A COMPARATIVE STUDY OF THE EFFECTIVENESS OF THE SYNECTICS MODEL OF TEACHING AND TRADITIONAL TEACHING IN TERMS OF CREATIVITY, EMPATHY, HIGHER MENTAL ABILITY AND ACHIEVEMENT IN SCIENCE AT THE MIDDLE SCHOOL LEVEL

A SUMMARY SUBMITTED TO
DEVI AHILYA VISHWAVIDYALAYA, INDORE
FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY
IN EDUCATION
January - 2024

SUPERVISOR
Dr. Archana Dubey
Professor (Retd), DAVV, Indore

INVESTIGATOR
Ms. Rubi Mian

In case of any lacuna, kindly communicate through the following emails:
Dr Archana Dubey (Supervisor) dubeyarchana1806@gmail.com
Ms.Rubi Mian (Researcher) rubyhussain2012@gmail.com

TOPICS/CONTENT	PAGE NO.

1.0.0 INTRODUCTION

The present study entitled *'A Comparative Study of the Effectiveness of the Synectics Model of Teaching and Traditional Teaching in Terms of Creativity, Empathy, Higher Mental Ability and Achievement in Science at the Middle School Level'* is related to fostering Creativity, Empathy, Higher Mental Ability and ultimately achieving higher grades in science in the Middle School students. The teaching of Science requires a higher ability on the part of the teacher to make the lesson interesting in terms of developing interest, inquisitiveness, creativity, and ultimately achievement in Science. But if it is coupled with an uncontrolled imagination, free flow of thoughts, and emotional and irrational thinking, it would make the learning of science reach the core of the learner's mind.

Interestingly, Science and Mathematics are ranked nearly as high as traditionally creative subjects in contributing to creative thinking.

The state of the science teaching-learning process is of great concern in the present age. Despite making science a compulsory subject for the past four decades, India's contribution to the world of science is negligible. There are several reasons for the condition which goes without saying about the prevalent system, lack of governance, the availability of resources, the heaviness of the syllabus, the pressure on the teachers, the deadlines to be met, the CCE system introduced, the unprofessional attitude of teachers, the remunerations, lack of training and competency, lack of knowledge of different methods of teaching, the dominance of a particular method of teaching, easy method of completion of syllabus, the no-detention policy till grade VIII, the list is endless…..

Over the past two decades, it has been observed that there has been a remarkable shift of learners from science to other streams. It needs no other reflection than just an introspection on the part of the science educators as to

- Was justice done to all the topics that were transacted?
- Was the introduction of the topic practical and effective which could raise inquisitiveness in the minds of the students along with a desire to know further?
- Was there the required spark in the educator to ignite further and activate the class?
- Were the explanations limited only to the textual matter and its language?
- Were the students encouraged to question and given the freedom to answer as per their level of understanding?

- Was required feedback taken from the students after the transaction of the topic and were critical areas taken care of by proper remediation for the topic?

The critical state in science teaching will continue to be so if students are not led to a path that will break the old boundaries and give them the freedom to be irrational and emotional in their thoughts and expressions.

The present generation is exposed to a plethora of information. Electronic media has all the content that a learner requires. Better and simplified ways of imparting knowledge are at the tips of one's fingers. Competition to excel and aspirations are higher. The external agencies of education have all the claims on earth for the students to excel better and all convincing reasons for charging a huge amount as fees in lieu of promising dreams.

In a few years to come, it is required to reflect on, whether or not educators in different fields including those in Science will be required in Schools. Would human educators be able to compete and secure their positions in comparison with the ever-modifying and highly effective Artificial Intelligence?

It is required that educators hone and modify their abilities to match the demands of the ever-evolving students and develop creative individuals who exhibit originality, flexibility, fluency, and elaboration in ideas.

1.2.0 SYNECTICS MODEL OF TEACHING

The name 'Synectics' comes from the Greek word, '*Synectikos'*, which means 'the joining together of different and apparently irrelevant elements.'

Synectics is an approach to creative thinking that depends on understanding together that which is apparently different. Its main tool is analogy or metaphor. The approach, often used by groups, can help students develop creative responses to problem-solving, retain new information, assist in generating writing, and explore social and disciplinary problems. This method was developed by George M. Prince and William J.J. Gordon, in 1961.

According to Gordon, Synectics research has three main assumptions:

Assumption - I: The creative process can be described and taught

Assumption - II: Invention processes in arts and sciences are analogous and are driven by the same 'Psychic' processes.

Assumption - III: Individual and group creativity are analogous.

With these assumptions in mind, Synectics believes that people can be better at being creative if they understand how creativity works. One important element in creativity is embracing the seemingly irrelevant. Emotion is emphasized over intellect and the irrational over the rational. By understanding the emotional and irrational elements of a problem or idea, a group can be more successful at solving a problem. Synectics is more demanding of the subject than brainstorming, as the steps involved imply that the process is more complicated and requires more time and effort. The success of the Synectics methodology depends highly on the skill of a trained facilitator. Synectics is an active, creative process of creating meaning through metaphorical activity.

This model of teaching generally consists of two approaches:

- ***Strategy-I: Making Familiar Strange (MFS)- Learner oriented***

and

- ***Strategy-II: Making Strange Familiar (MSF)- Instructor oriented.***

1.3.0 STEPS IN APPROACHES TO THE SYNECTICS MODEL OF TEACHING:

Strategy 1: ***Making Familiar Strange (MFS)- Learner-oriented*** (Create Something New)

1. ***Description of Present Condition***
   Students describe a situation or topic as they see it.
2. ***Direct Analogy***
   Students suggest direct analogies, choose one and describe it in detail.
3. ***Personal Analogy***
   Students try on the direct analogy; they become the thing.
4. ***Compressed Conflict***
   Students use descriptions from phases 2 and 3 to create compressed conflicts and choose one.

5. ***Direct Analogy***

   Students create a new direct analogy based on the compressed conflict.

