat 253. Vindhya was sitting to the right of Sujith in seat 254. In the seat to the left of Sujith was Raghu. Sahana was sitting to the left of Raghu. Which seat is Sahana sitting in?

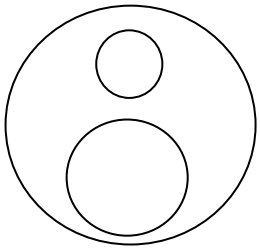
(A) 251
(B) 254
(C) 255
(D) 256

25. Which of the diagrams given below correctly represents the relationship:
Fruits, Fish, Eatables.

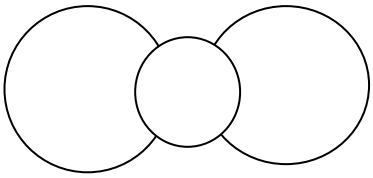
(a)



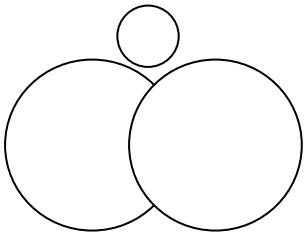
(b)



(c)

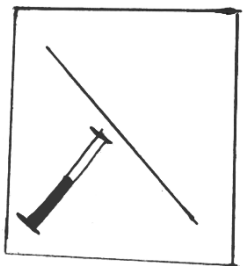


(d)



(A) a
(B) b
(C) c
(D) d

26. which will be the mirror image of this image if a mirroris place at the bottom of the image.



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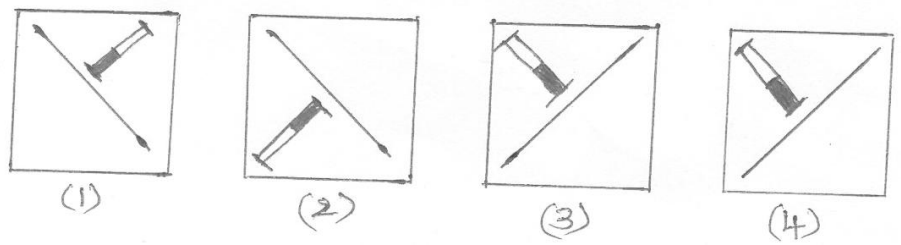
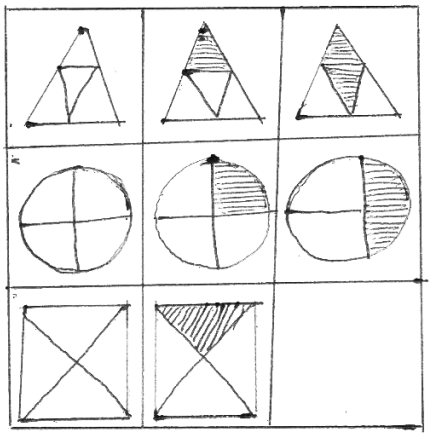
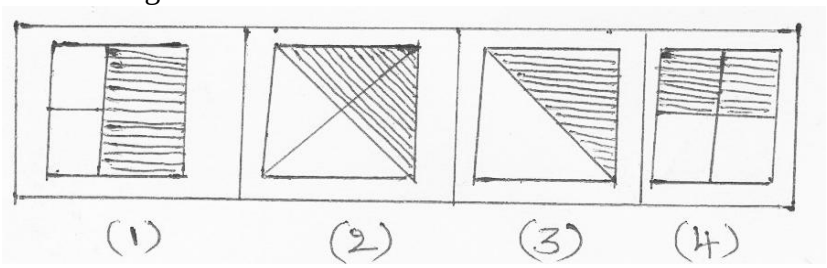


(A) 1
(B) 2
(C) 3
(D) 4

27. Select a suitable figure from the four alternatives that would complete the figure matrix.



These are the answers image.



(A) 1
(B) 2
(C) 3
(D) 4

28. Statement: "For better health have fruits instead of vitamin supplementing tablets.
Assumptions:

I. Vitamins are essential for good health.
II. Vitamin supplementing tablets do not help at all in attaining good health.

(A) Only assumption I is implicit.
(B) Only assumption II is implicit.
(C) Both I and II are implicit.
(D) Neither I nor II is implicit.

29. Statement: A warning in a train compartment-
"To stop train, pull chain. Penalty for improper use Rs500"

Assumptions: 1. Some people misuse the alarm chain
2. On certain occasions, people may want to stop a running train.

(A). only assumption I is implicit.
(B) Only assumption II is implicit.
(C) Both I and II are implicit.
(D) Either I or II is implicit.

30. Statement: “Put a notice on the notice board that all the teachers should come on time to school”- Head master tells his assistant teachers.

Assumptions: 1. All the teachers come late.
2. Teachers read such notice on the board.
3.Teachers will follow the instructions.

(A) Only assumption I and II are implicit.
(B) Only assumption II and III are implicit.
(C) Only III is implicit.
(D) Only I and III are implicit.

31. Fact 1: All chickens are birds.
Fact 2: Some Chickens are hens
Fact 3: Female birds lay eggs

If the first three statements are facts, which of the following statements must also be a fact?

I: All birds lay eggs.
II: Some hens are birds..
III: Some chickens are not hens.

