CHAPTER II

REVIEW OF RELATED LITERATURE

2.1.0 INTRODUCTION

Literature review serves as the driving force and jumping-off point for research investigation (Ridley, 2012). It is used to bring clarity and focus to the research problem, to broaden the knowledge base in the concerned research area, to understand the research design which could be feasible and best suited for the research problem, and also to highlight the constraints of the similar researches conducted over the past. It provides base to engage with concerned theories and written work on concerned research problem. A literature review is a way to uncover areas in which more research is needed, which is a critical component of creating theoretical frameworks and building conceptual models (Snyder, 2019). This chapter presents a review of researches conducted in the area of productive thinking skills. One of the focus of the review in this field was to study different types of strategies and programmes used by previous researchers to develop productive thinking skills in the students.

Today, we are giving emphasis on 21st century skills which involve creative thinking, critical thinking, collaboration and communication. Along with this our students also need to develop creative problem solving skills. Productive thinking allows to develop all these skills in students at one platform. Therefore, this chapter presents researches conducted over a broad range of higher order thinking skills to get a clear understanding of each component of productive thinking process.

To develop an insight about the strategies used by the previous researcher in this field, what is the specific age of the population on which strategy to be implemented, what are the feasible research designs that investigator could use to implement the strategy, what is the perfect sample size and sampling technique to choose a representative sample, what are the gaps exist between the researches conducted in this field and present demand, what are the limitation of the research, what are the available tools to assess productive thinking skills, what statistical analysis solve the purpose and what are the findings of the previously conducted researches that can give direction for the present research.

Therefore, this chapter accounts a comprehensive review of literature in the area of productive thinking. The review involved area of research, objectives, research design, sampling procedure, strategies, tools and findings. The review is divided in the following areas:

I. Researches conducted in the area of productive thinking
II. Researches conducted in the area of creative and critical thinking skills
III. Researches conducted in the area of problem solving
IV. Researches conducted in the area of higher order thinking skills

2.2.0 RESEARCHES IN THE AREA OF PRODUCTIVE THINKING

Researcher found six studies conducted in the area of productive thinking. Out of six studies 5 studies were experimental study and one was case study. The reviewed studies are discussed here as follows:

Hutchinson (1967) conducted experimental study on creative and productive thinking process. The main objective was to determine what learning and thinking processes would be elicited in the students by certain modifications of current teaching methods. There were total 8 groups (4 experimental and 4 control groups) and each group is having 32 students (16 boys and 16 girl) i.e. total 256 students studying in VII grade (1961-62) in Valley junior high school, Utah. Teachers taught the experimental group using group methods like brainstorming and giving emphasis on ideational fluency, originality, planning and elaboration. To observe the classroom discourse all the lessons were recorded and analyzed using Ashner-Gallagher system of verbal responses which consist of 5 categories; Cognitive memory, convergent thinking, divergent thinking, evaluative thinking and routine. A creativity test was also applied having 7 subtest; 1.hidden shapes 2. Gestalt transformation 3. Apparatus test 4. Elaboration 5. Plot tiles 6. Clip uses 7. Meaningful statements. Analyzed data revealed that experimental groups showing growth in creativity over control group. It shows programme was effective in terms of developing productive thinking among VII grade students comparatively.

Olton (1969) conducted experimental study to develop productive thinking skills in fifth grade students. The study was conducted in the light of following objectives: 1. to investigate the extent to which productive thinking ability (i.e. creative thinking and problem solving) can be taught to elementary school children independent of any specific subject field. 2. To discover whether some of these strategies are more readily taught than others. 3. To investigate the relationship between certain learner characteristics (intelligence and sex) and performance on a broad diversity of productive thinking measures. 4. To investigate extent to which overall classroom environment facilitates productive thinking in students and the extent to which students in different types of classroom environment profit from classroom instruction in

productive thinking. Total 704 fifth grade students of 44 classrooms in Racine, Wisconsin Unified School District no. 1 are matched and participated in the study. They used standardized productive thinking programme (Covington, Crutchfield & Davies, 1966) which contained 16 self-administrative lessons and each lesson took 50 minute to complete it. After the completion of 16 lessons, creative thinking test developed by Torrance was administered and data was analysed using 2×2×2 factorial design. The findings suggested that productive thinking programme increase the level of productive thinking among experimental group.

Schuler (1974) conducted experimental study in the area of productive thinking. They did experimental study and modified Solomon 4 group design was used. Total 546 fifth grade students in 21 classes in 4 upstate of New York school district were selected as sample for the study. They used productive thinking programme (Covington, Crutchfield & Davies, 1966) which considers 3 categories of productive thinking; fluency, flexibility and appropriateness in response. At the end of the programme Minnesota Test of critical thinking was used to assess productive thinking of different groups. Findings revealed the higher gain in the classroom where teachers are more actively engaged with students and encourage them followed by the introduction of programme.

Patel (1988) did an experiment to study the effectiveness of productive thinking programme in geography on creativity of students of class IX. Major objectives were: 1. To provide a reliable productive thinking programme (PTP) in geography for the development of creativity in the students of class IX. 2. To study the effect of PTP on various blocks constructed on the basis of creativity and intelligence. For this he used separate control group design where, he had two experimental group and one control group. A self-administrative PTP was developed based on geography content by considering convergent thinking, divergent thinking, and evaluative thinking as the component of productive thinking. In one experimental group teacher discuss about the programme content along with the textbook while the other experimental group not having discussion. After completion of programme data were collected using Torrance test of Creative Thinking (TTCT), 1964 and analyzed using 3×2×2 randomized group factorial design. Findings are 1. PTP is a powerful mean for creativity. 2. IQ has a role in developing creativity. 3. He found that programme proved to be very interesting and creative too in respect of all the students of IX standard.

Chin (2008) made an effort to study teachers questioning in science classroom as an approach to stimulate productive thinking. The study was conducted in VII standard of 4 different

schools where each class is having 40 students. To teach the students total 6 teachers were selected based on their expertise. Teachers taught the class using expository teaching, whole class guided discussion, laboratory work, demonstration, small group hands on task, and paired discussion. All the lessons are recorded and 6 lessons of each teacher were analyzed i.e. total 36 lessons. Findings shows four different types of questioning that stimulate productive thinking are: Socratic questioning, verbal jigsaw, semantic tapestry and framing. If teachers use these questioning techniques in the classroom then it will stimulate productive thinking among students.