6. ***Re-examine Original Task***

   Students use the new analogy to re-examine the original situation or problem.

Strategy 2: ***Making Strange Familiar (MSF)- Instructor-oriented.***

1. ***Substantive input***

   The teacher presents information for a new topic or subject matter.

2. ***Direct Analogy***

   The teacher suggests a direct analogy and the students describe it.

3. ***Personal Analogy***

   The teacher directs the student to become a direct analogy.

4. ***Comparing Analogy***

   Students describe the similarities between the analogy and the new topic.

5. ***Explaining Differences***

   Students explain how the analogy does not fit the new topic.

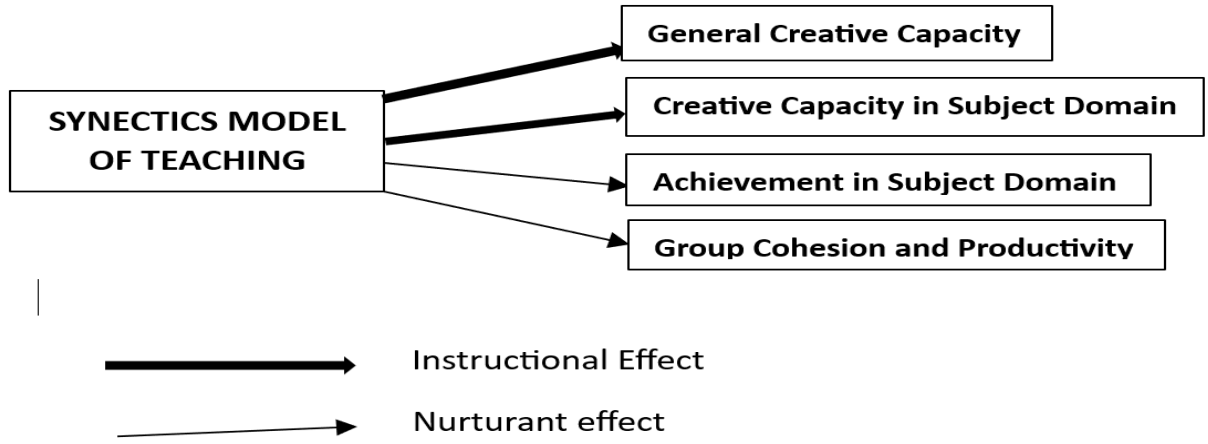
6. ***Exploration***

   Students re-explore the original topic on its original terms, free from analogy.

7. ***Generating Analogy***

   Students create their direct analogy and describe the similarities and differences with the topic. They feel free to recombine things in new and different ways, even if those combinations seem silly or even wrong.

1.4.0 INSTRUCTIONAL AND NURTURANT EFFECTS OF SYNECTICS MODEL OF TEACHING

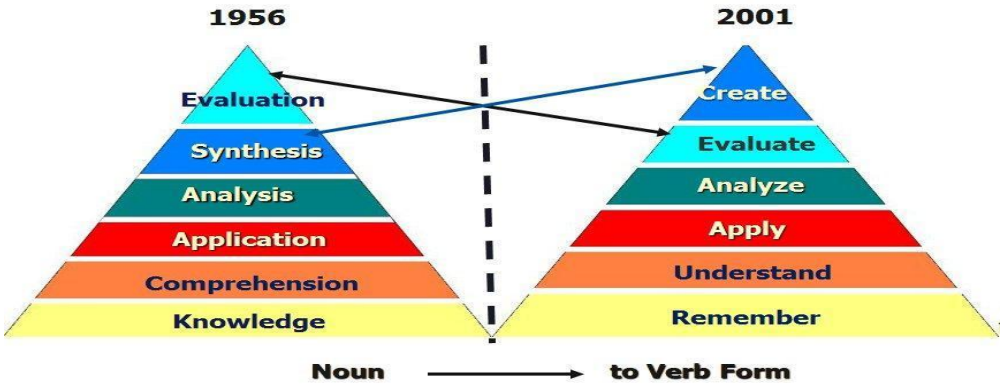


The model helps the students learn the art of creating a product

The process involves

- Brainstorming
- Thinking out of the box
- Creative thinking
- Using metaphors and analogies to promote creativity
- Turning logical into illogical and illogical to logical'

The revised Bloom's taxonomy has the evaluation replaced by Creativity.



Instructional effects are the direct effects of the model of teaching. These effects are directly achieved by guiding the learner in a planned direction. These effects can be seen as those for which the model was specifically designed to achieve. These effects can be cognitive or affective outcomes. Nurturant effects are indirect effects. They are those effects that come from experiencing the environment created by the model.

Synectics can be used:

i. in the classroom, as a creative learning technique that can be used with other models and a wide variety of subjects.

ii. in business as a tool for brainstorming, idea generation, and problem-solving.

1.5.0 BENEFITS OF USING THE SYNECTICS MODEL OF TEACHING

- Works well with all ages.
- Works well with diverse groups.
- Participants share different backgrounds.
- Creates fun, energizing, and bonding experiences.
- Enhances the ability to apply knowledge.
- Learners discover what they already know.
- Fosters new ideas.
- Learners internalize the abstract concept.
- Helps to overcome mental blocks.
- Promotes free thinking.
- Increases understanding of the subject.
- Enhances divergent thinking and problem-solving skills.
- Applicable, functional, and workable in Indian settings.
- Increases pupil's tendency to combine things in new ways and to see relatedness among divergent stimuli
- Adopts a playful attitude – thus "Suspending Judgment".
- Breaks the monotony of conventional classroom teaching.
- Democratic and Interactive in approach.
- Suits to explore individual differences.
- Encourages most timid participants also.
- Universal learning experiences can be applied. ,

- Emphasizes both processes of skills and knowledge of the content.
- Instructional and nurturing effects match the objectives of the study.