(A) I only
(B) II only
(C) II& III only
(D) I&II only

32. Fact 1: All dogs like to run.
Fact 2: Some dogs like to swim
Fact 3: Some dogs look like their masters.

If the first three statements are facts, which of the following statements must also be a fact?

I: All dogs who like to swim look like their masters.
II: Dogs who like to swim also like to run.
III: Dogs who like o run do not look like their masters.

(A) I only
(B) II only
(C) II& III only
(D) I&II only

33. **Statements** 1: Pictures can tell a story
2: All storybooks have pictures.
3: some storybooks have words.

Conclusion:

I. Some storybooks have words
II. All storybooks have words
III. None of the storybooks have words
IV. Some story books have pictures.
V.

(A) I only follows
(B) II only follows
(C) III & IV only
(D) II& III only

34. A, B, C, D, E and F are a group of friends. There are two house wives, one professor, one engineer, one accountant and one lawyer in the group. There are only two married couples in the group. The lawyer is married to D, who is a housewife. No women in the group are either an engineer or an accountant. C, the accountant, is married to F, who is a professor. A is married to housewife. E is not a housewife.
How many members of the group are males?

A) 1
B) 3
C) 4
D) 5

35. Study the following information carefully and answer the questions given below:
P, Q, R, S, U, V and W are sitting around a circle facing at the center. T is second to the left of P and third to the right of V. S is second to the right of W who is the immediate right of T. Q is third to the right of U.
Who is second to the right of P?

A) S
B) V
C) U
D) Q

APPENDIX- C

SOCIAL MATURITY SCALE

This scale is related to your level of social maturity scale. Carefully read the statements and decide your response on a four point scale. i.e., Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD) and whichever point you feel is your correct answer put a mark in the appropriate column.

Sl No.	Statement	Strongly Agree	Agree	Disagree	Strongly Disagree
1	It is hard to stick to anything that takes a long time to do.				
2	I often forget to listen to what others are saying.				
3	I would never go out of my way to help another person if it means giving up some personal pleasure.				
4	The future is so uncertain, one cannot really make any plan.				
5	There is no way to tell whom you can trust.				
6	I cannot be friendly with people who do things which I consider wrong.				
7	I get extremely hurt when people criticize me.				
8	I fight to the last with my group if they do not carry out what I tell them.				
9	Women should not be elected to top government positions.				
10	I often forget work I am supposed to do.				
11	I find it hard to speak my thoughts clearly.				

12	I am willing to give a lot of money to medical research on cancer or such deadly disease only if I know they would find a cure in my life time.				
13	I feel very uncomfortable when I disagree with what my friends think.				
14	Must people, I feel, would rather lie than speak the truth if they could get away with it.				
15	I do not make close friends with crippled/handicapped persons though I do not like to admit this.				
16	It is natural for anybody to feel extremely uneasy to speak to people whom he/she does not know.				
17	I settle fights and differences among my friends.				
18	A man should not cook dinner for his wife and children unless the wife is sick.				
19	I often get behind in my work.				
20	In a discussion, it is hard to understand what people are trying to say.				
21	I often think about doing things so that people, in future, can have things better.				
22	Someone often has to tell me what to do.				
23	There are more bad people than good people this world.				
24	There are a lot of useful things for us to learn from having a group of people of other communities living in our neighborhood.				
25	One feels miserable when one has to disagree with his friends.				

26	I get along well with teachers and classmates in my school.				
27	Many more women should be trained for jobs, usually held by men.				
28	I often don't finish the work I start.				
29	Even if I know how to do something, I find it hard to teach someone else.				
30	Members of one religion should never ask money for some religious causes from people who are not of the same religion.				
31	Other seem more in control of their lives than I do				
32	It is hard to ask even the best friends for help				
33	One should not offer food o people who belong to other caste as it is embrassing to refuse food offered.				
34	I am comfortable only with people of my own sex.				
35	It is obvious that one gets upset when one has to change all his/her plans to adjust to someone else.				
36	If we do not encourage women to work, we are seriously reducing what the country could accomplish.				
37	I tend to go from one thing to another before finishing the earlier one.				
38	It is hard for me to find anything to talk about when I meet a new person.				
39	I want to spend more time in work to help the society I live in.				

40	I keep my ideas to myself in class unless I am sure I am right.				
41	You can be sure that people will be honest with you if you are honest with them.				
42	I would not mind living next door to a family that is much poorer than mine.				
43	It is a source of great disappointment to me when the opinion of others differs from mine.				
44	There is no point helping, others inconveniencing oneself.				
45	I really worry the way many girls become doctors, engineers and lawyers these days.				
46	I get upset if I am not immediately successful in learning something new.				
47	My friends find it hard to figure out from what I say				
48	Why work for something that others will enjoy when you won't be able to enjoy yourself.				
49	In a group, I prefer to let other people make the decision.				
50	Even though it is hard to believe, the radio and news-papers give us true facts about important events.				
51	I don not mind playing with people who speak a language different from mine.				
52	One should be able to laugh at oneself and take jokes easily.				
53	If you haven't been chosen as the leader, you should not suggest how things should be done.				
54	More men should train themselves for jobs like nursery school teachers and telephone operators which are usually held by women.				

