CHAPTER- I

INTRODUCTION

1.1.0 INTRODUCTION

Human beings are superior to the other animals on the earth not because of physical strength they have but because of the presence of human brain. Presence of brain enabled with thinking power is reflected in various positive changes in human civilization and modern way of living. We have seen many changes in our civilization which are the result of creative endeavor and logical reasoning power of human beings. It is reflected in changes like manual work to machine automated work, bullock cart to airplanes, steam engine to electric engine, communication with letters to wireless communication, destruction from natural disasters to advanced warning with satellites, dark to LEDs, etc. Everyone know about the hidden power behind these changes but still this aspect of human endeavor is neglected in education system and it is restricted to mere cramming of written facts. Thinking skills are the demanding competencies that can be harnessed through the effective teaching learning process in education.

India has achieved universal access to education at primary level through national level programmes and schemes but there is still something to achieve i.e. the quality education. Kothari Commission (1964-66) highlighted the role of dull and uninspiring school teaching behind failure in achieving quality education. Quality education conclave (2019) also highlighted the lack of quality education in India. NCERT (2006) revealed that "our schools promote a regime of thought which discourages thinking and precludes new and surprising insight." By keeping in mind the present situation of educational outcomes Sustainable development goal (SDG) by United Nations General Assembly calls for SDG4 i.e. quality education for all by 2030. Similarly, in Vision 2020 document Rajput (2020) discussed future agenda for education as to empower individuals to assure high quality of life that will pave the way for a learning society. The report also put light on promoting critical and independent thinking to achieve quality education.

Organization for Economic Co-operation and Development (OECD) (2018) has emphasized some of the skills that will be needed in the future viz. adaptability, creativity, curiosity and open-mindedness. To attain such competencies the organization framed 'The OECD learning

framework, 2030' that recommends following construct; creativity, critical thinking, responsibility, resilience and collaboration to be successful. World Bank (2011) stated that employers want skills beyond memory or knowledge level in their employees and therefore, this is the time to realize that education is not only reading, writing and arithmetic (3Rs) but also communication, team work, critical thinking, creativity, problem solving are the skills that are needed to be successful in life and at workplace as well. Technological advancements are needed but proficiency in technology is only one part of the competencies needed. Along with this we also need some human skills like creativity, originality and initiative, critical thinking, persuasion, resilience, flexibility, and complex problem solving skills to be successful and employed (World Economic Forum, 2018). 'The future of jobs, 2018' report of World Economic Forum highlighted analytical thinking & innovation, creativity, originality & initiative, critical thinking & analysis, reasoning, problem solving & ideation and complex problem solving among the required skills for future. These skills are directly related to the higher order thinking ability of human being. Kothari Commission (1964-66) also recommended reforms for institutions to give opportunities to the students to think, read, study and discuss. In the same line, National Curriculum Framework (2005) and National Education Policy (2020) also give importance to creative and critical thinking in teaching learning process. Looking into the required skills in the students, several organizations, institutions and commissions in India and abroad talked about integration of thinking skill in teaching-learning process.

Velayati, Muslem, Fitriani & Samad (2017) and Flores, Matkin, Burbach & Quinn (2012) reported that our students are still not good at critical thinking, creative thinking, problem solving and face difficulties in applying those skills. Afifah & Retnawati (2019) highlighted the difficulties faced by the teachers in creative and critical thinking based instruction. Mehrotra (1995) highlighted the use of convergent thinking in the classroom by the teachers since their outcomes are objectively visible and they confirm to the expectation of the society. Therefore, teachers never go beyond the fact based conversation in the classroom which start from closed ended question and ended with an expected and most acceptable response. This is the picture of existing framework of discussion in the classroom and students cannot have situation to think upon in a different way other than the text book. This type of classroom discourse enable students with only retention skill which is not enough. Teachers also need to provide situations where students can transfer the knowledge and thereby giving emphasis on transfer and retention skill both. For this, we need competency based skills like creative

thinking, critical thinking, collaboration, communication and problem solving in the teaching learning process. For that we need an approach that can train the students to learn the demanded higher order thinking skills along with subject content.

In this direction, we have observed a paradigm shift in policies focused on quality education from knowledge acquisition to knowledge construction by the learners. As opined by National Curriculum Framework (2005) meaningful learning is a generative process of representation and manipulating concrete things and mental representations rather than storage and retrieval of information. It was suggested that the learning situation should be arranged to cater the learner's creative abilities and ensure active involvement in meaning making process with reference to the real world experiences and examples. Real classroom situation is different from the ideal one and we still consider students as empty vessel and we try to pour them with facts written in the text-book without giving opportunity to reflect upon. This situation need to be replaced with learning which believe in students' strength i.e. knowledge construction by them using their previous experiences and giving equal importance to nurture cognitive abilities. It could be helpful in integrating higher order thinking abilities in the students and this is the need of the present era.

Present study is an attempt in this direction by focusing on higher order thinking skills at one place as productive thinking. Productive thinking has its foundation in learner centered pedagogy where students are taught with learner centric techniques like classroom discussion, activity based method, audio-visual aids and ICT. Then students get opportunity to draw their creative potential collaboratively on situations related to their learned content and use their critical thinking power to find out the best possible answer or solution for the given task. We can say that productive thinking process creates opportunity for developing creative thinking and critical thinking at one place in terms of creative problem solving which is better known as productive thinking. It enables individuals to solve problem in a productive manner. Thereby, students develop their retention and transfer skill along with productive thinking, creative thinking and critical thinking skills. This chapter will discuss education in 21st century, present demand from school education, concept of productive thinking, rationale of the study, statement of problem, objective, hypothesis, delimitation of the study and structure of the thesis.

1.2.0 EDUCATION IN 21st CENTURY

Education is the process that leads to the development of whole personality of an individual. It prepares individuals for their better future. Our students are living in the world which is full of challenges. We need to develop new competencies as required by new and challenging future. NPE (1992) stated that coming generation should have the ability to internalize new ideas constantly and creatively. In the same line, Delors report also discussed about learning environment where mere transaction of facts are not learning. For meaningful learning we need to redefine learning objectives according to Delors report. Delors (1996) established 4 pillars of learning in 21st century:

- Learning to know: It involves development of sufficient general knowledge with the opportunity to work in-depth and not in superficial way.
- Learning to do: It involves development of occupational skills for the future along with the competence to deal with many situations and work in team.
- Learning to live together: It involves development of understanding for other people and respect for interdependence so that people can live in the society by shared experiences.
- Learning to be: It involves development of whole personality so that a person can work with full autonomy, free judgment, apply logical reasoning, develop physical capacities and communication.

Based on these pillars, purpose of education was emphasized as the holistic development of an individual. It could be achieved through better teaching-learning process where everyone is developed a critical mind and sense of responsibility, ability to use knowledge in order to solve problems, ability to make transition from concrete to abstract and vice versa, creativity, reasoning and communication (Delors, 1998).

In the same way, NCERT (2011) suggested core values for students to be successful in all the areas of life in 21st century and creative and critical thinking also found place in the required core skills. Afifah & Retnawati (2019) said 21st century bring various complex challenges and our young generation should be trained for not only to earn money for a better life but also required various skills ranges from core subjects to innovation, information and communication technology skills to life skills, and most importantly higher order thinking skills.

Partnership for 21st Century Skills (2009) provided 21st Century Curriculum and Instruction plan by emphasising following points to harness 21st century skills in the students:

- 21st century skills should be discretely taught in the context of core subjects and interdisciplinary themes.
- Focus should be on providing opportunities for applying 21st century skills across content areas and for a competency-based approach to learning.
- Introduction of innovative learning methods that integrate the use of supportive technologies, inquiry- and problem-based approaches and higher order thinking skills.

In the above points P21, 2009 stressed on equal importance of core subjects and higher order thinking skills which paves the way for integrated approach of learning where students get opportunity to learn particular skill through core subjects. Schleicher (2007) highlighted the role of OECD's Programme for International Students Assessment (PISA) in assessing the competencies like capacity of young adults to access, manage, integrate and evaluate information, to think imaginatively, to hypothesise and discover, and to communicate their thoughts and ideas effectively. It is designed to test whether students are able to transfer what they have learned to the novel situation. It highlighted the equal importance of transfer skill along with content knowledge and highlighted the need of learning situation to transfer the knowledge in real time.

World Economic Forum (2018) surveyed about the core competencies required in the future and results showed half of the candidates surveyed realized critical thinking and creativity are the most demanded skills along with complex problem solving. It means, in our education system there is a need to integrate creative thinking, critical thinking and problem solving skills which are the foundation for other competencies. The need of these higher order thinking skills prepared the foundation for the present study.