The Synectics process involves “Play of fancy” which is a better motivating strategy for a teacher. It is based on a set of three assumptions about the psychology of Creativity. They are:

1. By bringing the creative process to consciousness and by developing explicit aids to Creativity, one can directly increase the creative capacity of individuals and groups.
2. The emotional component is more important than the intellectual, and the irrational is more important than the rational. (Gordon, 1961).
3. “Emotional, irrational elements must be understood to increase the probability of success in a problem-solving situation”.

In addition, the “Personal Analogy” phase in the Synectics process requires the participant to lose himself thus transporting himself into another space or object. It gives a great chance to maintain a greater conceptual distance from the concept to the analogy.

It imbibes the participant so close to the analogy that he involves himself in

1. First-person description of facts.

2. First-person identification with emotion.

3. Empathetic identification with a living thing, and

4. Empathetic identification with a non-living thing.

One of the key differences between the Synectics model and the traditional teaching method is the focus on open-ended, non-linear thinking. In traditional methods, the focus is often on rote learning and the memorization of information, whereas in the Synectics model, the students are encouraged to explore multiple perspectives and make connections between seemingly disparate ideas.

1.6.0 CREATIVITY:

“Perhaps the most astonishing thing about creative thinking is that creative thinkers can tell us so little about it”- Mary Henle (1962)

An individual endowed with the ability to envisage a rich and varied set of schemes, images, concepts, and rules is usually considered to be intelligent, whereas the person who uses these units not only originally but also constructively is considered to be creative.

A creative idea comes from a previous set of explanations and solutions to a problem. That is, it never occurs on its own or without being closely related to previous solutions.

Creativity was believed to be a gift of God long to be found in highly talented people and geniuses. Therefore the view that very intelligent or very superior people would also be creative was held. Creativity was regarded as a rare quality. The relationship between creativity and intelligence is neither linear nor curvilinear. Creativity is distinguished by novelty, and originality and is unusually inventive. The more important feature of recent research is that creativity is not an extraordinary gift, but a basic ability of all human beings. All persons to a certain extent are potentially creative.

1.7.0 EMPATHY: The word empathy is derived from the ancient Greek word *'empatheia'* meaning physical affection or passion. It is the capacity to understand or feel what another being (a human or non-human animal) is experiencing from within the other being's frame of reference, i.e., the capacity to place oneself in another's position. There are many definitions of empathy that encompass a broad range of emotional states. In the development of human empathy, individual differences appear, ranging from no apparent empathic ability, or empathy that is harmful to self or others, to well-balanced empathy, including the ability to distinguish between self and others. Various theories and aspects of empathy have been researched, including empathy within non-human animals. Types of empathy include cognitive empathy, emotional empathy, and compassionate empathy.

The Synectics model of teaching helps in the integration of empathy in middle school students as

- It encourages the students to consider multiple perspectives while identifying a problem and generating ideas. This helps the students to understand different viewpoints and develop empathy for others.
- It encourages the students to connect the problem they work on to real-world issues and challenges that affect people's lives. This helps them to develop a sense of empathy by understanding the impact their solutions can have on others.

- After implementing the solutions it facilitates reflective discussions where the students share their experiences and insights It encourages the students to consider the emotional and social implications of their solutions and fosters empathy and a deeper understanding of the human aspect involved.

1.8.0 HIGHER MENTAL ABILITY:

Higher mental ability refers to a set of cognitive skills and capacities that go beyond basic intelligence or general mental functioning. It encompasses advanced cognitive processes and skills that involve complex thinking, problem-solving, reasoning and abstract reasoning. Higher mental ability is often associated with higher-order cognitive functions, such as critical thinking, creativity, logical reasoning, conceptual understanding, and the ability to analyze and synthesize information. It involves the capacity to think flexibly, make connections between different ideas, evaluate evidence, and generate novel and innovative solutions to problems.

Higher mental ability plays a significant role in the development and success of middle school students. Here are some key reasons why higher mental ability is significant at this stage:

1. Advanced Learning: Middle school is a time when students are exposed to more complex and abstract concepts across various subjects. The Higher Mental Ability allows students to engage with these advanced learning materials, grasp abstract concepts, and think critically about them. It enables students to understand and apply complex ideas across different disciplines.
2. Problem-Solving Skills: Middle school students with higher mental ability tend to possess strong problem-solving skills. They can analyze problems, break them down into manageable parts, and generate creative and innovative solutions. These skills are valuable in academic settings as well as in real-life situations, preparing students for future challenges.
3. Critical Thinking: Higher mental ability fosters critical thinking skills in middle school students. They can evaluate information, consider multiple perspectives, and make

informed judgments. Critical thinking enables students to question assumptions, think independently, and develop a deeper understanding of the subjects they study.

4. Academic Success: Students with higher mental ability often experience greater academic success in middle school. They can comprehend and assimilate complex material more effectively, resulting in higher grades and academic achievements. Their ability to think critically and solve problems enhances their performance in examinations and assessments.
5. Preparation for High School and Beyond: Middle school serves as a transitional period preparing students for the challenges of high school and beyond. Higher mental ability equips students with the cognitive skills necessary for advanced coursework, critical analysis, and independent research. It provides a foundation for future academic pursuits and career development.
6. Personal Growth: Higher mental ability contributes to the personal growth of middle school students. It encourages intellectual curiosity, a thirst for knowledge, and a love of learning. Students with higher mental ability often exhibit greater motivation, self-confidence, and resilience in their academic endeavours.
7. Future Opportunities: Developing higher mental ability during middle school can lead to broader opportunities in the future. Students who demonstrate strong cognitive abilities and critical thinking skills may gain access to advanced placement courses, honours programs, and scholarships in high school and college. These opportunities can shape their educational trajectory and open doors to a wide range of future career options.

Overall, higher mental ability in middle school students is significant as it enhances their learning experience, promotes academic success, nurtures critical thinking skills, and prepares them for future challenges and opportunities.