55	I often don't get my most important work done because I have spent too much time on another work.				
56	In a discussion, people find it easy to understand what I am trying to say.				
57	I would be willing to work for a good plan to make a better life for the poor, even if it costs me money.				
58	I usually let others take the lead.				
59	I feel a trusted person a person in one way, can be trusted in all the ways.				
60	I find more interest to work for friends whose caste is the same as mine.				
61	It is obvious that one gets angry when one loses an argument.				
62	In my class I need not accept any responsibility in which I am not interested.				
63	If everyone is to be really equal, some people will have to shed some of their advantages.				
64	I give up the work I am doing when things go wrong.				
65	I am not good at describing things in writing.				
66	It is possible to rush to neighbours to help them in all their troubles and needs.				
67	The outcome of my life is a matter of luck.				
68	A person is better off if he does not trust anybody.				
69	I don not care to tell my ideas about god, when I know others will disagree with me.				
70	I cannot keep cool when I get upset even though I am in a class – room or in a formal group				

71	I prefer to work for my own self than for the group I belong to.				
72	Giving higher education to women is a national waste.				
73	Hard work is never a fun.				
74	I have a talent for influencing people by just talking to them.				
75	A person should not be expected to do anything for his community unless he is paid for it.				
76	When things have gone wrong for me, it is usually because of something I could not do anything about it.				
77	A person who is completely trusting will have better experience in life.				
78	I prefer to break with a friend who disagrees with me other.				
79	I will not do the work I do not like though I am expected to do.				
80	I make my point clear when I discuss.				
81	I do not care to cut the use of water and electricity with a view to helping the government when there are so many others who are wasting it.				
82	I donot know whether I like a new dress/clothes/sarees until I find out what my friends think				
83	One can safely trust strangers as much as people they know.				
84	It is very difficult for me to be nice to people I do not like.				

APPENDIX-D

Achievement Test in Science scores of Experimental and Control Group

Sl.No of the Student	Gender	Scores of Experimental Group		Sl.No of the student	Gender	Scores of Control Group
1	M	43		1	M	24
2	M	45		2	M	31
3	M	42		3	M	33
4	M	44		4	M	29
5	M	46		5	M	28
6	M	48		6	M	32
7	M	49		7	M	40
8	M	40		8	M	34
9	M	47		9	M	25
10	M	39		10	M	30
11	M	44		11	M	34
12	M	41		12	M	37
13	M	45		13	M	36
14	M	48		14	M	31
15	M	43		15	M	29
16	F	45		16	F	33
17	F	47		17	F	31
18	F	44		18	F	28
19	F	48		19	F	32
20	F	43		20	F	35
21	F	42		21	F	30
22	F	46		22	F	23
23	F	49		23	F	24
24	F	44		24	F	38
25	F	43		25	F	36
26	F	49		26	F	39
27	F	40		27	F	34
28	F	41		28	F	40
29	F	45		29	F	33
30	F	43		30	F	26
31	M	44		31	M	34
32	M	48		32	M	29
33	M	42		33	M	31
34	M	46		34	M	28
35	M	41		35	M	36
36	M	45		36	M	39
37	M	43		37	M	29
38	M	47		38	M	32
39	M	49		39	M	37
40	M	44		40	M	30
41	M	43		41	M	35
42	M	48		42	M	33
43	M	46		43	M	34
44	M	42		44	M	32

45	M	43		45	M	38
46	F	45		46	F	33
47	F	42		47	F	30
48	F	48		48	F	39
49	F	46		49	F	40
50	F	48		50	F	38
51	F	49		51	F	34
52	F	41		52	F	29
53	F	47		53	F	39
54	F	49		54	F	28
55	F	42		55	F	36
56	F	41		56	F	35
57	F	43		57	F	38
58	F	46		58	F	37
59	F	44		59	F	35
60	F	48		60	F	36

Critical Thinking Pre-test Scores of Experimental and Control Group

Sl.No of the Student	Gender	Scores of Experimental Group		Sl.No of the student	Gender	Scores of Control Group
1	M	18		1	M	21
2	M	19		2	M	18
3	M	22		3	M	17
4	M	18		4	M	19
5	M	17		5	M	19
6	M	18		6	M	18
7	M	19		7	M	22
8	M	19		8	M	17
9	M	21		9	M	15
10	M	18		10	M	23
11	M	17		11	M	19
12	M	22		12	M	18
13	M	23		13	M	18
14	M	19		14	M	20
15	M	18		15	M	18
16	F	15		16	F	24
17	F	17		17	F	16
18	F	23		18	F	21
19	F	22		19	F	18
20	F	18		20	F	18
21	F	20		21	F	19
22	F	16		22	F	22
23	F	23		23	F	17
24	F	18		24	F	18
25	F	18		25	F	20
26	F	19		26	F	22