1.3.0 THINKING

Thinking mind makes distinction between human beings and other animals. It is the mental ability by which human beings power over the universe. Thinking has its own place in learning. Learning with thinking will result higher cognitive result depending upon the cognitive operation used. Therefore, it can be said that thinking has its role in making learning meaningful where both retention and transfer can be flourished. Thinking and learning has direct relation because effective learning depends upon correct thinking pattern. Sternberg &

Williams (2009) opined that inert knowledge is generated when it is not applied or used and having no meaning. But thinking skills are effective in converting inert knowledge into active and reflective use of knowledge. Without thinking information has no meaning and to provide meaning to the accumulated information we need to process the information. They defined thinking as "the process that involves manipulating and transforming information in memory which often is done to form concepts, reason, think critically, make decisions, think creatively, and solve problems".

In the words of Garrette (1968); "thinking is behaviour which is often implicit and hidden and in which symbols (images, ideas, and concepts) are ordinarily employed." (Cited in Mangal, 2021 p. 379)

Mohsin (1967) defined thinking as "an implicit problem solving behaviour." (Cited in Shergill, 2012 p. 288)

Gilmer (1970) defined thinking as "a problem solving process in which we use ideas or symbols in place of overt activity." (Cited in Kutty, 2019 p. 157)

Ross (1951) defines thinking as"mental activity in its cognitive aspect or mental activity with regard to psychological objects." (Cited in Shergill, 2012 p. 288)

Schraw (2017) defined thinking as "a large collection of individual skills and strategies that enable individuals to control, monitor, and regulate their learning and memory." (Cited in Mangal, 2021 p. 379)

By considering above definitions thinking may be defined as "the purposeful cognitive activity in which symbols are used to process information to regulate and monitor the learning process." The product of thinking depends upon the way of processing of information. Like Sternberg & Williams (2009) classified thinking as forming concepts, reasoning, thinking critically, making decision, thinking creatively, and solving problem. Seifert & Sutton (2009) considered three complex forms of thinking in classroom learning process: (1) creative thinking (2) critical thinking (3) problem solving. Mangal (2021) considered thinking as mental process and classified into; perceptual or concrete thinking, conceptual or abstract thinking, reflective thinking, and creative thinking. So, we can say that thinking are of different types depending upon the operation components used in the information processing. Similarly, productive thinking is also one of the thinking which make use of higher order thinking components viz.

analysis, synthesis and evaluation. So, in the next section we will talked about various psychological theories which create foundation for productive thinking and help to conceptualize it.

1.4.0 PSYCHOLOGICAL FOUNDATIONS OF PRODUCTIVE THINKING

Productive thinking brings its essence from different psychological theories and some of the foundational pillars from educational psychology are discussed here.

(1) Guilford's Structure of Intellect (SOI) model provides three dimensional structure of human intellect. Model presents different type of thinking abilities depending upon the combination of interrelated components. According to SOI model human intellect has three component viz. content, product and operation. Where content provide the input for the operational process to give a specific product. The model has 5 operations viz. cognition, memory, evaluation, convergent production and divergent production which interact with 5 content inputs (visual, auditory, symbolic, semantic and behavioral) to give variety of products (units, classes, relations, systems, transformation and implication). It can be represented with the three dimensional figure 1.1:

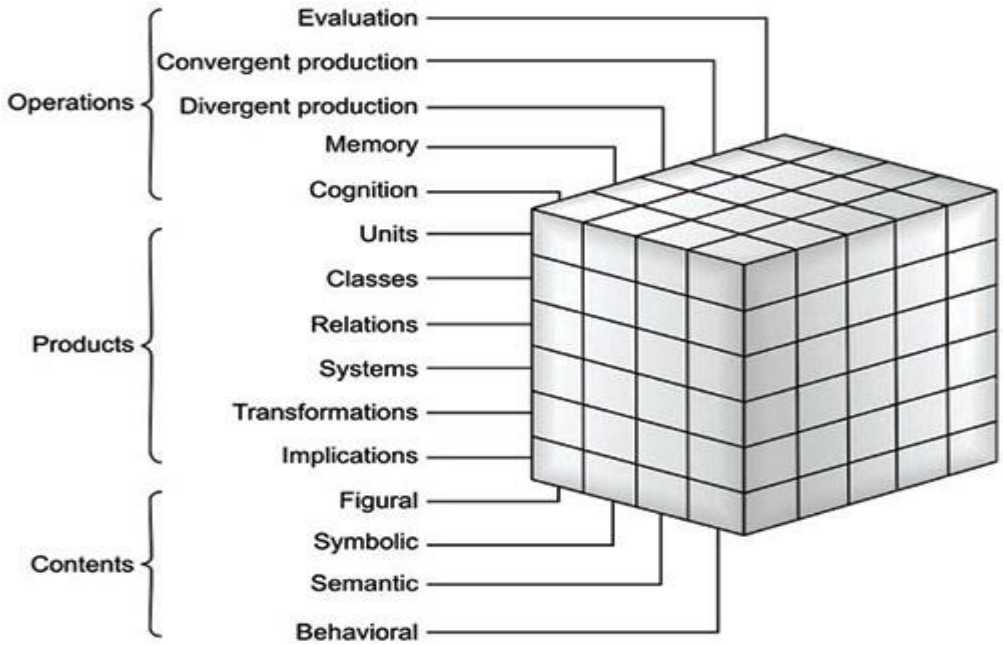

Figure 1.1: Guilford's Structure of Intellect

Source: https://www.jaypeedigital.com/book/9789351525646/chapter/ch8

Operation belongs to the thinking component of human intelligence. It decides how a person would act cognitively to do a task. It determines the cognitive activity involved while achieving the goal. Operations are responsible for nurturing cognitive abilities like creative thinking, critical thinking, logical reasoning, problem solving and evaluative thinking. Operation has following components responsible for different thinking ability:

- **Cognition**: It is the ability to perceive and retrieve information from the memory whenever it is necessary for the particular task.
- **Memory**: It is the ability to store information by making some relation with different elements of past experiences.
- **Convergent production**: It is ability opposite to divergent production. It is unidirectional in nature and directed towards single correct answer.
- **Divergent production**: It is the ability to draw various ideas on a certain criteria by considering multiple dimensions of the task at hand. Therefore, it is multidimensional in cognitive processing.
- **Evaluation**: It is the ability to assess the information to ensure appropriateness and relevance of the information and thereby reaching at the conclusion.

The above discussed components make foundation for productive thinking process as well where all the operational components are emphasized while solving a problem productively. Patel (1988) said that *"*in our present education system convergent production component is emphasized most and divergent production ability is somewhat ignored but it is important to bring imagination, novelty and newness in our education output." Productive thinking is the cognitive process which make use of operation components to solve problems creatively. Productive thinking is the cognitive ability that make use of memory as foundation which is accessed by cognition for divergent production, convergent production, evaluation and other higher order thinking abilities.

(2) Bloom (1956) proposed taxonomy of learning objectives and arranged different cognitive process in a hierarchical manner. He arranged cognitive processes in the following order; knowledge, comprehension, application, analysis, synthesis, and evaluation. Based on the complexity of the level, cognitive processes was categorized in two categories; lower order thinking level which include knowledge, comprehension and application and higher order thinking level which includes analysis, synthesis and evaluation.