1.9.0. ACHIEVEMENT IN SCIENCE: It is an outcome of knowledge, understanding, and process skills in a Science subject. It can be represented in the form of test scores.

Academic achievement refers to the measurable outcomes and accomplishments attained by students in their academic pursuits. It encompasses various indicators of success in educational settings, such as grades, test scores, awards, honours, and recognition.

Academic achievement is typically assessed concerning specific subjects or disciplines, including mathematics, science, language arts, social studies, and others. It can also extend to broader aspects of learning, such as critical thinking skills, problem-solving abilities, research capabilities, and effective communication.

The concept of academic achievement varies across different educational systems and institutions. In some contexts, it may be based on a standardized grading system, while in others, it could involve qualitative evaluations or the demonstration of specific competencies. Ultimately, academic achievement reflects a student's mastery of knowledge, skills, and competencies relevant to their educational level and field of study.

It's worth noting that academic achievement is not the sole determinant of a student's overall potential or intelligence. Different individuals may have different strengths and abilities that may not always be captured by traditional measures of academic achievement. Nonetheless, academic achievement plays a significant role in assessing a student's progress and serves as an important benchmark for educational advancement and opportunities.

1.10.0 KEY TERMS RELATED TO THE SYNECTICS MODEL OF TEACHING:

There are various terms related to the Synectics Model of Teaching. These terms are described below one by one:

Model of Teaching: It is a systematic plan, based upon well-defined principles. It follows the definite steps which are used by the teacher to create certain effects on the part of the learners.

Traditional Method of Teaching: It is a teacher-centric method that promotes the supremacy of the teacher within the classroom setup.

Synectics: Synectics is a problem-solving methodology that stimulates thought processes of which the subject may be unaware. Synectics is a creative way to learn new information or solve complex problems.

Instructional effects: Instructional effects are the direct effects achieved by the teacher leading to learners in a certain direction or the abilities that a teacher wants to develop among learners intentionally.

Nurturant effects: Nurturant effects are the effects that are not the intention of the teacher. These are side effects of the process and environment.

Creativity: Creativity is considered the capacity to put into effective innovations through the establishment of new connections, and the recombination of existing ones for the adoption of original means and methods.

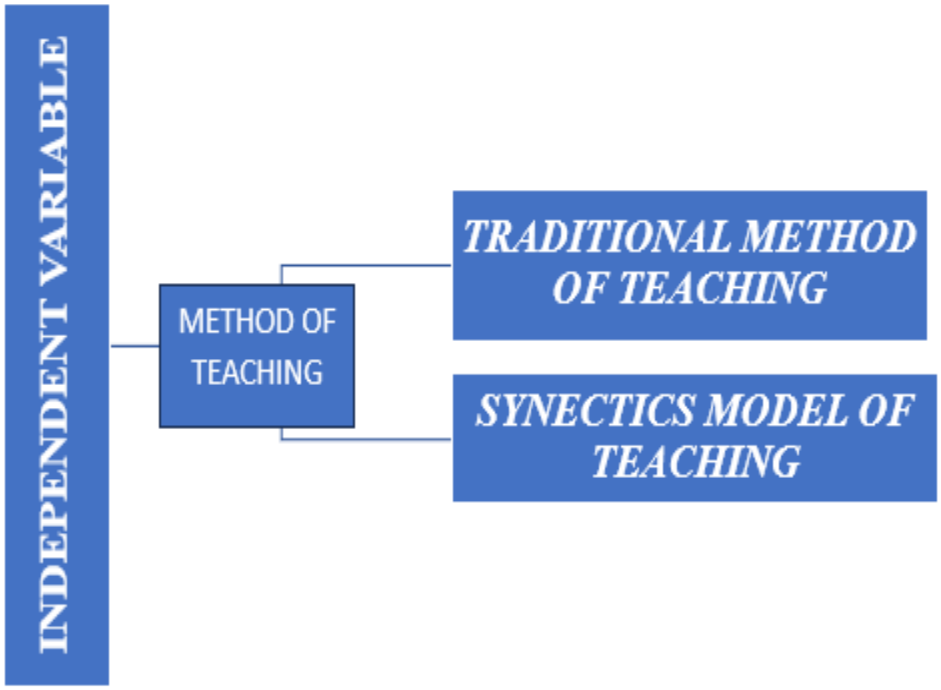
Academic Achievement: It is an achievement in the form of marks obtained in the test of a subject domain, especially after a lot of effort.

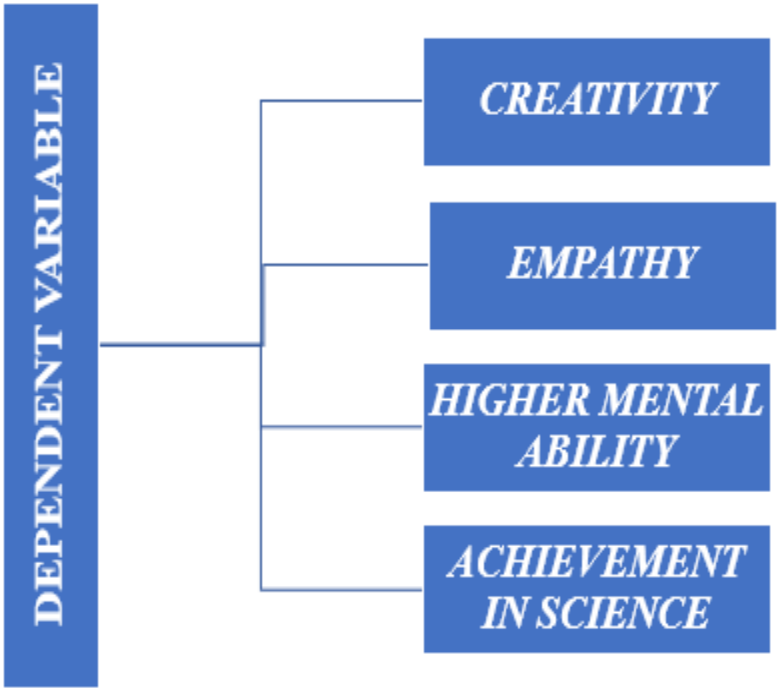
S.No.	Variable	Indicators
1.	Creativity	i. Ability to generate multiple ideas
		ii. Willingness to take risks and think out of the box
		iii. Originality and Uniqueness of ideas
		iv. Fluency in ideation and brainstorming
		v. Ability to make connections between concepts
2.	Empathy	i. Demonstrating understanding of others' emotions
		ii. Active listening and showing empathy in interactions
		iii. Considering multiple perspectives and viewpoints
		iv. Showing compassion and kindness towards others
		v. Ability to put oneself in others' shoes