27	F	21		27	F	19
28	F	18		28	F	18
29	F	19		29	F	19
30	F	20		30	F	22
31	M	19		31	M	20
32	M	21		32	M	19
33	M	22		33	M	18
34	M	18		34	M	21
35	M	20		35	M	20
36	M	23		36	M	24
37	M	21		37	M	22
38	M	24		38	M	19
39	M	20		39	M	19
40	M	19		40	M	18
41	M	18		41	M	17
42	M	19		42	M	21
43	M	20		43	M	20
44	M	18		44	M	19
45	M	17		45	M	18
46	F	19		46	F	22
47	F	20		47	F	17
48	F	18		48	F	19
49	F	18		49	F	20
50	F	22		50	F	23
51	F	19		51	F	22
52	F	20		52	F	18
53	F	25		53	F	24
54	F	21		54	F	25
55	F	18		55	F	19
56	F	17		56	F	18
57	F	19		57	F	18
58	F	21		58	F	19
59	F	18		59	F	16
60	F	20		60	F	20

Critical Thinking Post-test Scores of Experimental and Control Group

Sl.No of the Student	Gender	Scores of Experimental Group		Sl.No of the student	Gender	Scores of Control Group
1	M	31		1	M	24
2	M	29		2	M	18
3	M	33		3	M	19
4	M	31		4	M	21
5	M	29		5	M	19
6	M	30		6	M	20
7	M	32		7	M	23
8	M	33		8	M	19

9	M	31		9	M	18
10	M	33		10	M	23
11	M	32		11	M	19
12	M	34		12	M	24
13	M	34		13	M	20
14	M	32		14	M	21
15	M	33		15	M	22
16	F	29		16	F	26
17	F	32		17	F	18
18	F	34		18	F	21
19	F	33		19	F	18
20	F	32		20	F	19
21	F	29		21	F	22
22	F	28		22	F	23
23	F	34		23	F	19
24	F	31		24	F	22
25	F	32		25	F	23
26	F	30		26	F	20
27	F	32		27	F	19
28	F	33		28	F	18
29	F	31		29	F	23
30	F	30		30	F	22
31	M	34		31	M	23
32	M	31		32	M	21
33	M	32		33	M	22
34	M	28		34	M	21
35	M	32		35	M	23
36	M	32		36	M	26
37	M	33		37	M	24
38	M	34		38	M	20
39	M	31		39	M	19
40	M	30		40	M	20
41	M	33		41	M	21
42	M	34		42	M	23
43	M	32		43	M	19
44	M	29		44	M	21
45	M	31		45	M	20
46	F	30		46	F	24
47	F	32		47	F	19
48	F	31		48	F	21
49	F	30		49	F	22
50	F	32		50	F	26
51	F	31		51	F	21
52	F	33		52	F	20
53	F	34		53	F	27
54	F	32		54	F	26
55	F	30		55	F	19
56	F	33		56	F	20
57	F	30		57	F	18

58	F	32		58	F	19
59	F	31		59	F	20
60	F	32		60	F	23

Social maturity Pre-test Scores of Experimental and Control Group

Sl.No of the Student	Gender	Scores of Experimental Group		Sl.No of the student	Gender	Scores of Control Group
1	M	198		1	M	196
2	M	205		2	M	194
3	M	195		3	M	195
4	M	198		4	M	196
5	M	196		5	M	196
6	M	195		6	M	198
7	M	194		7	M	194
8	M	196		8	M	193
9	M	193		9	M	196
10	M	194		10	M	198
11	M	198		11	M	192
12	M	192		12	M	198
13	M	194		13	M	199
14	M	196		14	M	202
15	M	198		15	M	198
16	F	205		16	F	206
17	F	193		17	F	193
18	F	198		18	F	198
19	F	196		19	F	196
20	F	192		20	F	197
21	F	201		21	F	196
22	F	198		22	F	198
23	F	196		23	F	195
24	F	195		24	F	197
25	F	193		25	F	197
26	F	191		26	F	198
27	F	194		27	F	193
28	F	197		28	F	195
29	F	196		29	F	199
30	F	198		30	F	201
31	M	196		31	M	198
32	M	198		32	M	196
33	M	194		33	M	203
34	M	199		34	M	197
35	M	197		35	M	198
36	M	196		36	M	196
37	M	198		37	M	195
38	M	192		38	M	194
39	M	194		39	M	193

40	M	196		40	M	198
41	M	198		41	M	197
42	M	197		42	M	198
43	M	195		43	M	199
44	M	198		44	M	192
45	M	192		45	M	193
46	F	194		46	F	197
47	F	198		47	F	199
48	F	196		48	F	193
49	F	204		49	F	194
50	F	197		50	F	194
51	F	198		51	F	196
52	F	196		52	F	198
53	F	195		53	F	195
54	F	197		54	F	196
55	F	196		55	F	198
56	F	198		56	F	198
57	F	199		57	F	199
58	F	201		58	F	203
59	F	193		59	F	198
60	F	192		60	F	195

Social maturity Post-test Scores of Experimental and Control Group

Sl.No of the Student	Gender	Scores of Experimental Group		Sl.No of the student	Gender	Scores of Control Group
1	M	281		1	M	224
2	M	273		2	M	202
3	M	275		3	M	212
4	M	293		4	M	215
5	M	298		5	M	219
6	M	321		6	M	199
7	M	315		7	M	221
8	M	298		8	M	215
9	M	289		9	M	221
10	M	310		10	M	205
11	M	296		11	M	218
12	M	297		12	M	210
13	M	286		13	M	220
14	M	297		14	M	221
15	M	283		15	M	218
16	F	293		16	F	198
17	F	298		17	F	210
18	F	284		18	F	215
19	F	309		19	F	199
20	F	298		20	F	205
21	F	289		21	F	220