Aranda, Lie & Guzey (2019) conducted a case study on "productive thinking in middle school science students' design conversation in a design based engineering challenge." This study was focused on research question that how VI grade students employ different mode of thinking when solving a design based challenge in a science unit. This study considers cognitive memory, divergent thinking, convergent thinking and evaluative thinking as the component of productive thinking operation. She used qualitative and descriptive case study on a purposive sample of 26 students of V standard. For this, students are trained by experienced teachers for design based challenge using Aschner and Gallagher analytical framework of productive thinking which leads to three stages planning, redesign and communication to the client. At the end of the curriculum, discussion of students are recorded and analyzed by conversation analysis approach. The result indicated students employ different components of productive thinking at different stages of design challenge. At planning stage students employ cognitive memory, divergent thinking and convergent thinking and at redesigning stage students used evaluative thinking to improve the initial design and communicate to the client.

2.3.0 RESEARCHES IN THE AREA OF CREATIVE THINKING AND CRITICAL THINKING SKILLS

As creative thinking and critical thinking are the two main components of productive thinking therefore, researcher reviewed studies conducted in the area of creative thinking and critical thinking also and they are discussed in the caption 2.3.1 and 2.3.2 respectively. Researcher also reviewed studies in which both creative thinking and critical thinking were studied in one study and discussed in caption 2.3.3.

2.3.1 RESEARCHES ON CREATIVE THINKING SKILL

Researcher reviewed total 28 studies in the area of creative thinking to develop an insight about the creative component of productive thinking. The reviewed researches in this area are discussed as follows:

Passi (1972) conducted an exploratory study on creativity and its relationship with intelligence and achievement in school subjects at higher secondary stage. Research was aimed at developing a battery of test of creativity for measuring verbal and non-verbal factors involved in creativity and to explore the relationship between creativity, intelligence and achievement. Study suggested that creativity is a multi-factor construct having verbal and non-verbal factor. It was also reported that girls are superior to boys in non-verbal creativity and boys are superior in verbal creativity. It was also found that urban students are better than rural students on creativity.

Kumari (1975) conducted a survey to study the relationship among creativity, intelligence, adjustment and value patterns in adolescents. 1000 students (500 boys and 500 girls) studying in IX to XII were selected as sample. Students were surveyed on samoohik mansik yogyata pariksha developed by R. K. Tandon, Vyaktitwa parakh prashnavali developed by M. S. Saxena and Indian adaptation of Allport-Vernon study of values by R. P. Bhatnagar and R. K. Tandon for measuring values. The data obtained from the above discussed tools was analysed by t-test and correlation. No significant relationship was found between intelligence & creativity, creativity & adjustment and creativity and value patterns. It was concluded that the amount of creativity increased during adolescence i.e. from 13 to 18 years and therefore this period should be selected for creativity training.

Gupta (1977) studied institutional climate and classroom teaching behaviour in relation to creativity. The main focus was 1. To study the interaction between school climate, teacher's classroom behaviour and creativity of pupils. 2. To explore the relationship between institutional climate and creativity of the pupils. 3. To explore the relationship between teachers' verbal behaviour and creativity of students. He considered 2000 students studying in grades VI to IX in Jammu city and 20 teachers who teaches science to IX class as sample for the study. Data was collected from students using the verbal and non-verbal battery of MIER's test of creativity (Gupta, 1975) and Jalota's mental ability test. MIER interaction analysis techniques was used to collect data from teachers. The collected data was analysed by ANOVA, product moment correlation, the Wilcoxon signed rank test and chi-square test of

independence. Findings suggested importance of Laissez Faire institution in developing non-verbal creativity specifically whereas all students are same over composite creativity irrespective of their institutions. It was concluded that institutions with Laissez Faire leadership with democratic teachers are good for improving students' creativity those who have average and low creativity whereas pupils with higher creativity were likely to improve their creative potential with authoritarian teachers in Laissez Faire school.

Shah (1981) did an experimental investigation in the area of creative thinking. Objective of the study was to study the effects of selected teaching strategies on the development of creative thinking and achievement in science of standard VII students. Researcher selected lecturing (strategy 1), lecturing and discussion (strategy 2), lecturing, discussion, practical work (strategy 3), and lecturing, discussion, practical work and audio visual aids (strategy 4) as four different strategy for development of creative thinking. Researcher selected VII standard students of New education school, Petlad, Gujarat purposively as sample and for giving training to the students willing expert teachers were selected. Students were divided in 4 groups and taught by different teachers using different strategy for 14 weeks. Researcher used Torrance test of Creative Thinking to measure creative abilities. Collected data was analysed using descriptive statistics and ANOVA. The study concluded that strategy 4 i.e. combination of lecturing, discussion, practical work and audio visual aids was more effective in developing creative thinking and improving achievement in the VII standard students. It is also concluded that out of strategy 1, 2, and 3 strategy 2 i.e. lecturing and discussion was more effective among high intelligence level group. In total study revealed importance of discussion and A.V. aids in developing creativity.

Haleem (1984) conducted survey study to know the attitude of teachers towards non-creative students of high intelligence versus high creative students of average intelligence. Investigator selected total 353 (201 boys and 152 girls) students of Lucknow city studying in standard IX. Investigator divide the students into two groups one of high IQ with low creativity and other of low IQ with high creativity based on Mehrotra's test of intelligence and Zaidi's Trends of Imagination scale. Teachers were given attitude scale developed by investigator to know the attitude of teachers towards the two group of students. Findings reflected 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.

Vora (1984) investigated the impact of Divergent Thinking Programme in Mathematics (DTPM) on creative levels of the children of classes VII and VIII. The study was aimed to provide a reliable divergent thinking programme and see its effect on creativity level of students of VII and VIII class students. Investigator developed programme having three categories of problems viz. multipurpose type, hidden shape type and make-up problem type. This programme was implemented over sample of 271 students (130 VII class students and VIII class students). Baqer Mehdi test of creative thinking was used to collect the data after implementing programme. The data was analysed using 3×2×2 factorial design ANCOVA. Findings showed effectiveness of programme in increasing creativity of both the classes. It was also found that students gave positive and favorable opinion about the programme.

Gupta (1985) conducted a study on development and evaluation of creativity Training Programme (CTP) for sixth grade children. The study was aimed at; 1. To develop a creativity Training Programme (CTP) for VI grade children. 2. To study the effect of CTP upon the development of verbal fluency, verbal flexibility, originality, non-verbal elaboration, and composite non-verbal creativity of VI grade children separately. 3. To study the interaction of intelligence and effect of CTP and sex and effect of CTP. 4. To find out reaction of students towards the CTP. Total 357 students (188 girls and 169 boys) of government school comprised the sample of the study. Students were trained with CTP and its effectiveness was measured with Baqer Mahdi's test of verbal and non-verbal test of creativity and Jalota's group test of mental ability. Data was analysed using ANOVA, t-test and Hartley's test. CTP was found effective in developing verbal and non-verbal creativity in both male and female students but no interaction was found among intelligence, sex and CTP for any of the component of creativity.