3.	Higher Mental Ability	i. Critical thinking and problem-solving skills
		ii. Analytical reasoning and logical thinking
		iii. Ability to apply knowledge in new situations
		iv. Capacities for abstract thinking and conceptualisation
		v. Flexibility in adapting to new information
4.	Achievement in science	i. Understanding scientific concepts and principles
		ii. Applying scientific knowledge to solve problems
		iii. Conducting experiments and making observations
		iv. Analyzing data and drawing conclusions
		v. Communicating scientific ideas effectively

Each indicator requires specific assessment methods or tools to measure it accurately.

Dependent and Independent Variables of the Study





2.1.0 REVIEW OF RELATED LITERATURE

This section of research work deals with the review of related literature on the following areas:

2.2.0 STUDIES RELATED TO THE SYNECTICS MODEL OF TEACHING

Martis (1990) studied the impact of the Synectics model of teaching on 'Making Strange Familiar' (MSF) competencies and creativity in graduate student teachers. The findings indicated that MSF training, incorporating theory. discussion. demonstration. and practice, successfully enhanced desired competencies and received positive feedback from people and high school students. Additionally, the training significantly improved verbal, non verbal, and scientific flexibility, fostering increased creativity in school students. The study suggested minor adjustments to the MSF approach in response to classroom dynamics.

Kawenski (1991) in "Encouraging Creativity Design" described a six-week course for design students called "Needs Awareness and Design" which stressed the development of creative thinking skills, Problem-solving, and Creativity.

Alencar (1993): in 'Thinking in the Future: The Need to Promote Creativity in the Educational Context' suggests the use of Synectics as a classroom exercise to produce a new idea combination.

Talwar and Sheela (1994): conducted a study on the Synectics model of teaching. To them, education is one of the potent instruments for the development of Creativity and Problem-solving ability.

Anandi and Irene (1996) undertook a study to prepare instructional materials based on the Synectics model of teaching for developing Creativity. The developed instructional materials were found to be effective in increasing fluency and flexibility scores and not effective on originality scores i.e., of verbal creative thinking. The worksheets of pupils were very useful for the systematic presentation of matter and for evaluation. Further stretching exercises are a must for the Synectics approach.

Likhia (1998) studied the effectiveness of the "Making Strange Familiar strategy" of Synectics on Scientific Creativity in a sample of 80 IX-grade students. The tools used are

the Verbal test of Scientific Creativity by Sharma and Shukla. The results have shown that the experimental group had significantly higher scores on Scientific Creativity as compared to the control group.

Sheela (2000) studied the effectiveness of the Synectics model of teaching science on Creativity and Problem-solving ability of Class IX English medium students in 30 pairs of parallel experimental and control students. The tools were Raven's Progressive Matrices, a Test of Higher Mental Ability in Science by Sansanwal, Mehdi's verbal test of creative thinking, and the investigator's Problem-Solving Ability test. Two-way ANOVA and 't–test' revealed that the Synectics model of teaching Science is more effective than the Conventional method of teaching in developing components of Creativity and Composite Creativity as a whole and so is Problem-solving ability, are effective at all levels and for both sexes due to Synectics model of teaching.

Arkasali (2004): conducted a study on the effectiveness of the Synectics model of teaching in terms of instructional and nurturant effects and found out the Synectics model of teaching (Strategy-I and Strategy-II) got instructional and nurturant effects in General Creativity in Kannada language and essay/paragraph writing in the Kannada language. The Synectics model of teaching was also found effective in Kannada Language Creativity writing in story construction, poetic diction, descriptive style, and vocabulary tests amongst secondary school students.

Bincy(2010) and Meera (2008) showed that the Synectics model was effective in promoting Creativity

Madahi and Khalatbari (2010): Compared the effectiveness of the three methods of Brainstorming, Synectics, and Deductive methods on increasing creative thought in female students. There is such a difference that compared with the Synectics model of teaching, Brainstorming has a greater effect on students' Creativity, and the former, in turn, proves this variable much more effective than the Deductive method.

Sadathoseini and Memarian (2010): The Effect of Employing the Synectic Model in Teaching Palliative Care in Children on Nursing Students' Writing Creativity and Academic Performance. With regard to the results of this study, employing the Synectic method enhances the academic performance and writing Creativity of nursing students regarding children's Palliative Care.

Sudhakar (2011): conducted a study on the effect of the Synectics model of teaching on the development of language creativity in Hindi amongst the students of Hindi B.Ed. colleges found out that language creativity is enhanced when the students are exposed to the Synectics model of teaching. Not only language creativity but also proved its effectiveness' on general creativity. All the above studies showed that the Synectics model is effective in language creativity and its success brings more classroom activities to produce new ideas, new combinations, etc.

Kaplan and Ercan (2011): conducted a sample study on Synectics activities from creative thinking methods: creativity from the perspective of children. It was seen that the students began to see creativity differently and to perceive it as a process at the end of the Synectics applications, rather than just an activity aiming at the creation of an original product.