22	F	278		22	F	218
23	F	296		23	F	219
24	F	293		24	F	215
25	F	298		25	F	198
26	F	296		26	F	209
27	F	298		27	F	210
28	F	287		28	F	224
29	F	297		29	F	218
30	F	278		30	F	216
31	M	310		31	M	206
32	M	296		32	M	215
33	M	294		33	M	218
34	M	289		34	M	220
35	M	298		35	M	219
36	M	298		36	M	219
37	M	319		37	M	210
38	M	297		38	M	212
39	M	286		39	M	218
40	M	293		40	M	199
41	M	289		41	M	214
42	M	297		42	M	212
43	M	294		43	M	210
44	M	296		44	M	215
45	M	293		45	M	225
46	F	298		46	F	204
47	F	320		47	F	216
48	F	315		48	F	215
49	F	298		49	F	218
50	F	289		50	F	219
51	F	296		51	F	210
52	F	294		52	F	213
53	F	297		53	F	216
54	F	298		54	F	210
55	F	296		55	F	212
56	F	305		56	F	218
57	F	293		57	F	225
58	F	289		58	F	220
59	F	292		59	F	213
60	F	286		60	F	209

APPENDIX-E

GMA Scores of Matched Experimental and Control Group.

Student Numbers	Score of Experimental group	Score of Control group
1	51	50
2	40	41
3	31	31
4	38	38
5	34	33
6	47	48
7	58	58
8	55	54
9	37	37
10	40	40
11	42	43
12	47	47
13	44	44
14	30	31
15	53	54
16	50	52
17	49	49
18	51	51
19	36	38
20	57	58
21	53	52
22	51	51
23	49	49
24	46	44
25	36	38
26	52	50
27	55	54
28	37	35
29	53	53
30	59	58
31	44	41
32	34	32
33	38	38
34	41	41
35	44	46
36	53	50
37	42	42
38	50	52
39	39	39

40	32	31
41	55	54
42	37	37
43	58	57
44	32	30
45	40	39
46	48	48
47	51	51
48	59	57
49	39	37
50	49	48
51	44	44
52	50	53
53	36	35
54	52	50
55	49	49
56	56	55
57	38	36
58	32	30
59	40	41
60	34	32
61	42	42
62	54	56
63	51	51
64	37	39
65	34	33
66	53	50
67	50	52
68	36	35
69	31	31
70	41	44
71	53	55
72	46	43
73	42	42
74	53	50
75	37	35
76	32	30
77	39	38
78	45	44
79	49	47
80	50	50
81	48	48

82	45	43
83	30	31
84	35	37
85	55	56
86	41	44
87	34	34
89	37	35
90	58	56
91	43	43
92	45	46
93	43	41
94	39	37
95	58	56
96	47	48
97	39	40
98	45	46
99	42	41
100	33	33
101	55	56
102	48	48
103	40	40
104	53	51
105	30	32
106	38	36
107	49	50
108	52	52
109	32	34
110	55	54
111	43	43
112	51	52
113	40	39
114	58	57
115	54	54
116	31	33
117	46	46
118	38	36
119	51	52
120	44	41

APPENDIX-F

LESSON PLAN

Grade: 9th standard

Subject: Science

Topic: Natural resources

Duration:50 minutes

Social Constructive strategy: Anchored instruction, Concept map

Materials Required: Worksheets, Activity sheet, Chart with map of Karnataka state

CONTENT/ LEARNING POINTS:

- Natural Resources
- Air/water/soil/plants/animals/ fossil fuels/minerals and metal ores- natural resources.
- Classified ofNatural Resources as renewable and non- renewable.
- Important ores/metals and their availability

LEARNING OBJECTIVES:

At the end of this lesson the student will be able to:

- explain natural resources in their own words
- differentiate between natural and man made objects.
- Classify renewable and non-renewable natural resource.
- identify the ores/metals available in various districts of Karnataka.
- Critically relate the uses and demand of a natural resource

Five Es Instructional Model of Social Constructivism	Learning experience Provided/Activity	Teacher activity	Student Activity
Engage:-	Students are divided into smaller groups of four to five and are taken out into the field They are encouraged to observe various things and objects in the field. **Activity-1** Using worksheet-1: let students list all the things they notice and observe. Then teacher questions students about why certain items, although is a natural resources, they did not indicate them as naturally occurring? Subsequently groups discuss their observations and understanding and develop a shared meaning of natural objects and manmade objects.	Teacher tells them to observe the various things and objects present in the field by using hand lens observing small particles insects etc. Teacher encourages students to indicate whether they are naturally occurring in the environment or made by human beings. Teacher facilitates students to give their own definitions about natural resources and man made things. Teacher asks students :where we get things	Students carefully observe the various things. Students list out the observed things. Students try to indicate the naturally occurring things and man-made things. Students try to give different definitions for natural resources and man made things. Students try to give answer to the questions asked by

<table>
<tr>
<td></td>
<td>Teacher provides the groups with the following list of items and products found in our environment and asks them to identify or trace their original or base materials.