Brar (1987) did correlation study on creativity in relation to intelligence among the school children of 13 to 18 years age. Total 637 male students of age group 13 to 18 years from Faridkot, Punjab. Investigator considered four components of creativity viz. fluency, flexibility, originality and elaboration. Findings suggested independent nature of creativity and intelligence. It was also suggested that all the four components of creativity developed at a high rate in VIII grade students. It means age of VIII class students are favorable in developing creativity.

Patel (1987) conducted experimental study to investigate the effectiveness of the Purdue creative thinking programme on the creative abilities of elementary school children. The study

was aimed to provide standard creative thinking programme in Gujarati and to study the effectiveness of programme on the creative level of elementary school children. The experimental study was conducted in Kheda district where 4 classes were assigned as experimental and 4 were control group. Investigator developed some programme for creativity and some of the standardized programme were translated in Gujarati. Training was given to the experimental group and after training investigator administered test of intelligence and creative ability test both developed by investigator. Analysis was conducted using ANOVA and findings showed effectiveness of the programme in developing creativity and its two components viz. fluency and originality particularly.

Amin (1988) studied the effectiveness of creative thinking programme in relation to the programme correlates. The main focus of the study was to develop a creative thinking programme for enhancing the level of creativity in children. The sample comprised 200 random students of class V. Investigator trained students with creative thinking programme developed by J. Z. Patel and its effectiveness was measured with the creative ability test developed by J. Z. Patel. Findings suggested effectiveness of programme in developing creativity. It was suggested that whenever programme is implemented it should be of at least12 weeks for the better result and effective. It was also suggested that discussion at the time of idea production is good for enhancement of creative thinking.

Patel (1987) attempted an experimental study to develop and study the effectiveness of Brainstorming Technique Programme (BRTP) on creativity of the secondary school students. The study was aimed at establishing the procedure of Brainstorming Technique and see its impact on creativity levels of the pupils in relation to the intelligence level of secondary school children. Study was conducted over IX class students where, experimental group was trained through Brainstorming Technique Programme (BRTP). After the training data was collected with the help of creativity test developed by J. Z. Patel and the group test of intelligence developed by K. G. Desai. The collected data was analysed using 2×2 factorial design ANCOVA. Brainstorming Technique Programme (BRTP) was found effective in developing verbal and figural creativity along with developing fluency and flexibility component of creativity.

Rajagopalan (1988) conducted a survey to study creativity of secondary school students in relation to classroom climate, achievement motivation and mental ability. The study was focused around following objective; 1. To find out the level of creativity of secondary school

students of class VIII and IX. 2. To find out motivation and general mental ability of students. 3. To study the effect of classroom climate, general mental ability and achievement motivation on creativity. 4. To study the effect of different interaction between achievement, motivation, mental ability and classroom climate. The study was conducted over 1200 students of class VIII and IX of Madurai city. Data was collected by using achievement motivation inventory developed by Prayag Mehta, mixed group intelligence test developed by P. N. Mehrotra, Verbal test of creative thinking by Baqer Mehdi and Classroom climate scale developed and standardized by CASE. 2×2×2 factorial design ANOVA was used to analyse the data and the findings reflected low level of creativity among students. It was also found that creativity and mental ability and creativity and classroom climate had positive correlation in both classes. It can be concluded that favourable classroom climate and high mental ability were two conducive factors for the growth of creativity in students.

Kachhia (1990) conducted experimental study on creative thinking ability of primary school children. The objective was to study the effect of CoRT thinking programme on creative thinking of primary school children. 163 children of VII standard were selected purposively and divided into two experimental and one control group. One experimental group was taught using CoRT thinking programme along with feedback but another experimental group without feedback. Effectiveness was measured by tools; creative ability test developed by J. Z. Patel and Social economic status scale developed by B.V. Patel & I. N. Vora. Data were analyzed by 3×2×2 factorial design ANOVA. It was found that CoRT thinking programme showed better result when programme is integrated with feedback. It was also found that socio economic status has no influence on enhancement of creativity.

Sharma (1994) conducted an experimental study by organizing activities like brainstorming, problem solving, quiz and project work. The result shows significant gains with respect to verbal fluency, verbal flexibility and verbal originality and non-verbal creative thinking.

Paltasingh (1998) conducted an experimental study on creative thinking training in biology teaching for secondary level students. The study was focused around major following objectives: 1. To determine the relationship between intelligence and creativity. 2. To determine the relationship between achievement and creativity. 3. To find out the effect of creative discussion method and Synectic model in teaching biology on development of creative thinking ability. 4. To find out the scholastic achievement scores of experimental and control group. He chose pretest posttest parallel group design. All IX standard students of Orissa were

population for the study. Two school of Orissa were selected purposively and IX standard of each school were divided into 3 groups A, B and C. Group A was taught through creative discussion method, group B was taught through Synectic model and group C was taught through traditional method and the duration of training was 20 weeks. To test the effectiveness of training researcher used Baquer Mehdi test of creativity, achievement test in biology developed by researcher and Jalota's group test of general mental ability. Findings of the study suggested that significant and positive correlation between creativity and achievement and creativity and intelligence. It is also reported that training through creative discussion and Synectic model made a significant improvement in creativity and achievement of experimental group. In conclusion it can be said that intelligence level made training easy and this type of training raise creativity of the secondary level students.

Nathalal (2002) attempted experimental research to study the effectiveness of creative thinking programme on developing creative thinking ability. The main objective was to develop and standardise creative thinking programme for secondary school students of IX standard of Mehsana district and find its effectiveness on the development of creativity and creative ability of the students. Creative thinking programme was developed based on DeBono's work on creative thinking. 150 students of IX standard of Mehsana district were selected purposively and divided into 3 groups (2 experimental and 1 control). One experimental group got thinking training with feedback and another without feedback. Creative ability test developed by J. Z. Patel and verbal and non-verbal group intelligence test developed by K. G. Desai were used to collect data on creative ability and analyzed using ANOVA (3×2×2) where gender was one of the studied variable. Findings reflected effectiveness of creative thinking programme in developing creative ability and better effect was seen in training along with feedback. It was also found that boys were better on progress in creative ability than girls.

Pandit (2006) conducted experimental study in the area of creative teaching. Objectives of the study were as followed 1. To develop test for measuring creativity in languages, science and geography based on textbook syllabus for standard VII.2. To design and deliver an intervention programme for teachers for using creativity techniques in teaching process. 3. To test the effectiveness of intervention programme on content based creativity in language, science and geography of students of English and Marathi medium with respect to fluency, flexibility and originality. 4. To test the effectiveness of intervention programme on content free creativity of students of English and Marathi medium with respect to fluency, flexibility and originality to assess the transfer of learning.