In revised Bloom's taxonomy cognitive processes are arranged in the following order; remembering, understanding, analysing, applying, evaluating and creating. It was believed that for creating a new theory or drawing a conclusion an effective evaluation must be done first and therefore, creating or creative thinking is at the highest level and always supported by evaluative thinking (Wilson, 2001). Bloom's taxonomy and its revised taxonomy can be better understood by the following figure 1.2:

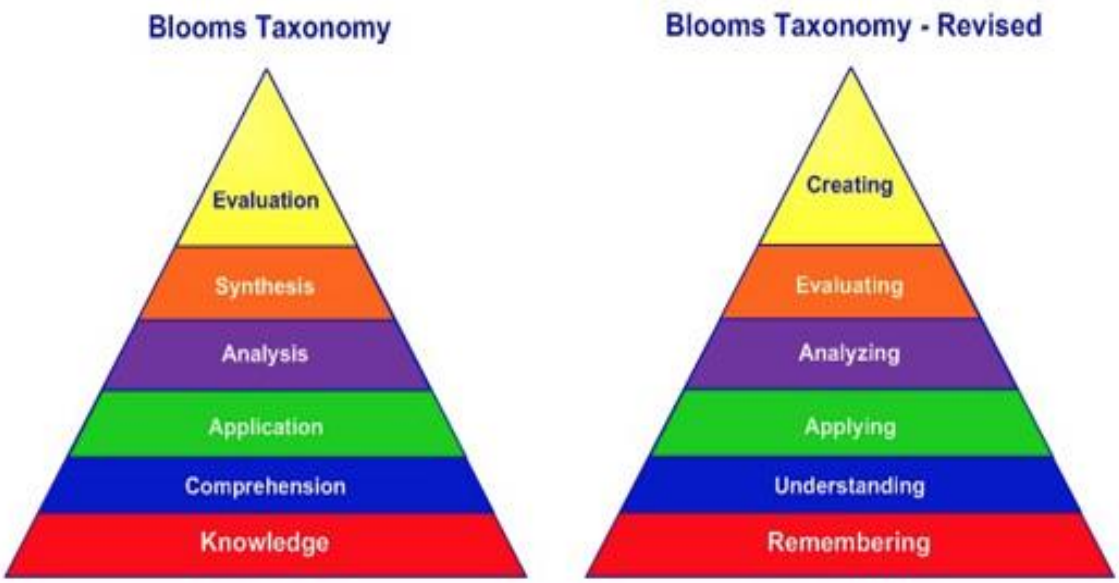

Figure 1.2: Bloom's Taxonomy and Revised Bloom's Taxonomy
Source:https://blogs.edweek.org/edweek/learning_deeply/2018/03/heres_whats_wrong_with_blooms_taxonomy_a_deeper_learning_perspective.html

Bloom's taxonomy and its revised edition provides scope for productive thinking. In the revised Bloom's taxonomy, place of creative thinking is at the highest level followed by critical thinking component i.e. evaluation. It can be said that when creative thinking is supported by evaluation or critical thinking it will give novel result of high value. Romiszowski (1981) relates productive thinking with Bloom's taxonomy and applied the term productive thinking to Bloom's (1956) higher order thinking level – the analysis, synthesis and evaluation processes. According to him productive thinking is what can successfully generate ideas, develop plans, guide decision making and problem solving, and lead to actions. Therefore, we can say that productive thinking has its foundation in Bloom's taxonomy by which lower order thinking level is used and merge with higher order thinking operations to give productive result.

(3) Creative thinking is one of the component of productive thinking. There are two different classes of theories that define creative thinking. Guilford and Torrance who looked creative thinking from the psychometric point of view which considers intelligence as the base of creativity whereas second theory is the confluence theory or investment theory (Sternberg, 2010) given by Sternberg who considered several other factors along with intelligence for creativity.

Guilford's structure of Intellect (SOI) Model (as discussed earlier in this chapter) talked about divergent production as one of the operations which is the base for creative thinking. In the divergent production operation Guilford talked about four sub-operations viz. originality, flexibility, fluency, and elaboration.

- Originality: It is the ability to generate new, original and novel ideas.
- Fluency: It is the ability to generate as many ideas as possible.
- Flexibility: It is ability to generate ideas from different categories.
- Elaboration: It is the ability to add value to the idea by applying it in new situations.

By considering Guilford's work as the base and creativity as the cognitive ability Torrance also worked upon creativity and developed the test to evaluate creative thinking ability. He also considered fluency, flexibility, originality and elaboration as the components of creativity and developed a test of creativity to measure creative ability of an individual.

Sternberg & Williams (1996) studied creativity as the result of combination of factors where intelligence is one of the factor. They developed a theory known as 'confluence theory of creativity'. According to this theory, creativity is the result of confluence of six components where threshold level of each component is required for the development of creative abilities. The six components are:

- Intellectual abilities
- Knowledge
- Style of thinking
- Personality
- Motivation
- Environment

For creativity, intellectual abilities comprise of synthetic ability, analytic ability and practical ability (Sternberg, 2010). Synthetic ability refers to a person's ability to think in a novel and interesting way. It is also considered as divergent thinking ability by which a person thinks in different way. Analytic ability refers to a person's ability to analyse and evaluate the ideas. It

is the base for analytical thinking and evaluative thinking ability by which a person critically judge an idea. Practical ability refers to the ability to transform abstract ideas into real. It is the base for implementation aspect of creative thinking that makes creativity real and practical. Along with this, a threshold level of knowledge of a particular field is required to think in a creative way. It creates a foundation because creativity never comes in vacuum (without knowledge). Thinking style and some personality attributes that encourage a person to consider various directions to think upon and to remove the hurdles in the way are also inevitable which make a person self-efficient to think in a creative manner. The above discussed components could not give creative result in the absence of motivation and positive environment that helps a person to think freely and creatively.

From the discussion of the two theories of creative thinking it can be said that creative thinking ability is the higher cognitive ability that demands a minimum level of knowledge and an encouraging environment that act as an external motivation. It can be deduced from the above discussion that divergent thinking ability is always supported by convergent thinking ability in a constructive manner. But it is also true that over emphasis on convergent thinking ability or critical thinking restrict creativity as well. Therefore, a balanced use of both thinking ability is needed. Productive thinking is a way of doing so. Which provide a balanced approach to make use of both the thinking ability in constructive way.

The above discussed theories helped the researcher to conceptualize productive thinking, its components and productive thinking as the process. The next section puts light on productive thinking and programmes developed by various researchers to develop productive thinking.

1.5.0 PRODUCTIVE THINKING

Productive thinking is the cognitive ability that has its definite place in education. The concept of productive thinking is not new rather Wertheimer was the first to define productive thinking as insight based reasoning. He classified thinking in two categories based on the way of thinking i.e. productive thinking and reproductive thinking. According to Wertheimer, reproductive thinking is associated with chained behavior or repetition and ultimately lead to the rote learning whereas productive thinking is an insight based logical reasoning (Wertheimer, 2020).

Hurson (2011) wrote a book *think better* wherein he differentiated productive thinking and reproductive thinking with two Japanese words *kaizen* and *Tenkaizen*. Literal meaning of

Kaizen is *good change* and *Tenkaizen* means *good revolution*. He described reproductive thinking as kaizen where person gives fixed response to a given stimulus every time. It will lead to rote repetition, conscious systematization and continuous improvement whereas productive thinking is Tenkaizen which leads to new ideas. According to him, productive thinking has two components viz. creative thinking and critical thinking. In productive thinking both the elements need to be separated because simultaneous use of both the elements will lead to no new product or idea. Hurson (2011) define productive thinking as "a process of suspending judgment to generate long list of ideas and then returning to those lists to make choices by judging the ideas against pre-established success criteria".

He gave ThinkX model to develop productive ideas particularly in the field of management and industries. This model is a six step process and can be described as:

(1) What's going on? : This is the first step to develop an understanding about the problem by asking questions about the problem.
(2) What's success? : This step involves criteria establishment on which creatively generated ideas would be test to achieve success.
(3) What's the question? : This step involves listing down the questions that you want to be solved about the problem to achieve the success.
(4) Generate answer: This step is to creatively address the questions that are asked in the phase 3 about the problem.
(5) Forge the solution: This step involves evaluation of the ideas generated in the phase 4 against the criteria established in phase 2. This phase is critical thinking phase which is for refining the generated ideas.
(6) Align resources: This step involves identification and relocation of the required resources to implement the ideas in real setting.

The steps of ThinkX model can be represented by the following figure 1.3:

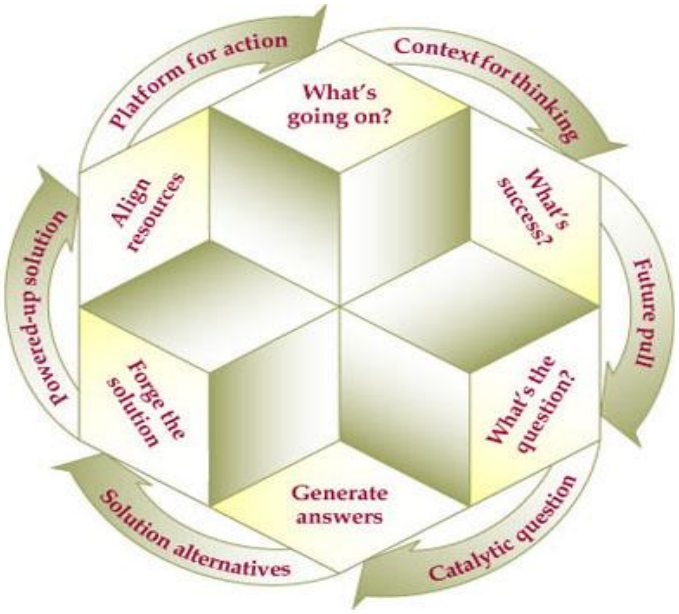

Figure 1.3: ThinkX Model of Productive Thinking

Newton (2017) described productive thinking as the skill of reasoning, understanding, creative thinking, evaluative thinking, decision making and wise thinking. She introduced "Model of productive thought" and can be explained by the figure 1.4.