Activity-2
<table>
<tr><td>School bag

Tiffin box

Water bottle

Wooden table

Plastic bag

Pencil

Black Board</td><td>Note book

Ice cream

Steel stool

Silk saree

Mobile phone

Pen

Iron Door</td></tr>
</table>
</td>
<td>like petrol, writing paper, water etc.

Then again teacher asks them, why petrol and water are called as natural resources where as writing paper is not considered so?

Teacher helps the students</td>
<td>the teacher.

Students discuss in their groups and exchange their thoughts in the group.

Students will identify the original base materials present in the given list items.

From the above activity students can differentiate the items.</td>
</tr>
</table>

EXPLORE:-	After the above activity groups gather back in the class.	Teacher asks them to list the several uses of water, similarly that of plants and animals. Based on their understanding of natural and manmade objects. Teacher encourages students to discuss among themselves and develop the concept of resource. Teacher then ask them to list some more such resources without which life cannot exist. Teacher asks questions like: where do the resources occur? How do they occur?	Students make a list of the several uses of water, plants, and animals. Students try to give the explanation about the resources. Plants, animals, water are all called as resources because they are available for use and can be used for support or help. These questions enable students to develop the concept that those resources that are available in nature are called Natural Resources.

	After all the activities and explanation students get the answers to the questions : Why water is called Natural resource and why not the writing paper?	Teacher helps students to explain that a natural resource is anything that people can use which comes from nature. Examples of natural resources are air,water, wood , oil, wind energy, hydroelectric energy, iron, coal, cotton, crops, etc. Teacher again asks them to choose a product /object from	Students are made to explore that although these items are not called as natural resources, they are made from a natural resources a tree/bamboo/sheep wool, etc,. Let students discuss and come out with the differences between man made and natural resources. Students now they can easily differentiate and make a list of it. Students will trace the original material. (ZPD)

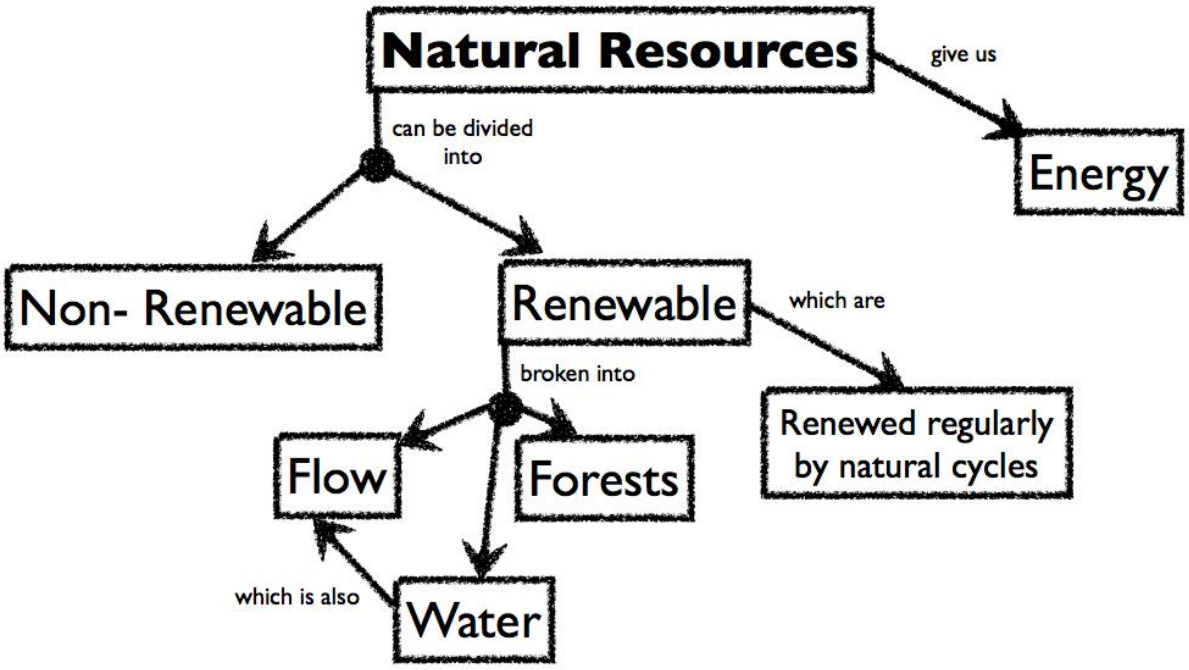
	Teacher asks students to make a list of things they see in their classroom which they think are made from natural resources?	the earlier developed list or from the following viz, paper, electricity, PVC pipes, leather shoes, coffee/tea, Bournvita, etc. to trace and explore their original materials ingredients made up of and where these materials are naturally occurring or made from natural resources or whether they are human synthesized materials? Teacher asks the questions that whether the natural resources that are used to make the products are used to make the products are available in plenty or exhaustible. Where each resource is found? Teacher asks questions: which are all the natural	

	Here teacher tries to give concept of types of Natural resources.	resources used in manufacturing a Pencil? Teacher asks question: is this renewable or non-renewable resource? Teacher helps the students to answer to the above question. Renewable resources are resources that can be regenerated where as non- renewable resources cannot be generated when they are exhausted. For example: Minerals and Fossil fuels. Teacher asks students to give examples for renewable and non-renewable resources.	Students give answers that wood, Graphite, dyes, water, etc.(ZPD) Students give answers to the questions.