Quasi experimental pretest posttest single group design was used. Sample of the study was selected purposively from a school of Pune wherein VII standard section of Marathi and English medium were selected to train. Students were trained for 3 months by teachers using inquiry skills, observation skills, visualization, brainstorming (guessing causes & consequences), Synectic (direct analogy & personal analogy), transformation and poetry writing. To test the effectiveness of programme on content based creativity researcher developed test of creativity in science, geography, Marathi and English and Torrance test of creative thinking, TTCT was used to test content free creativity. Findings suggested that programme was effective in improving content based and content free creativity among students of VII standard of both the medium. It was concluded that creativity training on content based approaches also helpful in improving creativity in general.

Prashanth (2006) did experimental research to study the effect of synectic model of teaching on creativity, problem solving ability and attitude towards science at secondary level. Objective was to compare the effectiveness of synectic model and conventional method of teaching science. Cluster random sampling was used to select sample where, there were two clusters rural and urban. One school from each cluster is selected randomly and IX standard of each school was selected as sample for the study. Experimental group was trained using synectic model and effectiveness was measured using verbal test of creative thinking (Baqer Mehdi, 1973), test of higher mental ability in science (D.N. Sansanwal and Anuradha Joshi, 1989), Attitude towards science (Avinash Grewal), Ravens Progressive Matrices, 1938, and problem solving ability test developed by investigator. Findings suggested that synectic model of teaching science is effective in both rural and urban samples in fostering fluency, flexibility, originality, composite creativity, problem solving ability, and attitude towards science. It was also found that synectic model is effective in improving creativity irrespective of intelligence level.

Kirshnan (2011) did a study to see the effect of blended learning strategy on higher order thinking and learning science among secondary school students. The study was aimed at 1. To find the effect of blended learning on students' critical thinking, problem solving, science process skills and science achievement. 2. To find the reaction of students towards blended learning strategy. 3. To identify the difficulties faced by students while learning science through blended learning strategy. Quasi experimental pretest posttest non-equivalent design was used. Secondary school students constituted the population for the study and researcher purposively selected two schools from Bangalore city. Intact IX standard of one school with

online learning platform www.thinkquest.org selected as experimental school and other school was not having online learning facilities as control school. Researcher taught experimental group with blended learning strategy where students use online learning platform along with face to face interaction in the classroom for 20 weeks. To study the effectiveness of strategy researcher developed critical thinking test, problem solving test, science process skill test and science achievement test. Data were analyzed using descriptive strategy and ANCOVA. It was found that blended learning strategy was equally effective in improving critical thinking, problem solving ability, science process skill and achievement of IX standard students. Shortage of time and extra workload along with the positive reaction of students were also reported.

Siddiqi (2011) attempted a descriptive survey on creativity among boys and girls of VII standard. For this 2 schools was randomly selected from Aligarh city and 50 boys and 50 girls of VII standard were surveyed randomly using Torrance test of creative thinking (1968). Creative thinking data was analysed component wise using mean, SD and t-test. It was found that boys and girls are same on flexibility and fluency but significantly differ on originality i.e. boys possessed greater originality but overall creativity is same in boys and girls of VII standard.

Hu, Wu, Jia, Yi, Duan, Meyer & Kaufman (2013) conducted experimental study in the area of scientific creativity. They prepared instructional material "learn to think" to improve students' scientific creativity. This program having activities in two sets 1. Thinking training activities in three categories i.e. concrete thinking (image conversion, imagination, space cognition, and association), abstract thinking (comparison, classification, reasoning, generalization, analysis, synthesis, and differentiation), creative thinking (analogy, reorganization, brainstorming, divergent thinking, breaking the set, and transference) and 2. Inquiry activities (problem finding, problem solving and scientific inquiry). Experimental group is having 54 students (27 boys and 27 girls) and control group is having 43 students (24 boys and 19 girls). Trained professionals gave training to experimental group using intervention program for 2 years while control group was taught by traditional classroom teaching. To test the effectiveness of program the scientific creativity test (Lin, 2009) was used to collect data from experimental and control group and they also study the delayed effect after 6 months of terminating experiment. The data was analyzed using ANOVA and findings revealed that intervention program "learn to think" promote scientific creativity. They conclude

that an education intervention rooted in well-established theories of cognitive development can have long term and replicable effects on young adolescents' scientific creativity.

Kumari (2014) undertook an experimental study on effectiveness of six thinking hats strategy on the development of parallel thinking, lateral thinking, and general creativity in high school student. The objective of the study was to study the effect of six thinking hats strategy on parallel thinking, lateral thinking, general creativity and argumentativeness. Researcher used pretest-posttest control group design to conduct the study. For this investigator selected 160 students randomly out of 450 boys of government boys senior secondary school, Nagloi district. Researcher took pre-test for intelligence level using Raven's Progressive Matrices, socio-economic status using scale developed by Kalia & Sahu, argumentativeness using scale developed by Infante & Rancer, 1982, general creativity using Baquer Mehdi test of creativity, lateral thinking using test developed by Sucheta & Aggarwal, 2012, and parallel thinking using test developed and standardized by investigator. After the completion of intervention program posttest was taken and data was analyzed using ANOVA 2×3×2 factorial design and conclude that six thinking hats strategy is effective in developing parallel thinking and argumentativeness. It was also found that this strategy is more effective in improving lateral and creative thinking among high intelligent students than low and middle one.

Pany (2014) attempted a comparative study on creative thinking ability of government and private school students. The objective was to compare creative thinking ability of boys and girls with respect to the type of management of the school i.e. government and private. For this all primary school students were population for the study. 5 government and 5 private school were selected purposively and 50 boys and 50 girls studying in V standard from both government and private school were selected i.e. 200 (100 boys and 100 girls). To test the creative thinking ability Baqer Mehdi test (1985) of verbal creativity was used and data was analyzed by descriptive statistics and t-test. Findings revealed that children of private school performed better on creative thinking task and it is significant in terms of gender also. It was concluded that this difference is because of the autonomy given to the students and various activities involved in the teaching learning in private schools.

Ramesh (2015) studied effectiveness of the Programme to Develop Thinking (PDT) on creativity and achievement in science among the students of standard IX. He developed PDT based on deBono's CoRT tools. He used pretest posttest control group design. All IX standard students of Bangalore city were population for the conducted study and simple random

sampling was used to select 159 students and assigned to two groups experimental and control group. Investigator used Raven's Progressive Matrices to test intelligence, achievement test in science developed by investigator and Baqer Mehdi test of creativity were used to collect pre and post data. The data were analyzed using Pearson's product moment correlation, independent t-test, and two way ANOVA. Findings suggested that 1. PDT enhanced creativity and achievement of the students. 2. There is very high correlation between achievement and creativity. 3. High intelligence group performed better on creativity and achievement.