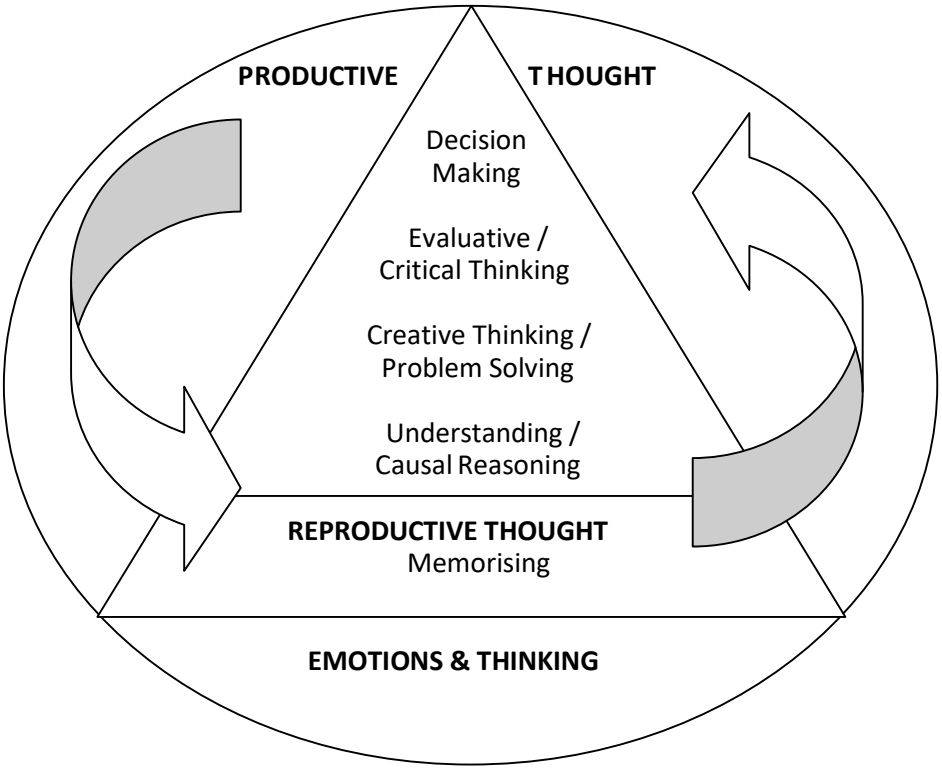

Figure 1.4: Model of Productive Thought

According to Newton (2017) productive thought has five components and can be described as follows:

(1) Memorizing: This component emphasizes the role of a knowledge foundation or facts in higher cognitive operations.
(2) Understanding and causal reasoning: This component helps to establish the relationship between existing knowledge and experience with the new ideas.
(3) Creative thinking and problem solving: It involves identification of problem, generation of ideas, and evaluation of ideas to select the best one.
(4) Evaluative and critical thinking: It is for improving the quality of ideas using constructive judgment.
(5) Decision making and wise thinking: It is the ability to make decision by looking multiple dimension of the situation and being impartial.

Gallagher and Aschner (1963) (cited in Aranda, Lie & Guzey, 2019) considered productive thinking as the combination of creative and critical thinking skills where memory creates the base for higher cognitive activity. They arranged the components in the following order:

(1) Memory: It is the lowest level of thinking which involves repetition of facts and results into rote learning.
(2) Convergent thinking: It involves analysis and integration of information to give one result.
(3) Divergent thinking: It involves generation of ideas, alternatives, consider multiple perspectives and give various possibilities.
(4) Evaluative thinking: It involves making evaluative judgment to improve quality and making choices.

It means productive thinking involves memory, convergent thinking, divergent thinking and evaluative thinking.

Covington, Cruthfield & Davis (1966) (cited in Olton, 1969) defined productive thinking as process that involves creative thinking and problem solving. They developed self-instructional productive thinking programme by considering convergent thinking and divergent thinking as the two main component of productive thinking.

Lumbelli (2018) conceptualized productive thinking as creative problem solving process that involves a restructuring of the problem elements to solve a problem creatively.

Davis & Scott (1971) (cited in Patel, 1988) described productive thinking as the cognitive ability that involves convergent, divergent and evaluative operations. Individual's past experiences plays important role in productive thinking to draw new ideas and conclusion. Therefore, productive thinking can be defined as the process that include both the creative thinking, critical thinking and evaluative thinking.

Rusbult (1997) explained productive thinking as combination of creative and critical thinking. He gave four elements of productive thinking: motivation, memory, creative thinking and critical thinking. He explained that productive thinking is the result of motivation, memory, creative and critical thinking. The basic principle of Productive thinking is to provide separate place to creative thinking and critical thinking to get productive result.

Birch & Rabinowitz (1951) defined productive thinking as not merely arriving at the solution of problem through direct application of previous learning rather in productive thinking past experiences are re-patterned and restructured to meet current demands.

Gallagher (cited in Hoffman & Hoffman, 1964) defines productive thinking as the result of the individual operation upon information from internal or external sources in order to change it into some different product. It involves problem solving, creative thinking, analytical thinking and logical reasoning dimensions.

It can be deduced from the above discussion that it is the combination of creative thinking and critical thinking where motivation and memory are the two components that provide support to the productive thinking process. Productive thinking needs a minimum knowledge level and a motivating environment in the background also which facilitates productive thinking process. As discussed by Hurson (2011) that productive thinking process requires separate place for creative and critical thinking because being critical at creative phase may create hindrance for creativity. We need a constructive relation between both thinking rather than restrictive one. We know that sufficient knowledge provide foundation for creativity but not always because functional fixedness bound oneself to the way in which he/she solved problem earlier. Therefore, it is necessary to overcome from fixed pattern of looking at things. Ready to change the perspective and considering multiple dimensions while addressing the problem open the door for creativity. Therefore, we can say that productive thinking is the process where creative thinking and critical thinking are blended in such way that produces a high-quality solution for problem.