2.3.0 STUDIES RELATED TO SYNECTICS MODEL OF TEACHING AND ANALOGIES IN LEARNING

Clement (1987): studied the spontaneous use of analogies systematically. He investigated how novices and experts employ analogies when solving physics problems. The main findings are that both novices and experts frequently make spontaneous use of analogies or at least comparisons. The studies, therefore, reconfirm that analogies are common tools for explaining and trying to make sense of the unknown.

Black and Solomon (1987): investigated students' use of analogies for electrical current. They found that the analogies presented helped students to learn. They interpreted this finding from a constructive view; analogies were helpful because they allowed the students to construct their knowledge by forcing them to view the new knowledge within the framework of the analogy.

Serge and Giani (1987): summarized their findings on analogical reasoning about transport processes in the following way: "Our students are almost unable to employ analogical reasoning to solve similar problems regarding different phenomenologies in the field of transport processes". They thought the lack of their student's ability to "formalize" was responsible for their negative results. They stated that attempts to use analogies in

learning situations did not work because the learners were not able to "see" an analogy. Research on students' conceptions supports these findings in so far as areas that are seen as obviously similar by the teacher (or scientist) are viewed as being fundamentally different by many students.

Sutala and Krajicik's (1988): study points in a similar direction. They found that students with high cognitive abilities benefited more from creating their analogical connections, whereas students with low abilities benefited more from having the teacher help them make the analogical connections.

Tierney (1988): observed four Social studies teachers for 20 lessons. He focused on "small scale" comparisons (use of analogies, metaphors, and similes) as examples, or reinforcements of verbal or written explanations of content used in history lessons. Such comparisons were often employed but mostly in a limited manner: "Like comedians, these teachers went with what worked. It was clear that simply telling the story of history was insufficient. Seldom did the teachers stop to check specifically that students understood the metaphors used". Very much like analogies used by authors in textbooks, the teachers observed by Tierney (1988) appeared to pre-suppose that students were familiar with the analogy domain and would use the metaphors, analogies, or similes without any guidance.

Glynn et al (1989): stated that guidance toward the effective use of analogies was not explicitly given in the introduction of textbooks.

Steven (1989): has written teaching materials for two high school biology units with extensive analogies, similes, and metaphors. Their effect on learning and attitude was assessed by comparison to students using a literal version of the same test. Little was found to support the contention that the use of these systems increases students' achievement, and there was some indication that they may have a negative effect on the student's attitudes.

Glynn et al (1989): examined the use of analogies in an analysis of 43 elementary, high school, and college science textbooks. The analysis was interpretive i.e. it was not based on formally developed categories. Glynn et al. have found many simple analogies such as "Mitochondria are the powerhouse of a cell" in textbooks. Elaborate analogies, which were a paragraph or even a page long, were relatively rare. High school Physics and Physical science books appeared to contain the largest number of such elaborate analogies the frequency of V in the Physics and Physical science textbooks varied between relatively

extensive and little use. There is another interesting observation. Although it was common in the introduction to provide the reader with hints as to how to use the textbooks effectively (e.g. hints about advance organizers) no mention of analogies was found there – not even in the textbooks in which excellent use of analogies was made.

Dupin and Johsna (1989): conducted a study in which VI, VII, and X-grade students were instructed about electricity over a period of 20, 24, and 34 hours respectively. The teachers first discussed students' perceptions, and then they presented a mechanical analogy about a continuous train that moves without an engine and with identical cars pushed at a station by people. The teacher asked the students to find the corresponding elements in the closed circuits, thus emphasizing the conceptual aspect of analogical mapping. The results indicated a clear difference between the Experimental and Control groups after instruction and underscored the advantage of sequencing the analogies to reduce the limitation that arises from using the classic water analogy. The authors concluded that the analogies do contribute to the Experimental groups' improved performance despite the confounding factor of time.

Tobin (1990): suggested that metaphors might be used as "Master Switches" to change belief sets and teaching practices.

In a study by Treagust et al. (1990), limited use of analogy is also reported. Forty lessons by eight science teachers were observed. The study was carried out within an interpretive research framework (Erickson, 1986). Field notes of lessons and an interview with every teacher at the end of the observation period formed the basis of interpretation. The use of analogies based on structural relationships (rather than surface similarities) was the focus of the study. The teachers in this study seldom used such analogies in their teaching (in the 40 lessons observed, only eight of them were detected) and tended not to use them elaborately even when such analogies were present in the textbooks used by the class. This finding seemingly contradicts the results of the interview, which revealed that most teachers were very aware of both the benefits and limitations of analogies. However, the teachers in the study seemed not to have a repertoire of good analogies and were not confident concerning the effective use of analogies. Where the broader context of analogy use within a constructivist learning perspective is concerned, the study points out that the

teachers mainly held traditional views of the learning process. Accordingly, analogy use, if it occurred, was not based on a constructivist approach to learning.

David (1993): in his research study asked the participants to create, apply and modify their analogies as opposed to applying a specific analogy provided by an outsider – as a heuristic for constructing, evaluating, and modifying their explanations for a given scientific phenomenon. Non-trivial changes in explanation facilitated by the use of generative analogies were observed. Changes in understanding ranged from the emergence of new explanations to the raising of important questions about the nature of the phenomenon. The study has concluded that the use of self-generated analogies may facilitate conceptual growth through several time-honoured principles of effective instruction. Constructing one's analogy serves to – 1. Make new situations familiar, 2. Represent the problem in the particulars of the individual's prior knowledge and 3. Stimulate abstract thinking about underlying structures or patterns. Further, when students were allowed to work with their analogies, three important educational outcomes were served. They are, Firstly students are provided with a rare opportunity to problem-find, as opposed to simply problem-solving. Secondly, questions emerging from the specifics of the learner's prior knowledge are likely to be more interesting, non-trivial, and personally relevant to the learner, and thirdly individuals can come to identify, confront and work through their prior conceptions with minimal guidance from an outsider, such as a teacher.