George (2016) studied experimentally the impact of play, brainstorming and storyline on creativity among middle school children. The purpose of the study was to assess the impact of individual intervention and their combinations also. Investigator used pretest posttest control group design. One government school from Madurai, Tamilnadu was selected as sample conveniently and all the students of V standard were selected as sample. There were 8 section with 301 students total in V standard. So, 6 sections were assigned as experimental group and 1 section as control group. To give the training researcher prepared a module for each intervention having 10 activities. Activities involved in brainstorming; complete the diagram, uses of objects, situational uses, consequences, and consequences of having a magical wand, product improvement, and situation improvement, similarities between objects and places and qualities. Data were collected using Baqer Mehdi test of creativity and analyzed using descriptive statistics and ANOVA. It was found that all interventions are equally effective and play and brainstorming combination was more effective in combinations in enhancing creativity of V standard students.

Ozyaprak (2016) made an effort to study effectiveness of SCAMPER technique on creative thinking skills. Investigator used one-group pretest-posttest design of experimental research. 14 undergraduates who are the part of gifted teacher training program at Istanbul University constituted the sample of the study. Investigator prepared a training programme using SCAMPER technique and gave training to the sample group for 6 weeks. To test the effectiveness of training programme test for creative thinking- drawing production (TCT-DP) was used and analysed by paired sample t-test. Result reflected the usefulness and effectiveness of SCAMPER technique in developing creative thinking skills. It was concluded that SCAMPER provides an enjoyable environment for practicing creative thinking for all age group.

Raj (2016) conducted an experiment on effectiveness of brainstorming and quiz activities in the development of scientific creativity of secondary school students. The main objective was to study the effectiveness of brainstorming activity and quiz activity in comparison to conventional method of teaching in the development of scientific creativity of secondary school students with reference to fluency, flexibility and originality. Non-randomized pretest-posttest quasi experimental design was employed. Investigator construct and standardized the tool using random sampling and purposive sampling was used to select sample for experimentation wherein one school from Varanasi selected and one section was assigned as experimental group and other as control. After the training effectiveness was measured in terms of following test: mixed group test of intelligence (P.N. Mehrotra, 2012), Socio-economic status scale (S. K. Upadhyay & A. Saxena, 2011), and the test of scientific creativity developed by investigator. Data were analyzed by t-test and ANCOVA and findings shows brainstorming activity and quiz both are effective in teaching science in development of fluency, flexibility, originality and overall creativity among students of IX standard.

Gundogan (2019) undertook a study on SCAMPER to improve creative imagination of young children. The study was focused to investigate the effect of SCAMPER in improving creative imagination of 5 year old children. Researcher selected 49 children from kindergarten purposively and train them using SCAMPER technique, creative games and activities for imagination development by Bob Eberle (2008) and activities prepared by Gundogan (2011) for 3 month. After the training the data was collected using test of creative imagination developed by investigator. Investigator used paired samples t-test for analysing pretest-posttest data and independent samples t-test for analysing posttest means scores. Analysis revealed increased imagination level of children who received SCAMPER training. It was concluded that SCAMPER is effective for overall creativity but more effective in raising fluency component of creative thinking.

2.3.2 RESEARCHES ON CRITICAL THINKING SKILL

Researcher reviewed total eight studies in the area of critical thinking to develop an insight about the critical thinking component of productive thinking. The reviewed researches in this area are discussed as follows:

Nayar (1971) explored the predictors of achievement in science at the secondary school stage. This study was aimed at predicting achievement in science in terms of 6 variables: verbal reasoning ability, numerical ability, comprehension and interpretation, problem solving,

critical thinking and spatial ability. 370 students of X standard of Trivandrum revenue district comprised the sample of the study. Findings revealed verbal reasoning ability, numerical ability, comprehension and interpretation, problem solving, critical thinking and spatial ability are the components of science and boys and girls differ significantly on specific component.

Meghani (1999) undertook an experimental study on effectiveness of teaching learning strategy to develop critical thinking in students of standard XI using psychology as content. The study was aimed at to evolve a strategy for teaching learning critical thinking in students of XI using the subject psychology and to develop a tool to measure the effectiveness of strategy to teaching learning critical thinking. Investigator used CoRT programme (PMI, OPV, & CAF) for developing strategy for critical thinking. All the student of XI who took psychology as a subject in a school selected purposively as sample. Investigator used one group pretest-posttest design and train the children. Investigator analyzed data by both qualitative and quantitative methods and result highlighted the effectiveness of strategy in developing critical thinking. Qualitative data reflected that after intervention students was able to think dialectically, to apply knowledge in a new situation, and to demonstrate critical thinking skills.

Paily (1999) undertook a descriptive comparative study on development of critical thinking among secondary school students in relation to some psycho contextual variables. The main objectives were: 1. To establish the norms for critical thinking ability of the secondary school students in the state of Goa. 2. To study the levels of critical thinking of the secondary school students. 3. To study the correlation between critical thinking and intelligence and critical thinking and socio-economic status. 4. The extent to which the secondary school teachers make use of the various techniques for developing critical thinking in their students. 918 students from X standard and 209 teachers selected randomly from secondary school in Goa in the academic year 1997-98. Investigator conducted survey with following tools: Watson-Glaser critical thinking appraisal (1994), Culture fair intelligence scale-III by Cattel et al., Critical thinking teacher behavior inventory, and Home background data sheet. Findings revealed average level of critical thinking among X standard students. It was also reported that a very negligible percentage of teachers used critical thinking teaching strategies while teaching.

Gurubasappa (2010) attempted a descriptive survey to study critical thinking, emotional intelligence, creativity, and their effect on academic achievement in science of secondary school students. The objective was to study the relationship between critical thinking, emotional intelligence and creativity with achievement of students. 600 students from 398 high

schools were selected using stratified proportionate random sampling. Students were divided on levels of gender, types of school and location of school. Following tools were used to collect data: 1. Test in physics developed by investigator 2. Emotional intelligence inventory developed by Shailendra Singh 3. A new test of creativity by Rama Pal 4. Socio-economic status scale by Lakshminarayana, and 5. Achievement test in science developed by researcher. The data were analyzed by correlation and findings suggested students with moderate and high critical thinking, creativity, emotional intelligence and socioeconomic status have excellent achievement in science learning.

Patel (2011) conducted an experimental study on development of a critical thinking programme and its effectiveness for students of class IX. Study was aimed at to develop, implement and study the effectiveness of programme for enhancing critical thinking in relation to gender, socioeconomic status and IQ. Investigator developed programme for critical thinking that include inductive reasoning, analysis, inference, problem solving and evaluation as component to be developed. Research followed one group pretest-posttest design. For this IX class students of Anand high school, Anand was selected purposively and trained by the researcher. Effectiveness of programme was measured by critical thinking test developed by investigator, socioeconomic scale by Pallaviben P. Patel, and intelligence test by Dr. R. S. Patel. Findings reflected effectiveness of programme in enhancing critical thinking. It was also found that critical thinking programme is equally effective in terms of gender, socioeconomic status and intelligence.