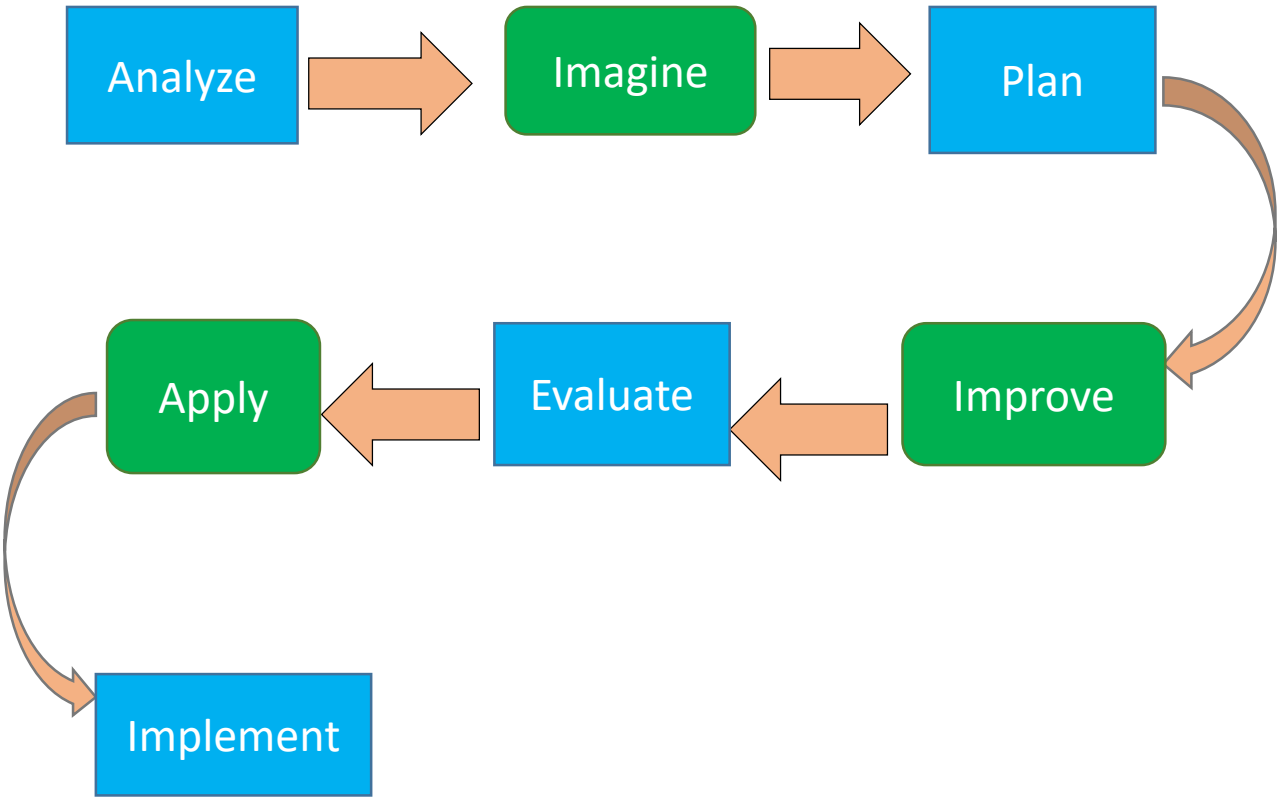

Figure 1.5: Process of Productive Thinking

Figure 1.5 represents shift in mode of thinking while solving a problem. To solve a problem using productive thinking starts with critical thinking (blue colour in the figure) – analysing a problem and then shift to the creative thinking (green colour in the figure) – imagining solutions. Step three includes planning for the solution that how the solution would be applied and how it would work. Fourth step is to apply the generated solution in a different way or some other way than traditional way of doing. Fifth step involves evaluation of the solution to examine whether it would match with the success criteria or not. Sixth step involves improving the solution by keeping in mind the failure occurred in the fifth step. Last step is implementing the solution to solve the problem is a critical thinking phase. Likewise, by shifting back and forth between the two types of thinking, a person eventually arrive at a solution through productive thinking process.

1.6.0 COMPONENTS OF PRODUCTIVE THINKING

Productive thinking is the cognitive process that refine creative product with constructive evaluation by critical thinking. As Rusbult (1997) explains productive thinking as combination of creative and critical thinking and Davis and Scott (1971) (cited in Patel, 1988) described

productive thinking consisting in those convergent, divergent and evaluative operation. By considering different definitions and explanations given by researchers and psychologist it can be said that productive thinking is the blending of creative thinking and critical thinking to make use of positive components of both the elements. Therefore, elements of productive thinking are creative thinking and critical thinking.

1.6.1.0 CREATIVE THINKING

Creative thinking found its place at highest hierarchical order in Bloom's taxonomy. It is the ability to see an object, process or idea from new perspective. It is the ability to think something new and different. It can be identified in terms of process as well as product. Like Maedi (2013) considered creative thinking as the process to solve problem in not normal, unique, and various ways. Maedi (2013), Torrance (1993) and Guilford (1950) (cited in Michael, 1995) described three components of creative thinking viz. fluency, flexibility, and originality. Drevdahl (1956) (cited in Mangal, 2021, p. 307) stated that it is not always that product or composition of creativity is completely new, it may happen that the product is previously unknown to the producer. In the same line, Stagner & Karwoski (cited in Mangal, 2021, p. 307) defined creativity as the production of totally or partially novel identity. Seifert & Sutton (2009) defines creativity as the process which often associated with usefulness and appropriateness and ready to solve the purpose. According to Shah (1981) creativity is a way of looking and finding unexpected relation between two or more components of problem and reaching to a novel product. Ramalingam (2013) defines creative thinking is the process of applying a person's mental ability to discover something new, ability to relate and connect and capacity to develop new idea, concepts and processes. It is viewed as a type of cognition or mental ability to look at things in different perspective and provide newer solutions to existing problems. He describes following characteristics of creative thinker:

- Tendency to be more impulsive.
- Non-conformity
- Less susceptible to peer pressure.
- Self-reliant.
- Unafraid of experimenting new things.

In the same manner, Hurson (2011) described three essential characteristics of creative thinking:

- It is generative which produce something new.
- It is nonjudgmental and allow free imagination.
- It is expansive in nature.

Sternberg & Williams (1996) discussed creative thinking as one of the higher order thinking ability that is present in every individual but a stimulating environment bring this potential in reality or as an output of the creative process. It can be done by number of creative exercises and some of the techniques are discussed in the next section.

1.6.1.1 TECHNIQUES TO DEVELOP CREATIVE THINKING

Creative thinking can be innate as well as acquired but to realize such potential we need an environment that allow free flow of ideas where, students are encouraged to think out of the text-book without any criticism. This type of classroom environment can be developed through following creative techniques:

(1) Brainstorming

Besant (2016) discussed about brainstorming and said the word brainstorming was first introduced by Alex Osborn through his book 'Applied imagination, principles and procedures of creative thinking'. Brainstorming is a creative process of generating ideas that can be done individually or in the group. The procedure starts by forming the group (if it is a group brainstorming) then each group or individual is presented with a problem/question/situation that breaks the equilibrium and generate the spark for creative imagination. Each group/individual is given a particular time to brainstorm and share their ideas with other group/individual then last is judgment to select appropriate idea.

Wilson (2013) described three basic principles for the easy processing of brainstorming:

- Aim for sheer quantity: In the brainstorming session, focus is not over the quality of idea rather a good number of ideas are generated without considering their quality and appropriateness.
- Defer judgment about the quality of ideas: In the initial phases of brainstorming implicit or explicit criticism is strictly prohibited. It is assumed that criticism hinders the creative imagination.

- Encourage new and wild ideas: Wild ideas are welcomed in this process because many a times it happens that an idea does not has direct implication but can act as catalyzer or starting point to generate another potent idea.

For effective brainstorming it is very important to form the group according to group dynamics i.e. students from different cultural background, gender, cognitive level and interest constitute the group. It gives an opportunity to consider multiple dimensions of the problem which is the essence of creativity.

(2) Synectics:

Gorden (1963) (cited in Pandit, 2006) explained this technique. It comes from the personal family of teaching models and known as synectics model. In this, creative thinking is developed by applying unexpected analogy. It can be done by following analogy techniques:

- Personal analogy: It involves addressing the problem by considering past experience of related problem.
- Direct analogy: It involves direct comparison between two object or phenomenon or applying one principle to the other comparable phenomenon directly.
- Symbolic analogy: It involves impersonal images and poetic response to address the problem.
- Fantasy analogy: It involves fantasy or wishes to come true in some inventions.

By applying different analogies to address the problem a person can reach at the novel ideas or solution of the problem.

(3) CoRT thinking programmme:

Patel (2010) & Ramesh (2015) found CoRT thinking programme effective. They used CoRT lesson for creative thinking. It consist of four components to train the students for creative thinking:

- Plus Minus Interesting (PMI): This thinking tool intend to explore plus or good points (P), minus or negative points (M) and interesting points (I) about a process, object or person. For example apply PMI on “Glass is used in various place”. This will lead to consider positive, negative and interesting points about uses of glass.

- Considering All Factors (CAF): This tool helps to consider multiple perspective or factor at a time without evaluating or criticizing any factor. For example "A glass piece to become lens" What factors to be considered.
- Alternative possibilities and choices (APC): This tool helps to consider possibilities or choices beyond the available choices and help to think out of the box. For example "what are the alternative uses of nylon wire?"
- Consequences and Sequel (C & S): This tool helps to imagine what will be the consequences in the future if we do some changes at present. For example "what are the consequences if only natural light available?"

(4) SCAMPER:

It is an acronym which was first introduced by Bob Eberle in 1996 (Besant, 2016). SCAPMER is the collection of thinking process where each letter directs towards a way of creative process. Ozyaprak (2016) explained SCAMPER as presented in the following table 1.1:

Table 1.1: Components of SCAMPER technique

S	Substitute	It refers to figure out alternative ideas/object.
C	Combine	It refers to form novel ideas by combining various connected and disconnected ideas.
A	Adapt/Adjust	It refers to modify former ideas to create new ones.
M	Modify/minify/magnify	It refers to make changes on the present object by magnifying, minifying, or magnifying it.
P	Put to another use	It refers to use an object in a different and preferably an unexpected concept/situation/place.
E	Eliminate	It refers to eliminate a part of the existing object on behalf of creating a better version of it or of figuring out the consequences of elimination.
R	Rearrange/Reverse	It refers to rearrange/reverse present situation/order/pattern with an aims of considering alternative ends, practice or ideas.