Stephen (1994): in his study "Metaphor as a Tool for Constructivist Science Teaching" reports how one experienced general science teacher used the metaphor tool during the implementation of Constructivist approaches in both Biology and Physics topics. The Constructivist classroom is characterized as a learning place where students are encouraged to take responsibility for their learning as they take on the role of an explorer. The study has shown that the metaphor tool is effective when compared with other models and involves an economical commitment of time and resources. Because teachers are busy professionals, they are likely to get the advantage.

David (1994): in his study "Facilitating conceptual change using analogies and explanatory models" with forty high school students, he indicated the table would not exert an upward force interacted with a written bridging explanation. Students responded in writing to questions embedded throughout the explanation. Analyses of these written responses

supported the following hypotheses raised in earlier interviewing studies: 1. Analogies that might seem appropriate to the scientists may not appear so to the students, who would thus reject the analogy relation, 2. In such cases bridging analogies may be necessary to establish analogical relationships and 3. These analogies may need to help students construct an explanatory model to aid learning (The model of a table as springy on a microscopic scale). This previously unrecognized microscopic springiness can help the student make sense of the idea that the solid table can exert an upward force by helping the student focus on previously hidden mechanisms operating in the target situation.

Zoubeida (1995): in his study examined teachers' analogies in context and highlighted some of their special characteristics. The purpose of this analysis was to increase our understanding of how analogies operate in naturalistic instructional settings and to generate new research questions about science teaching and learning given the broader dimensions of the curriculum. The findings of the study are 1. Teachers' analogies represent windows into their values, concerns, pedagogic content knowledge, and skill in engaging their students. 2. Teachers show sensitivity in their analogies to students' knowledge frames. The source domains selected include actual life experience, observed life experience, science fiction, personalized stories, and common objects. 3. Teachers used analogies mainly in an explanatory or descriptive capacity, but never in an evaluative one. Finally, it is concluded that the recognition that analogies take on a life of their own in the minds of students requires teachers to be careful about the context and level of detail used about students' knowledge, and requires researchers to redress their questions in a way that enables them to capture the creative elements that go into the restructuring of concepts and conceptual schemes in and about science.

2.4.0 STUDIES RELATED TO SYNECTICS MODEL OF TEACHING AND CREATIVITY

Dhalla (1990): tried to profile Creative children in the area of Psychology and Education. She also attempted to find some commonalities among creative children. Five (Two VII and Three VIII) students of National public schools formed the sample of the study. The tools used were Verbal test of Creative Thinking by Baquer Mehdi, ravens Progressive matrices Test, Attitude Scale towards school, home, and self, Attitude of parents towards children and teacher perception. The major findings of the study revealed that 1. The creative children were: a. above the 90^{th} percentile in "Originality" and at 99th percentile in

"Elaboration", b. high in "Intellectual Capacity" and c. "Fluent" and "High Achievers". 2. Creative individuals did not have good reading habits. 3. Creative individuals were confident about their future aspirations. 4. Usually the children did not have leadership qualities but possessed some special talents. 5. They did not perceive themselves as popular in the classroom but as happy about the world around them. 6. They had a highly positive Self-concept and were very optimistic about life. 7. Parents of creative children had a democratic style of parenting and 8. They were quick, attentive and disciplined.

Goel and Tanuja (1990) attempted to study the impact of Institutional Locale and sex on the development of Creativity components among 300 Rural and urban junior higher secondary students. The tools used were Verbal Test of Creative Thinking by Mehdi. The major findings of the study are 1. A significant developmental change in the mean creativity scores was perceptible among teachers of Classes VI to VIII but the change between classes VI and VIII was only marginal and insignificant. 2. Females were significantly superior to males in creativity. 3. Developmental differences in creativity existed between the urban students of Class VI and VII; VI and VIII as well as their counterparts in rural areas.

Afsan (1991): studied to find out the Vocational interests and creativity of 410 rural gifted girl students and 425 urban gifted girl students of class IX from different higher secondary schools of Srinagar and Baramulla districts. The tools used included the Information Blank sheet, Non-language preference schedule by Chatterji, Verbal test of Creative Thinking by Baquer Mehdi, and Standard Progressive Matrices Test by Raven. The findings of the study revealed - 1. Rural and Urban girls showed no characteristic difference in parental education and occupation. 2. Rural gifted girls in comparison to urban gifted girls were found to be higher in Creativity, but the difference between the mean scores couldn't reach any level of significance. No significant difference was found between the two groups on the components of Creativity viz. Fluency, Flexibility and Originality. 3. The Vocational Interests of Rural gifted girls and urban gifted girls were more or less similar when compared to one – to – one basis.

Gujarathi (1992): dealt with the identification and development of Scientific creativity in sixty students at the school level to enable them to face the challenges and problems of the 21st Century. The tools used were Majumdar's Scientific Creativity test (part I and II), the

Scientific Creativity test developed by the researcher and the Standard Progressive Matrices test by Raven. The findings of the study reveal that 1. On the Scientific creativity test, the experimental group received higher "Z" scores than expected. The results were highly significant. 2. On results for the researcher's Scientific Creativity Test, as the experimental "Z" scores were much higher than the table value of "Z" on all the four scores of creative abilities the results were highly significant. 3. The main objective of preparing an integrated training program in scientific creativity was achieved. 4. The test in Scientific creativity constructed by the researcher was reliable and valid for measuring the effectiveness of the training program. 5. The gain in the tests of Scientific creativity by the experimental group was highly significant.

Kumari and Usha (1993): studied the effect of CORT treatment on the Creative thinking and Problem-solving of ninth-class students. The students were exposed to tasks and problems and were encouraged to produce a large number of creative solutions. The results of her study supported the hypotheses regarding the use of guided discovery methods and educational materials.