Seeja (2012) carried out a study on influence of active learning strategies on critical thinking, thinking style and achievement in physics among secondary school students. The objective was to study the influence of active learning strategies on critical thinking, thinking style and achievement in physics. Quasi experimental pretest-posttest non-equivalent design was used. Two intact group of student of secondary school were chosen purposively and one group was trained using active learning strategy. Effectiveness of strategy was measured with tools; Raven's progressive matrices test (1976), achievement test in physics developed by investigator, test of critical thinking skills in physics considering interpretation, analysis inference, evaluation, explanation and self-regulation as component of critical thinking, critical thinking disposition scale considering open-mindedness, inquisitiveness, truth seeking, analytic & self-confidence as component and thinking style inventory (Sternberg-Wagner inventory) and students' reaction scale. Findings revealed effectiveness of active learning strategy in enhancing all the dimensions of critical thinking and improving critical thinking

disposition except inquisitiveness and self-confidence. It was also effective in promoting judicial and legislative thinking style but not executive thinking style.

Manjula (2013) conducted a study on effectiveness of interactive multimedia strategies (IMMS) on achievement in mathematics and critical thinking ability of standard IX students. Study was focused around the objectives: 1. To develop IMMS based on selected topics of standard IX mathematics syllabus. 2. To study the effectiveness of IMMS on the critical thinking ability and achievement in mathematics. 3. To find out the relationship between critical thinking ability and achievement of students of standard IX. Pretest-posttest equivalent group design was used. Multistage sampling was used, in the first stage. Two schools are selected using convenience sampling and from these schools80 students were selected randomly and assigned two groups experimental and control having 40 students in each group. Experimental group was taught using strategies like induction, inductive and deductive method, analysis and synthesis and introductive method. In these strategies multimedia like chart, flip over charts, models, videos, graphic organizers, power point presentation, etc. are incorporated. Researcher used Ravens SPM, 1988 for making both the group equivalent. Researcher developed achievement test on mathematics and test for critical thinking to collect pre and post test data. Data was analyzed using descriptive statistics, Pearson's product moment correlation, independent sample t-test and ANOVA (2×2). Findings suggested that IMMS enhanced critical thinking and achievement in mathematics in experimental group. Achievement and critical thinking ability are positively correlated and students with higher intelligence performed better on critical thinking and achievement task.

Joseph (2018) attempted a study to develop and find the effectiveness of a strategy based on Andes Intelligent Tutoring system for enhancing problem solving ability, critical thinking and achievement in physics of students at higher secondary level. He selected 220 students of standard XII from two school randomly and assigned control and experimental group for the pretest-posttest nonequivalent design of experimental study. Experimental group students was taught through the developed strategy based on Andes intelligent tutoring system and control group was taught through activity oriented teaching. Data were collected using the Ravens Progressive Matrices and problem solving ability test, critical thinking test, achievement test developed and standardized by the researcher. Pretest and posttest data were analyzed using t-test, ANOVA and ANCOVA. Findings of the study revealed that developed strategy is effective in terms of developing problem solving ability, critical thinking and achievement in physics than the existing activity oriented teaching. It is also found that there is lack of time

allotted to complete the whole syllabus and for numerical problems. Lack of computer facilities for teaching is also reported. The study suggested that there should be more facilities in the schools so that various programs can be conducted.

2.3.3 RESEARCHES ON CREATIVE AND CRITICAL THINKING IN ONE STUDY

Researcher also reviewed 3 studies in which creative thinking and critical thinking were taken in one study as variables to study. The reviewed studies are discussed here as follows:

Patel (2010) developed an instructional strategy for primary school teachers to teach creative and critical thinking skills. The major purpose of the study were; 1. To select appropriate thinking tools for enhancing creative and critical thinking skills. 2. To develop an instructional strategy using selected combination of thinking tools using appropriate content to enhance creative and critical thinking skills. 3. To enable teachers to incorporate the creative and critical thinking skills into lesson plans. 4. To study the impact of the instructional strategy in enhancing creative and critical thinking skills in teachers. He conducted experimental study with one group pretest posttest design. He used Edward DeBono's CoRT lessons as a thinking tool to train the teachers. This thinking tool is having five strategies; Plus Minus Interesting (PMI), Considering All Factors (CAF), Alternatives Possibilities Choices (APC) and Consequences & Sequel (C & S). There were total 25 teachers who participated willingly in the study. To test the effectiveness of instructional strategy researcher developed creative and critical thinking tool. Pre and post test data were analyzed using correlated t-test and findings revealed that teachers have improved on creative and critical thinking.

Alghafri & Ismail (2014) studied the effectiveness of integrating creative and critical thinking on school students' thinking. They conducted experimental study to see the effect of combining creative thinking and critical thinking together in one strategy. They prepared strategy by considering interpretation, analysis, evaluation and inference component of critical thinking and fluency, flexibility and originality components of creative thinking. 68 fifth grade students were selected randomly from two primary schools and divided in experimental (32 students) and control group (36 students). Experimental group was trained using developed strategy for 3 months. Both the groups were tested on test developed and standardized by the researcher; 1. Test of creative thinking and 2. Science task of thinking. Gathered data were analysed using descriptive statistics, ANCOVA and MANCOVA. Findings showed that strategy was effective in terms of creativity and critical thinking in students'. But it was not effective in terms of originality and science task achievement.

Siburian, Corebima & Saptasari (2019) conducted a descriptive correlational research to see the relation between critical and creative thinking skills on cognitive learning results. The study was aimed at study the relationship between critical and creative thinking skills on cognitive learning results in inquiry learning strategy and to reveal contribution of critical and creative thinking skills to students' cognitive learning results.Study includes training of inquiry learning of all the students (6 male & 46 female) of biology education study program in the education and teacher training faculty of Jambi University, Indonesia of 2017-18 academic year as sample for one group pretest-posttest design. The data were collected using critical thinking skill rubric developed by Zubaidah, Wrebima, & Mistianah (2015), creative thinking skill test developed by Treffinger, Young, Selby, & Shepardson (2002), and cognitive learning results developed by researcher. The data were analysed by multiple regression analysis and findings shows significant correlation between both the skills and creative thinking skill contributes 64.91% and critical thinking contributes 7.89% in cognitive learning results. It was also reported that simultaneous contribution of creative and critical thinking was 72.80% in the cognitive learning results. It can be concluded that inquiry learning training can improve cognitive learning outcomes along with creative and critical thinking skill.