These are some of the effective techniques used by different scholars and psychologists for the development of creative thinking in the students. In the present study, creative thinking is one

of the component of productive thinking and therefore specific technique used to solve the purpose is described in detail in the chapter 3.

1.6.2.0 CRITICAL THINKING

Critical thinking is one of the higher order thinking ability which has its root in reasoning but many people misinterpret it as negative judgment or restrictive judgment. The word critical is often associated with criticism but it is not like that. Critical thinking is the ability to analyze critically by considering each aspect before arriving at conclusion. It is an unbiased, objective and disciplined way of thinking where reasoning has its own place in background. Hurson (2011) described it as analytic, expensive and selective. As emphasized by Paul (1989) critical thinking involves truth, open-mindedness, empathy, autonomy, rationality and self-criticism that make a clear line between thought with critical thinking and without critical thinking i.e. without processing the information. They illustrated the thoughts without and with critical thinking those lead to unclarity to clarity, imprecision to precision, vagueness to specificity, inaccuracy to accuracy, irrelevance to relevance, inconsistency to consistency, illogical to logical, superficiality to depth, incompleteness to completeness, triviality to significance, inadequacy to adequacy and bias or one-sidedness to fairness.

Barua & Chakrabarti (2017) defined it as a self-guided and self-disciplined thinking which attempts to reason at the highest level of quality in a fair-minded way. They also described critical thinking as the ability to identify the relevance and importance of ideas, to understand the logical connections and establish linkages between ideas, to identify, construct and evaluate arguments, to detect inconsistencies and common mistakes in reasoning, to help in solving problems systematically, and to reflect upon the accuracy of one's own beliefs and values.

Sternberg & Williams (2009) stated that critical thinking involves thinking reflectively and productively and evaluating the evidences. Krishnan (2011) defines critical thinking as one of the higher order thinking skill which is pervasive and self-rectifying human phenomenon which constitute interpretation, analysis, evaluation and inference. Tanujaya, Mumu & Margono (2017) and Seifert & Sutton (2009) described critical thinking as the essential element of problem solving and decision making. Patel (2010) and Seifert & Sutton (2009) opined that if a person is accepting the information without questioning or objectively looking at the source or without considering the authenticity of the information can never be a critical thinker.

As it is one of the important component of teaching learning process, Central Board of Secondary Education (2013) listed it in the life skills and described it as a thought process that involves analysis, evaluation and reflection upon an idea, an observation or an experience that a person has undergone, so as to arrive at a judgment, or a conclusion. It involved following skills:

- Interpretation: It is the ability to grasp the actual meaning of content encountered.
- Analysis: It is the ability to break the problem into its constituents to better understand the structure of the problem.
- Inference: It is the ability to draw conclusion by logical process.
- Explanation: It is the act of clarifying something.
- Evaluation: It is the process of systematic assessing or appraising something.
- Self-regulation: It is the ability to control one's emotions and propensity to suspend judgment.

Padget (2012) gave following characteristics of critical thinking:

- The ability to analyze.
- The recognition of different point of views and assumption.
- The skill of evaluating against a range of accepted criteria.
- The skills of making inferences and draw conclusions.
- The skill to see interconnections between ideas.

Coughlan (2007) described following components for developing critical thinking like;

- Reflection: It involves reflective processes to reflect upon an issue, problem or process.
- Rationality: It involves application of logical reasoning to arrive at conclusion and avoid emotional intervention.
- Self-awareness: It involves recognition of our own motives, bias, and prejudice to make a fair decision which is fully based on logic.
- Open-mindedness: It involves considering all the perspective to address an issue. It also involves new possibilities after reevaluation of solution to give a better solution.
- Judgment: It involves identification of strength and value in alternative possibilities based on set criteria.

By keeping in mind the above discussion on critical thinking it can be said that "critical thinking is a cognitive process that involve analysis, evaluation, interpretation, reflection and judgmental ability." An environment that provide sufficient opportunity to the students to analyse, evaluate and reflect upon can help students to develop critical thinking. Barua & Chakrabarti (2017) reported that it has been overlooked at the elementary and high school levels where the primary focus is on rote learning of concepts rather than skilful application of ideas. Therefore, an attempt is needed to develop this skill in students.

In productive thinking, two opposite components are creative thinking and critical thinking. To use two opposite modes of thinking (as displayed in figure 1.6) at one place we need a plan for implementing, which provide instructions to attain objectives.

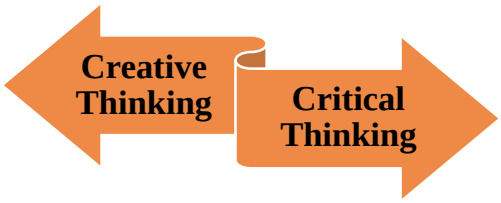

Figure 1.6: Opposite nature of creative and critical thinking

This can be done by a planned strategy that can provide specified place to knowledge, creative thinking and critical thinking and create an environment that encourage students to think freely and out of the box. The details of the developed strategy is given in chapter 3.

1.7.0 COMMON OBSTACLES TO PRODUCTIVE THINKING

Productive thinking is beyond the most predictable way of responding. It is a way of looking differently and therefore have some obstacles in implementing the productive thinking process that need to be resolved for effective processing. Here, some of the obstacles are given:

- **Functional fixedness**: It is the tendency to always look at a problem from fixed perspective as he/she used to solve the problem earlier by ignoring new demands from the problem at hand.
- **Restrictive criticism**: Restrictive criticism is the inappropriate use of judgement in the early stages of productive thinking. It stops creative process by demotivating the thinker to think differently.

- **Insufficient time:** Productive thinking process requires sufficient time to draw creativity supported by critical thinking. Insufficient time hinders creative operation and also critical evaluation.
- **Lack of motivation**: Motivation is one of the important ingredient to productive thinking. It will be flourished if teachers motivate the students to think in a particular way by modelling productive behaviour and setting examples. But when students are continuously demotivated by teachers, peers and family members for their creative endeavour then they will never repeat this behaviour in future and stick to the acceptable ways.
- **Authoritarian environment**: Authoritarian environment of the school and class hinders productive thinking but democratic environment where students have freedom to express themselves flourish productive thinking in the students.
- **Closed-ended questions**: The atmosphere of quiz in the classroom close the door for productivity because closed ended questions never disturb the equilibrium which demand thinking. This type of operation only sticks the learner to previously learned behaviour and students give most acceptable answers in a traditional way.
- **Quest for immediate success**: In the traditional classroom, teachers assess the students and give response like correct or incorrect. This pattern had mechanized our students to get immediate success therefore, they don't want any exercise which don't have immediate success but have creative value.
- **Fear of failure**: It is always tried to be successful and perfect in the classroom teaching learning process by the learners. This quest for perfection hinders productivity.
- **Fear of rejection**: Human beings are having desire of acceptance by others and accordingly we do work to be best accepted by others. Some work which resulted in failure is associated with criticism and rejection therefore, learners don't take risk for creative steps and they mechanized in a way to be acceptable always.
- **Conformity**: Conformity towards socially and culturally set norms make acceptable people in the society or a group of people. This conformity never allow to think beyond the set rules and norms which make a way of doing things. This creates barrier in the process of productive thinking.

To overcome the above discussed obstacles, role of a teacher is inevitable. A teacher can avoid the hindrance and obstacles in the way of productive thinking by becoming a constant motivator and open-minded thinker. To inculcate productive thinking practices in the regular

classroom teaching learning process teachers' role will be changed and is discussed in the following section.

1.8.0 ROLE OF THE TEACHER

To foster productive thinking among students it is necessary for teachers to remake their job from instructor to the facilitator. In present time, teachers are not the only source of information. This era is full of information and therefore our students need a facilitator who would facilitate the information to make meaning. It can be possible if our teachers realize the potential of students and value their experiences. Haleem (1984) stated that it is evident that teachers show their preferences and regards towards characteristics like; discipline, good grades, hard work, spirit of cooperation over self-expression, imaginativeness, flexibility of ideas and non-conformity. At this time imagination is the power that is ruling the world in the field of innovation and problem solving. So, we expect from the teachers to value and harness the inventiveness and imaginative power present in the students.

Teachers play a significant role in helping students to develop 21st century skills by applying methods that increase students' abilities. Alismail & McGuire (2015) stressed upon the use of innovative strategies and modern learning technologies by the teachers that help to integrate cognitive and social skills with content knowledge as well as increase student's participation in the learning environment in order to promote these future skills.