	Here teacher shows the Video of manufacturing of Pencil? **Activity:-3** Teacher distribute Karnataka map to students to identify where some important ores/metals and their availability in various district of Karnataka.	Teacher facilitate to identify the district	Students give examples for renewable and non renewable resources. Students discuss in the group then they use their pervious knowledge (ZPD)
Explain: In this stage students explain all the above concepts in their own understanding		Teacher helps the student to explain the concepts	students tries to explain in own words Students give definition of natural resources. (ZPD) Explains the difference between renewable and Non-renewable. Resources and identify the availability of ores/ metals in various district of Karnataka. From each group one student will come and present it.
Elaborate: In this stage teacher add some more information		Teacher gives more examples for Natural resources, renewable	Students carefully listen and add more information regarding the above concepts and get

regarding the above concepts and explains.		resources and non renewable resources. Teacher explains the applicability of these concepts in their daily life. Teacher gives complete information regarding availability of ores/ metals in various districts of Karnataka.	more knowledge. Then students try to identify the various districts where metals/ores available.
Evaluate: In this stage evaluation will be done	The process of evaluation is carried to assess whether students have developed the meaning and understanding of natural resources , how some of them are non renewable? Where we get the metals/ores from various parts of the Karnataka?	What are the Natural resources? Mention the types of Natural resources. Give examples for non-Renewable resources. What is the difference between the renewable and non renewable resources?	In this stage students will answer the questions asked by teacher.

CONCEPT MAP OF NATURAL RESOURCES



LESSON PLAN

Grade: 9th standard

Subject: Science

Topic: Meaning of force, Balanced and unbalanced force

Duration: 50 minutes

Social Constructive strategy: Simulation

Materials Required: Straws, rubber balls.

CONTENT/ LEARNING POINTS:

- Meaning of force
- Balanced and unbalanced force

LEARNING OBJECTIVES:

At the end of this lesson the student will be able to:

- explain the meaning of force.
- identify forces in the world around them.
- explain the meaning of balanced and unbalanced force.
- differentiate between balanced and unbalanced force.

Five Es Instructional Model of Constructivism	**Learning experience Provided /Activity**	**Teacher Activity**	**Student Activity**
ENGAGE In this stage: ∗Teacher stimulates the learner's curiosity ∗Teacher discovers what students know about force	Questioning	Ask the students to face each other and place their hands chest high with palms facing their partner. Each student places his/her palms on the other's and at teacher's signal begins pushing. Allow students to push for about 30 seconds. Teacher asks following questions What did you feel when your partner pushed against your hands? What did you do? What would happen if you did nothing? Now ask students to hold each hand and pull. Allow students to pull for about 30 seconds. Teacher asks following questions	Student answers Pushing on my hands I had to push back I would be pushed back or pushed down

		What did you feel when your partner pushed against your hands? What did you do? What would happen if you did nothing? Write the words PUSH and PULL on board. What did you experience?	Student answers Pushing on my hands I had to push back I would be pushed back or pushed down FORCE
EXPLORE In this stage: * Students experience themselves * Students compare and get directly involved with what they think about force with what they are actually observing	Activity	Students will be divided into 4 groups, each of which has two straws and one rubber ball. They will take turns blowing on the ball.	Students get a feel of how the ball responds to the force
EXPLAIN	* Students analyse and	* Teacher encourages the students to explain	* Students explain about force in their

In this stage: * Students get opportunity to connect their previous knowledge to make exact conceptual sense of force	try to give an explanation. * Supporting ideas with evidence for students	concepts and definitions of Force in their own words Teacher shows the animated video for explaining the concept of force.	own words. * Students listen to others explanations. * Students listen to and try to compare the explanations of force
ELABORATE In this stage: * Students apply the concepts in new situations and relate their previous knowledge to new experience	Group Discussion Answering the questions	Teacher encourages the students to apply their understanding of the concept of force in present situation	* Students use previous information and try to answer the questions raised. * Students draw their conclusion about the meaning of force * Students observe others and give their own explanations and compare it with that of others.
EVALUATION: In this stage: * Ongoing diagnostic	Performance assessment	* Teacher assesses student's knowledge about force * Teacher looks for answers that show students have evidence for understanding and changing their previous thinking of the concept. * Teacher asks open-ended questions	

process that allows the teacher to determine if the learner has attained understanding of concepts and knowledge		1) What is Force? 2) What are balanced and unbalanced force?	Students answer the open ended questions Force is push or pull. Force can change the shape and size of objects. Balanced forces do not cause change in motion. They are equal in size and opposite in direction. When the net force of an object is not zero, the forces on the object are unbalanced. An unbalanced force always causes a change in motion.

LESSON PLAN

Grade: 9th standard

Subject: Science

Topic: Newton's I Law of Motion

Duration: 50 minutes

Social Constructive strategy: Cooperative learning, Collaborative learning

Materials Required: Card, tumbler, coin, small car, ramp, small doll

CONTENT/ LEARNING POINTS:

- Concept of inertia
- Newton's I Law of Motion

LEARNING OBJECTIVES:

At the end of this lesson the student will be able to:

- define the concept of inertia
- state Newton's First Law of motion.
- identify situations from daily life in whichthe law is applied.
- Critically analyze situations and apply the concept of inertia to problems fromdaily life.