2.4.0 RESEARCHES IN THE AREA OF PROBLEM SOLVING

Productive thinking is a way of solving problem creatively and therefore it is also known as creative problem solving. Researcher reviewed total four studies in this area and reviewed studies are discussed as follows:

Jain (1982) made an effort to study the problem solving behavior in physics among certain groups of adolescent pupil. Total 180 pupils (90 boys and 90 girls) of class XI science group were randomly selected from higher secondary school of Ajmer city. Students were surveyed on following tools: 1. Raven's progressive matrices 2. The Baqer Mehdi verbal test of creativity 3. Four Piagetian task 4. Problem solving ability test 5. Academic achievement test in science conducted by school authority. The data highlighted following facts; 1. Piagetian tasks scores showed that out of 180 students only 65 were at formal level, 83 at post-concrete level and 32 were still at concrete level. 2. When we give hints along with problem it would make problem easy to solve. 3. It was also found that relation of problem solving and creativity is positive but not significant. It was concluded that level of cognitive development of the pupils of higher secondary school of Ajmer city was not satisfactory with respect to their chronological age.

Gill (1989) studied the effect of training strategies on creative problem solving skills and cerebral dominance in relation to intelligence, personality and cognitive style. Study was aimed to determine whether the training strategies effect creative problem solving skills (CPS) and cerebral dominance or not, to study if the intelligence, personality and cognitive style effect the CPS and cerebral dominance. Multi-stage random sampling was used to select 4 school randomly from Ludhiana city and 65 IX standard students were selected randomly from each school as the sample for the study. There were 2 experimental and two control group. One experimental group was taught using strategy to train right hemisphere and another by left hemisphere. The effectiveness of training was measured in terms of following test scores: achievement test to test CPS in mathematics, Torrance test for style of learning and thinking (1988), Hundal's general mental ability test, (1962), Eyesenk's maudsley personality inventory (1966), and group embedded figure test (1971). Data were analysed using ANOVA (2×2×2×2) and descriptive statistics. Findings shows superiority of right brain strategy to the left brain strategy for CPS skills in mathematics. Study also revealed the direct effect of intelligence on originality whereas other components were not affected by levels of intelligence. It was also summarized that introvert students performed better on originality in solving problem in mathematics than extroverts.

Kumari (1993) conducted study on creative problem solving ability with guided discovery method and result shows guided discovery method is useful in improving creative problem solving ability.

Thambi (2018) studied the effectiveness of an instructional strategy based on path-smoothing model on creative problem solving ability, perpetual speed and achievement in mathematics of students at secondary level. The objectives of the study are: 1. To analyze the present status of mathematics at secondary level. 2. To develop instructional strategy based on path-smoothing model. 3. To find out effectiveness of instructional strategy and activity oriented method on creative problem solving ability, perpetual speed and achievement in mathematics of students of secondary level. Researcher employed pre-test post-test non-equivalent control group design for the experimental study. Total 296 students (148 each in experimental and control group) of VIII standard of 4 different schools in Thissur district were selected using random sampling technique. Experimental group was taught through instructional strategy based on path-smoothing model where teacher split the lesson into small fraction to make it easy while control group was taught through activity oriented method. To collect the data researcher developed and standardized Creative Problem Solving Test (CPST), perpetual speed test and achievement

test. Pre and post test data was analyzed using ANOVA, ANCOVA and t-test. Findings suggested that instructional strategy based on path-smoothing model is better than the activity oriented method in terms of creative problem solving ability, perpetual speed and achievement in mathematics. It is also found that teaching through this strategy develops creative thinking power of the students and allows teachers to scaffold the students' progress.

1.5.0 RESEARCHES IN THE AREA OF HIGHER ORDER THINKING SKILLS

Productive thinking is a higher order thinking which combines analysis, synthesis and evaluation components. Researcher reviewed two studies in the area of higher order thinking and reviewed researches are discussed as follows:

Saido, Siraj, Nordin & Amedi (2015) surveyed higher order thinking skills among secondary school students in science learning. The main objective was to assess Higher Order Thinking Skill level of VII grade students of 2013-14 academic year. For this researcher selected 6 secondary school from Duhok city, Kurdistan conveniently and total 418 students were surveyed. Result shows 79.7% students of VII grade were at lower order thinking level and only 20.3% students were at higher order thinking level. It was also found that girl students are good at higher order thinking skills than boys.

Afifah & Retnawati (2019) studied difficulties faced by teachers in teaching higher order thinking skills in classroom. It was a descriptive exploratory research. Sample was comprised of 10 high school mathematics teachers from Yogyakarta, Indonesia. Investigator collected data from teachers using developed questionnaire. Study revealed total 6 difficulties faced by teachers: 1. Teachers has low knowledge about HOTS. 2. Teachers face difficulty in delivering apperception to students. 3. Teachers face difficulties in designing and applying assessment based on HOTS. 4. Teachers face difficulty in making and delivering HOTS based learning material. 5. Teachers face difficulty in preparing learning tools based on HOTS.

2.6.0 MAJOR OBSERVATIONS OF THE REVIEW OF RELATED LITERATURE

Thinking skills can never be separated from learning. It has its own place in teaching learning process which cannot be ignored. Learning with simply repetition of the facts is the result of reproductive thinking or retention without developing the transfer skills. The researchers tried to give emphasis on developing thinking skills by integrating it with content knowledge. This process has its roots in Bloom's taxonomy which gives learning objectives ranges from lower order thinking skills to the higher order thinking skills i.e. knowledge, comprehension,

application, analysis, synthesis and evaluation. Survey conducted at VII standard students revealed that 79.7% students are at lower order thinking level (Saido, Siraj, Nordin & Amedi, 2015). One of the reason of this is teachers' difficulty in teaching, assessing and designing Higher Order Thinking Skills (HOTS) based material (Afifah & Retnawati, 2019). Questioning is one of the techniques by which teachers can inculcate higher order thinking skills. Questioning techniques viz. Socratic questioning, verbal jigsaw, semantic tapestry and framing can be used effectively to stimulate students' productive thinking (Chin, 2008). Creative and productive thinking process in the classroom discourse can be categorized into five categories viz. cognitive memory, convergent thinking, divergent thinking, evaluative thinking and routine responses (Hutchinson, 1967). The study revealed the place of ideational fluency where criticism is not allowed and quantity precedes over quality in the process of developing productive thinking. Productive thinking programme developed by Covington, Crutchfield & Davies (1966) can be used to train the students. It considers creative thinking and problem solving as the component of productive thinking (Olton, 1969 and Schuler, 1974). The studies highlighted active involvement of teacher for success of productive thinking programme. It is better to develop thinking skills through the subject content rather than separately (Patel, 1984). The study helped to emerge the idea of integrated strategy where subject content is used to draw higher order thinking skills. Cognitive memory, divergent thinking, convergent thinking and evaluative thinking are involved in solving a problem creatively (Aranda, Lie & Guzey, 2019). It means a person needs to shift the thinking process between creative and critical thinking to solve a problem.