Newton (2017) highlighted the questioning pattern prevalent in the classroom by stating that teachers normally initiate discussion by a question, then students gave response and then feedback or evaluation by teacher. This closed-ended pattern is typical of traditional classroom teaching and it restrict thinking leading to reproductive or rote learning. Teachers are comfortable with the existing classroom processes and are unaware about the higher order thinking skills which are the need of the hour. Afifah & Retnawati (2019) stated that teachers face difficulty in designing, applying, preparing learning tools and assessing higher order thinking skills. It was suggested that teachers are the implementer of education and must be aware of the importance of teaching higher order thinking skills. Seifert & Sutton (2009) emphasized the effort of teacher in stimulating creative thinking among students. In this line Asari (2014) suggested ways to introduce creative and critical thinking in classroom by teachers:

- Keep asking students to think, reason, and implication, strength and weakness of any claim or argument.
- Asking them to consider alternative ideas.
- Modelling the critical thinker behaviour by the teacher.

Teachers have command of the classroom process, they can direct it either in the direction of convergent thinking by asking questions that lead to single correct answer or in the direction of divergent thinking with question that lead to divergent answers. The type of thinking process depends on the type of question asked but unfortunately most of the questions asked by teachers in the classroom are those for which students already know the answer. NCERT (2011) highlighted that over 90% questions asked in the class call for information given in the textbook only and are highly structured. It will be good if teachers choose to ask open-ended questions that explore new ways of looking at or thinking about problems.

We need to overcome from the perspective that lead to responses like 'it must be like this only' because different students have different perspective therefore multiple perspective need to be considered to develop productive thinkers in the classroom for future. It means avoiding functional fixedness is essential to consider multiple dimension of the task at hand. Criticism is the evil in productive thinking process which stops creative process. Criticism from the part of teachers which is restrictive in nature will lead no new product. Therefore, teachers need to take care of avoiding restrictive criticism especially at the stage of creativity and convert it into constructive criticism at the later phases of productive thinking process which refine creativity to give productive result.

One of the ingredient of productive thinking is motivation. Motivation could be internal as well as external. Here comes the role of teacher as constant motivator and supporter to create interest in the students by posing interesting and challenging situations to motivate students internally. Along with this, appreciation and reward are the techniques to motivate externally. We can say that role of a teacher in fostering productive thinking is like a facilitator and motivator. Paul (1989) reflect upon the teachers role in make use of beliefs of the students which have two sources "belief: beliefs that the child forms as a result of personal experience, inward thinking and interaction with peers and environment, and beliefs that the child learns through instruction by adults". Teacher can make use of beliefs of the students obtain from different sources for personalized learning.

1.9.0 PRODUCTIVE THINKING AT ELEMENTARY SCHOOL LEVEL

Piaget's cognitive development theory prepares foundation for productive thinking. Piaget gave the stages of cognitive development by relating it to chronological development of a child. The stages of cognitive development ranges from pre-operational stage to formal operational stage. Early adolescents, adolescents and adults come under formal operational stage (11+ years). It means the theory gave us an age group which is favourable for abstract thinking. Simatwa (2010) described some of the characteristics of this formal operational stage as follows:

- At this stage, chid shifts from the level of concrete operations to the final stage of formal operations.
- Child is capable of considering the ideas of others and the ideas of others and communicating with others.
- Pupil develop the ability to reason by hypotheses based on logic of all possible combinations.
- Pupil can deal with abstraction and mentally explore similar and differences because child is mastered in reversibility.

At the age of adolescence child can play with imaginative ideas as he/she is ready for abstract thinking. Shekhar (2012) stated that at this age child can use hypothesis testing to arrive at the best possible solution of a problem in a systematic manner and a child is also indulge in effective decision making process. It is assumed that the learner can think in the prescribed way at the formal operational stage. The biological maturation is only one of the factor that allows a child to develop cognitively. But the importance of environmental effect can never be ignored. Environmental conditions bring components of higher order thinking into the classroom that stimulate learning, thinking and reasoning power of learners. Without it such changes from concrete operational stage to formal operational stage cannot be imagined. So, abstract thinking power needs biological maturation as well as environmental factors to foster it. And upper primary stage of elementary school education is best for training of creative thinking, critical thinking and productive thinking because students' curiosity is at its peak at this stage of cognitive development. If a conducive environment is provided at this age, then majority of students will shift from concrete operational stage to formal operational stage in their thought processing. In the school, the environment can be provided separately or in a

integrated way through a subject. In the present study researcher selected science as the subject of teaching for productive thinking inculcation.

1.10.0 PRODUCTIVE THINKING IN SCIENCE EDUCATION

Science is not only the body of knowledge or a fixed set of facts rather it is a way of thinking which is regularly updated and challenged in the knowledge society by various scientific methods. It is the process aspect of human cognition by which life around us is regularly changing to give better life. It is misinterpreted that scientific knowledge is static rather it is changing day by day because science creates a room for investigation, observation, hypothesis formation, verification, evaluation and finally a conclusion is drawn. It is the subject that opens the door for developing higher order thinking skills i.e. analysis, synthesis, and evaluation. Science is the subject to play with and enjoy it by experiencing the link between textbook and real life. But still in our society science is no more than a factual knowledge. This makes science one of the difficult subject and students use rote learning for getting marks without internalizing it. It was also realized and emphasized by National Policy on Education (POA, 1992) "that we need to improve and strengthen our science education that develop well defined abilities and value such as the spirit of inquiry, creativity, objectivity, the courage to question, and aesthetic sensibility." It was also recommended by NPE, 1992 that science education programs should enable learners to foster problem solving and decision making skills by making links with real life phenomenon." But unfortunately school science teaching learning process is still at lower order thinking level as it is emphasized by National Curriculum Framework (2005) that in India science education does not develop competence like innovation skills. To improve the present practices in science teaching we first need to understand and identify the key skills that could be imbibed with science as a subject. Keeping in view this objective NCERT (2015) suggested process skills of science which includes observation, pose question, searching various resources of learning, planning investigation, hypothesis formulation and testing, analyzing, interpreting data, critical thinking to consider and evaluate alternative explanations, reflecting on their own thinking. Based on process skills NCERT (2015) recommended expected learning outcomes for class VIII in science. One of the learning outcome is to exhibit creativity in designing, planning, making use of available resources, etc. but this outcome cannot be achieved by traditional classroom approach where teacher's voice dominates to control class and students speak occasionally or to give answer of the asked

question in a most acceptable manner. To revamp this type of classroom situation and to attain prescribed learning outcome NCERT had suggested following pedagogical processes:

1. Pose questions and find answer through reflection, discussion, designing, and performing appropriate activities, role play, debates, use of ICT, etc.
2. Exhibit creativity presenting novel ideas, new designs/patterns, improvisation, etc.

But, it was observed that teachers consider science as fact based subject and ignore students' participation in the teaching-learning process. Teachers need to introduce process skills of science in learners while teaching the content rather than simply putting information before students. This type of atmosphere never encourage learners to relate science content with the real life phenomenon and they never think beyond the four walls of classroom. Therefore, it is necessary to introduce a strategy that foster higher order thinking ability in the students at one platform through science learning.

Productive thinking process opens the door for higher order thinking abilities (analysis, synthesis and evaluation) in science and ensure learners' participation in the knowledge construction. Along with this, it is also helpful in developing creative abilities and critical thinking power of the learners in classroom while learning science.

1.11.0 RESEARCH QUESTIONS

1. Whether productive thinking can be inculcated in students?
2. Whether specific strategy can be developed to inculcate productive thinking among students?
3. Whether inculcation of productive thinking will have an impact on academic achievement?
4. Whether it will be feasible to complete to course using strategy for the inculcation of productive thinking?
5. Whether productive thinking can be inculcated among elementary school students?

1.12.0 RATIONALE OF THE STUDY

Innovation is the best gift of human cognition on the earth. Each and every second we enjoy and feel the essence of innovations but what power is standing behind this cognitive ability that direct all the mental processing. Here comes the role of thinking ability that makes human

being superpower and make superior to other animals. We are living in the 21st century where several thinking skills are expected from our students to address the challenges of the changing scenario. Creative thinking, critical thinking, collaboration and communication are 4 C's that are required to bring our students beyond 3 R's i.e. reading, writing and arithmetic. It is needed to develop classroom atmosphere that will lead to prepare our students for 21st century.
Siburian, Corebima & Saptasari (2019) highlighted the role of educators, researchers, and curriculum developers to integrate the above discussed skills in the teaching-learning process. In the same line National Education Policy (2020) framed one of the guiding principle on creativity and critical thinking to encourage logical decision making and innovation at institutional level and stated that we need to reduce curriculum content to enhance such thinking skills.