Five Es Instructional Model of Constructivism	Suggested Activity	Teacher Activity	Student Activity
ENGAGE In this stage: * Teacher stimulates the learner's curiosity * Teacher discovers what students know about force and types of forces	Questioning	* Teacher asks the following questions 1) What is Force? 2) What are balanced and unbalanced force?	Students answer Force is push or pull. Force can change the shape and size of objects. Balanced forces do not cause change in motion. They are equal in size and opposite in direction. When the net force of an object is not zero, the forces on the object are unbalanced. An unbalanced force always causes a change in motion.
EXPLORE In this stage: * Students get experience themselves * Students compare and get directly involved with what they think about laws of motion with what they are actually observing	Activity	Place a card on a tumbler and a coin on top of the card. Flick the card and see the coin fall into the tumbler Place a car on the top of	Students will analyze the observations in both the activities.

		a ramp and a toy doll on the car. Let the car roll down the ramp and observe the doll fall backward. Place a doll in a car and move it. Stop the moving car suddenly and ask the student to observe that the doll falls forward.	
EXPLAIN In this stage: * Students get opportunity to connect their previous knowledge to make exact conceptual sense of laws of motion	* Students analyse and try to give an explanation . * Supporting ideas with evidence for students	* Teacher encourages the students to explain concepts and definitions of inertia and Newton's 1st law of motion in their own words	* Students explain possible answers about inertia and Newton's 1st law of motion. * Students listen to others explanations. * Students listen to and try to compare the explanations of force
ELABORATE In this stage: * Students apply the concepts in new situations and relate their previous knowledge to new experience	Group Discussion Answering the questions	Teacher encourages the students to apply their understanding concept inertia and Newton's 1st law of motion in present situation	* Students use previous information and try to answer the questions raised. * Students draw their conclusion about the concept of inertia and Newton's 1st law of motion * Students observe others and give their own explanations and compare it with others.

EVALUATION: In this stage: ∗ Ongoing diagnostic process that allows the teacher to determines if these learner has attained understanding of concepts and knowledge	Performance assessment	∗ Teacher assesses student's knowledge about inertia and Newton's 1st law of motion Teacher looks for answers that show students have evidence for understanding and changing their previous thinking of the concept. ∗ Teacher asks open-ended questions ∗ What is inertia? ∗ State Newton's I law of motion	Students answer: Inertia is the resistance of any physical object to any change in its state of motion An object at rest stays at rest and an object in motion stays in motion with the same speed and in same direction unless acted upon by an unbalanced force

LESSON PLAN

Grade: 9th standard

Subject: Science

Topic: Production and vibrations

Duration: 50 minutes

Social Constructive strategy: Simulation / Anchored Instruction

Materials Required: Music instrument, Speaker and grains, Rubber string, Balloons, Tuning fork

CONTENT/ LEARNING POINTS:

- Production of sound due to the vibrations of any material (Strings, Stretched membrane, sudden expansion)

LEARNING OBJECTIVES:

To enables students to:

- Recognize the reason for production of sound,
- Design an instrument to produce sound,
- Describe production of sound in Humans.

Five Es Instructional Model of Constructivism	Suggested Activity	Teacher Activity	Student Activity
ENGAGE In this stage: * Teacher stimulates the learner's curiosity	Audio and Questioning	Teacher plays an audio file (any music or sound or thunder) and asks the learners to analyse the process by which sound is produced.	Students answer Learners will listen to the audio file and discuss in their groups to identify the sound first and then the process of producing it.
EXPLORE In this stage: * Students get experience themselves * Students compare and get directly involved with what they think about production of sound and vibrations with what they are actually observing	Activity	Teacher provides different activities to each group (Music instrument, Speaker and grains, Rubber string, Balloons, Tuning fork) and record their observations.	Learners perform the experiments in their groups, observe and note their observations.
EXPLAIN In this stage: * Students get opportunity to	* Students analyse and try to give an explanation . * Supporting ideas with evidence for students	Teacher then allows the learners to explain their observations and conclude their idea of how sound is produced.	* Students explain possible explanation of production of sound and vibrations Students listen to others explanations. Learners will explain their observations and their idea of how sound is

connect their previous knowledge to make exact conceptual sense production of sound and vibrations		Teacher then will summarize and conclude that the sound is produced due to the vibrations.	produced. Learners make a note of how sound is produced.
ELABORATE In this stage: * Students apply the concepts in new situations and relate their previous knowledge to new experience	Group Discussion Answering the questions	Teacher asks the learners to identify the source of sound in Humans. Teacher then asks the learners to produce some sounds and observe their throats. Teacher then explains about the Larynx (Sound Box) and its functioning briefly.	Learners may identify the source of sound in humans as their throat. Learners perform the activity as instructed by the teacher and observe. Learners make a note of Larynx and its functioning.
EVALUATION: In this stage: * Ongoing diagnostic process that allows the teacher to determines if these learner has attained understanding of concepts and knowledge	Performance assessment	Teacher asks the learners to design their own instrument that can produce some sound as Home assignment.	Learners go home and design their own instrument based on the concept that sound is produced due to vibrations.