Higher order thinking skills can be developed through all the subjects and science provides tremendous opportunity to bring different thinking skills while teaching. There are six variables that predict achievement in science viz. verbal reasoning ability, numerical ability, comprehension and interpretation, problem solving, critical thinking and spatial ability. These variables are the part of learning in science (Nayar, 1971).

Studies conducted in the area of creative thinking investigators developed the programme or took some standardized programme to develop particular type of thinking. CoRT thinking programme developed by DeBono was found effective in developing creative thinking among students (Nathalal, 2002 and Kachhia, 1990) and SCAMPER was also found an effective techniques for developing creative potential (Gundogan, 2019 and Ozyaprak, 2016). Similarly, researchers used Synectic model to develop creative thinking where students used unusual analogies to draw their creative imagination (Paltasingh, 1998, Pandit, 2006 and Prashanth, 2006). Brainstorming is the technique where students get chance to work in the group and

develop creative thinking by shared idea and understanding and it was also found very effective in developing creative thinking in generic as well as in integrated manner (Patel, 1988, Raj, 2016, George, 2016, and Pandit, 2006).

To implement the creativity programme in the classroom teachers need to be active, energetic, democratic and able to create favorable classroom climate where criticism has no place (Rajagopalan, S., 1988 and Gupta, A. K., 1977). In many cases, teachers continuously show their preferences and regards towards characteristics like; discipline, good grades, hard work, spirit of cooperation and neglect self-expression, imaginativeness, flexibility of ideas and non-conformity in the students was also reported (Haleem, 1984). Reviewed studies highlighted the programmes to develop creative thinking among students and found it effective (Patel, 1987, Gupta, 1985, Vora & Gira, 1984, Shah, 1981, Amin, 1988, Hu, Wu, Jia, Yi, Duan, Meyer & Kaufman, 2013, Krishnan, 2011 and Pandit, 2006). All the studies help to establish a fact that if we create an enjoyable atmosphere in the classroom where teacher supports the students to draw their creative potential along with critical thinking at the correct place then it would be easy to develop productive learners in the classroom only.

Some of the researchers thought that intelligence as the prerequisite to be a creative and critical thinker (Kumari, 2014, Paltasingh, 1998 and Gupta, 1985) and others established that creativity is independent of intelligence (Brar, 1987 and Prashanth, 2006). It was also observed that creative thinking training also lead to better achievement (Passi, 1972 and Shah, 1981). Critical thinking involves abilities like inductive reasoning, analysis, inference, problem solving, evaluation, interpretation, self-regulation, open-mindedness, inquisitiveness, truth-seeking and explanation (Patel, 2011, Seeja, 2012, and Alghafri & Ismail, 2014). It is one of the 21st century skill and important component of achievement (Manjula, 2013, Siburian, Corebima & Saptasari, 2019 and Ramesh, 2015) but our students possess very low or average critical thinking skills and very negligible percentage of teachers used strategies to develop critical thinking skills in the classroom (Paily, 1999). To address this issue strategy based on Edward DeBono's CoRT thinking programme to develop critical thinking along with creativity found effective (Meghani, 1999 and Patel, 2010). It is well evident that technology support to enhance thinking skills as it provide way to explore upon the content (Manjula, 2013 and Joseph, 2018). Researchers also used inquiry learning training (Ramesh, 2015), active learning strategy (Seeja, 2012) and critical thinking programme (Patel, 2011) to train the students for critical thinking. Studies conducted in the area of critical thinking reflects that students need to have a knowledge foundation that provide criteria to analyze, evaluate, draw inference, make judgment and interpret. Studies conducted on creative problem solving shows involvement of creative and

critical thinking potential to solve a problem creatively is important (Jain, 1982, Gill, 1989, Kumari, 1993, and Thambi, 2018).

2.7.0 IMPLICATIONS OF THE REVIEW OF RELATED LITERATURE

Review of literature related to thinking skills was conducted to develop an insight about the development of productive thinking among elementary school students. Total 51 researches were reviewed and most of the researches were conducted on programme to develop productive thinking, critical thinking, creative thinking and creative problem solving skills. Reviewed researches have following implications for the present research:

- A good number of studies had been conducted in the area of creative thinking and critical thinking but there is lack of studies in the area of productive thinking particularly in India.
- Reviewed researches emerged the need of a strategy by which productive thinking can be developed through the shift in thinking at each step.
- There are very less number of studies where productive thinking is developed and assessed in an integrated manner.
- It was reflected in the researches that productive thinking has positive correlation with achievement of the students. So, programme or strategy should be developed that develop thinking skills along with achievement of the students.
- Teacher's role is very important in the process of development of thinking skills. Teachers need to be open-minded who always welcome multiple responses of a problem and encourage creativity.
- For the development of productive thinking it is very necessary to restrict criticism and give emphasis on ideational fluency at the stage of creativity.
- Critical thinking or evaluative thinking has its role in developing a clear understanding about the problem and improving the generated ideas on some criteria.
- A strategy that make a balance between all the components of productive thinking is required to train the students.
- Thinking skills can be taught in separated way or through the subject content as integrated strategy. Researches shows effectiveness of integrated strategy in developing thinking skills.
- Enjoyable environment and thinking programme help learners to improve thinking skills along with mastery of subject content. If students are trained in such a way then they will be benefited by it.

- Researches suggested use of quasi experimental design of experimental study for the better result.

Reviewed studies highlighted the importance of thinking skills and made it clear that thinking skills can be developed through various thinking training programmes. There were total 51 studies reviewed out of which 6 studies were conducted in the area of productive thinking, 39 studies were conducted in the area of critical thinking and creative thinking, 2 studies on higher order thinking skills and 4 on creative problem solving skills. But investigator come across very less number of studies on productive thinking and found no tool to measure productive thinking for elementary school students. Hence, this study will address the need of development of strategy for productive thinking in elementary education through science as the subject. For this, a tool will be developed through which effectiveness of strategy would be assessed.

2.8.0 CONCLUSION

Review of related literature help a researcher to develop an insight about chosen study. The present review helped the researcher a lot to develop an understanding about the existing level of thinking among students and various initiatives that has been taken in the form of researches to add on to the existing situation. The present review of related literature highlighted that thinking is the integral part of teaching-learning process but somehow it is restricted to lower order thinking ability only in the classroom. Present review highlighted that there are enough studies in the field of creative thinking and critical thinking but researcher could find very less number of studies in the area of productive thinking which has essence of both the thinking processes. Inculcation of productive thinking is important for our learners as it provide scope for 21st century learning skills and therefore, this lead to create foundation for the present study.