Thinking skill is innate in every human being but the ability to think in a particular way is acquired. According to Piaget's cognitive development theory, biological maturation leads to cognitive maturation also but Kuhn, Langer, Kohlberg & Haan (1977) argued that "maturation establishes the basis only but a special environment is required to attain this stage." Therefore, it is inevitable to create environment that stimulate development of cognitive ability. Unfortunately, our school system is getting failed in creating environment that stimulate cognitive development and thinking process. It was well reported that our school practices focused on rote learning and very less focus is given to higher order thinking skill. Pany (2014) opined that most of the schools are preparing their students for getting very high score in examinations by getting the subject matter may be by cramming and for this, schools provide very little scope for thinking critically and divergently in the existing teaching-learning process. It creates no scope for novelty, originality and innovations.

To get rid of this situation, productive thinking is a way of integrating higher order thinking skills in the teaching-learning process. As Davis & Scott (1971) (cited in Patel, 1988) defines productive thinking as the ability that include creative and critical thinking dimensions of cognitive ability. It consist of divergent, convergent and evaluative operation whereby the individual drew upon available past and present acts, ideas, association and observation in order to bring forth new facts, ideas and conclusion. It is the ability that bring learner beyond mechanical application of previously learnt behavior in every new situation and make ready to see the new situation from a different perspective. It creates scope for novelty in the teaching-learning process in the classroom and creates scope for thinking beyond memory level.

As we know that creative thinking and critical thinking are the two components of productive thinking having opposite nature and therefore we need to separate these two in the productive thinking process. Birch & Rabinowitz (1951) highlighted the hindering effect of our past experience which blocks creative endeavor and reduces it to stereotyped and fruitless essays channelized through reproductive thinking. But critical thinking can be fruitful also when it is acted on correct place like Gallagher (cited in Hoffman & Hoffman (1964) highlighted the role of critical thinking component which enables the individual to select the most appropriate solution out of number of solutions for the particular problem. Barua & Chakrabarti (2017) highlighted the importance of critical thinking in promoting creativity by saying critical thinking plays a crucial role in evaluating new ideas, selecting the best ones and modifying them if necessary. It can be said that productive thinking is the skill to imbibe knowledge with creative thinking and critical thinking to give productive results followed by high motivation and no criticism. So, we need a strategy by which this can be done and positive components of both thinking skills can be used at one place.

In India, researches were conducted over various thinking skills like; creative thinking, critical thinking, reflective thinking, evaluative thinking, problem solving and many more. But investigator could find only one research in India and very few researches in abroad on productive thinking development. This study will focus on developing strategy for teaching through productive thinking. The teaching strategy for productive thinking will also guide teachers about their role in the process, classroom atmosphere and role of the students. The strategy will use different techniques that can be combined to strengthen knowledge foundation, creative potential and make use of critical thinking to refine creative potential.

Productive thinking can be developed through separated from school subjects or in an integrated manner with all school subjects like science, mathematics, language, social sciences, etc. NCERT (2015) described the nature of science that include process skills like observation, pose question, searching various resources of learning, planning, investigation, hypothesis formulation and testing, analyzing, interpreting data, critical thinking to consider and evaluate alternative explanations, reflecting on their own thinking, etc. The present science teaching is over burdened by factual knowledge where a little room is provided for discussion and creative and critical thinking process which are the heart of science education. So, in this study science is taken as the subject through which productive thinking development can be done in an integrated manner because science provides tremendous opportunity for the higher order

thinking skills. Since present study aimed at developing productive thinking through science as the subject of teaching, achievement of students in science is also need to be considered. When a particular skill is taught through subject content researcher should keep it in mind that achievement of the students should not be negatively affected. So in the present study science achievement of the students will also to be studied. It will help the researcher to draw the conclusion about use of integrated strategy for the development of productive thinking through a subject.

Upper primary stage of elementary school education is the foundation for secondary and higher secondary level as well as for future. According to Piaget (1952) this is the stage where students' cognitive mechanism shift from concrete operational stage to formal operational stage. Simatwa (2010) said at this level, students are able to consider abstract ideas and manipulate them also. Researches shown that this is the stage where students' creative potential is its peak therefore, in this study upper primary stage is taken for the productive thinking development.

To implement this in the classroom role of a teacher is inevitable. Schuler (1974) emphasized active role of teacher in the classroom for the effective implementation of the productive thinking program. Teacher need to be active, vibrant, ready to model creative behavior, and very importantly a constant motivator who is away from destructive criticism and who can channelize creative thoughts on the correct track.

Thinking operations determine the way of doing things and the perspective of looking things. A person needs enough time to change the way of looking at things and it cannot be done immediately in some days. A person who use reproductive thinking everywhere to solve problems he/she cannot change the way of solving problem in the training of some days. Therefore, in this study students will be taught through productive thinking strategy in an integrated manner for the whole academic year (2019-20).

1.13.0 STATEMENT OF THE PROBLEM

DEVELOPMENT AND IMPLEMENTATION OF AN INTEGRATED STRATEGY TO INCULCATE PRODUCTIVE THINKING AMONG ELEMENTARY SCHOOL STUDENTS.

1.14.0 OBJECTIVES

Following objectives helped researcher to complete the present study.

1. To develop an integrated strategy to inculcate productive thinking among elementary school students.
2. To implement the developed integrated strategy to inculcate productive thinking among elementary school students.
3. To study the effectiveness of the developed integrated strategy in terms of productive thinking of elementary school students.
4. To study the effectiveness of the developed integrated strategy in terms of achievement of elementary school students in Science.
5. To study the effectiveness of developed integrated strategy in terms of reaction of elementary school students.

1.15.0 HYPOTHESES

The following null hypotheses were constructed and tested at 0.05 level of significance.

$H_0$1: There will be no significant difference between the mean scores of productive thinking of the experimental and the control groups.

$H_0$2: There will be no significant difference between the average thinking pattern of experimental and control groups.

$H_0$3: There will be no significant difference between the mean scores of achievement of the experimental and the control groups.

1.16.0 EXPLANATION OF THE TERMS

Integrated strategy: In the present study, integrated strategy is the interweaven of the subject content with a developed productive thinking model for the development of higher order thinking skills among elementary school students. Integrated strategy involved different activities having opportunities for students to develop higher order thinking skills through the teaching of content.

Traditional method of teaching: It is a teaching method in which a teacher regulates and control the process of teaching and learning.

1.17.0 OPERATIONAL DEFINITION OF THE TERMS

Productive thinking: Productive thinking is the score obtained by elementary school students in productive thinking scale developed by the researcher.

Effectiveness: Effectiveness of the integrated strategy is the significance of difference between the post-test scores of the experimental and control groups in productive thinking and achievement in Science.

Effectiveness in terms of reaction: Effectiveness of the integrated strategy is the average intensity index of 3.5 and more on a five point reaction scale prepared by the researcher towards the developed strategy and its implementation.

Thinking pattern: Thinking pattern is the average frequency score obtained by the students in the productive thinking scale developed by researcher by considering the components of productive thinking starting from reproductive thinking, critical thinking, and creative thinking to productive thinking.

1.18.0 DELIMITATION OF THE STUDY

The present study is delimited to the English medium elementary school students of standard VIII affiliated to Central Board of School Education, New Delhi. Teaching subject is also delimited to the teaching of Science subject.

1.19.0 FRAMEWORK OF THE CHAPTERS

Chapters in the present thesis are organized as follows.

Chapter I presents conceptual framework and rationale of the present study. It also presents the details of statement of the problem, objectives, hypothesis, operational definition, explanation of the terms, and delimitation of the study.

Chapter II presents the detail account of work done to review the related literature. It includes literature review in the area of productive thinking, creative thinking, critical thinking, and higher order thinking skills and implications of the reviewed researches for the present study.

Chapter III presents the details of the methodology adopted for the present study. It includes design of the study, population and sample, sampling technique used, development of the model and strategy, and development of tools for data collection.

Chapter IV deals with analysis and interpretation of collected data with respect to the objectives and hypothesis of the present study.

Chapter V presents findings and an elaborate discussion of the result obtained by analysis and interpretation of the data.

Chapter VI presents summary of the whole study. It also presents implication of the present study, suggestions for further researches and conclusion.