Sharma (1994): conducted an experimental study by organizing activities like brainstorming, problem-solving, quizzes, and project work in a science teaching class. She found that the students of the experimental group showed significant gains in verbal fluency, verbal flexibility, verbal originality, and non-verbal creative thinking.

Mehrotra and Sushma (1995): studied the application of specific imagery exercises among Grade IV children from diverse Socio-economic statuses and measured their effect on creativity. The study was carried out on 374 students. Imagery exercises, of three types namely – Divergent-Thinking – Processing - Imagery exercises (DTPIE), Synthesis – Destructuring – Imagination – Imagery Exercises (SDIIE), and both DTPIE and SDIIE combined are found to have a positive influence on creativity. Further, they have allowed the expression of latent thoughts, imaginations, and emotions without any pressure or demand.

Bawa and Parvinder (1995): have studied the relationship between creativity and academic achievement. Their sample contained 600 class X students. Their findings revealed a significant positive correlation between all four measures of creativity and

achievement in all the school subjects except social studies. Achievement in languages tended to be better related to creative thinking than in Social studies and General science.

Gulati and Sushma (1995): conducted a study to analyze how instructional materials helped children's creativity in the classroom and its effectiveness in fostering creativity. The sample comprised of students of class V. Alternate uses the test of Guilford, Parallel lines of Torrance and Unusual uses and circle of Torrance and a questionnaire were the tools used. The collected data were treated with mean, SD, and t-ratio. It was found that the differences between the mean scores of the pretest and the posttest were consistently significant both in the case of flexibility and originality.

Gulati and Sushma (1997): in their study titled "Understanding Creativity – Psychometricetric View" attempted to analyze the nature of the abilities which have been used very often as measures of creativity in terms of their relationship with intelligence (Gf and Gc), personality – temperament and motivation measures. Treating all the variables within the same theoretical frame, the main objectives of the study were to ascertain and compare the proportion of variances attributable to fluid intelligence, crystallized intelligence, personality and motivation to both verbal and figural creativity and study their underlying factorial structure. The sample comprised 400 girl students of class XI and the tool administered was the Torrance Test of Creative Thinking (TTCT) with words form – A, TTCT – with pictures form – A; Cattle's Culture Fair Intelligence Test Scale-2 form – A; Hundal's General Mental Ability test; High school Personality Questionnaire and 4F or 16 PF Questionnaire (16PF) and School motivation Analysis Test. The data with a score of 43 variables has yielded the following results: - 1. There is a significant positive but low relationship between the measures of Creativity and Intelligence. 2. Verbal creativity measures are contributed to more by Gc while figural measures are attributed to more by Gf, but there is not much difference between the variances of both Gf and Gc in figural Creativity measures except elaboration. 3. Creativity and Intelligence constitute distinct factors relatively independent of each other. 4. Verbal and Figural creativity measures synthesize into separate factors indicating creativity is multifactor in nature. 5. Verbal creativity measures involve to a lesser extent the variance of personality – temperament than motivation measures while figural creativity measures are affected more by variations due to motivation measures. 6. The overall relative efficacy of fluid and crystallized

intelligence, personality, and motivation measures varies with the two types of creativity. Verbal creativity measures relate more closely to the measures of intelligence particularly Gc while figural creativity measures relate more closely to the measures of personality – temperament traits.

Pachaury (1997): aimed at uncovering the perceptions of Indian scientists regarding creative students. The study focussed on the characteristics of creativity in students endorsed by scientists and compared these to the perceptions of experts in the field of creative personality. No difference was found in the perception of the scientists and experts in creativity regarding the characteristics of creative students. Some of the traits common to both and ranked most desirable were: Curious, Courageous in convictions, Independent in judgment, and preoccupied with tasks. Traits ranked by both the groups as least desirable in students were: timidity and naughtiness.

Girjesh and Singh (1999): have studied different dimensions of creativity in relation to the Locality of Scheduled castes and Non-scheduled castes students. The tool used in the study was Torrance Test of Creative Thinking. The study revealed that scheduled caste students belonging to the urban locality have been found significantly superior to their rural counterparts in all the dimensions of Verbal and Figural (Except Originality) creativity. In originality of figural creativity, the mean scores of the urban group were slightly higher than those of the rural groups. Among the non-scheduled castes students, the urban group maintained its significant superiority over the rural group students in all dimensions of Verbal creativity (except originality) and figural creativity. This shows that the environment significantly influences the creative thinking of students.

Hota (2000): in his study of the Creative potential achievement motivation and Self-concept of Urban, Rural and tribal adolescents" tried to study the Creative Potentiality, Verbal and Figural Creativity, the Sex difference in creativity, differences in Achievement motivation, Self-concept and the relation between Intelligence and Creativity of Rural, Urban and Tribal adolescents. The tools used for the study are

a. Wallach and Kogan test of Creativity adopted in Oriya by Tripathy,

b. Achievement Motivation test by Mohan,

c. Personality Word List by Deo and

d. Cattle's Culture Fair test of intelligence Form A -factor "g" scale –II. The findings of the study were 1. High creative urban adolescents, as compared to low creative urban adolescents, in general, possess higher achievement motivation or greater achievement need. 2. High-creative rural adolescents as compared to low-creative rural adolescents, in general, possess greater achievement needs. 3. High creative tribal adolescents, as compared to low creative tribal adolescents, in general, possess a greater need for achievement. 4. The perceived Self-concept of highly creative urban adolescents as compared to low creative urban adolescents, in general, is significantly higher. 5. The perceived Self-concept of highly creative rural adolescents, as compared to low creative rural adolescents, in general, is significantly higher. 6. The perceived self-concept of highly creative tribal adolescents does not differ markedly. In other words, the perceived Self-concept of low-creative tribal adolescents is as high as their high-creative counterparts. 7. The relationship between verbal creativity and intelligence is significant but low. 8. The relationship between figural Creativity and Intelligence is significant but low. 9. The relationship between composite Creativity and Intelligence is significant but low.

Shrivastava and Nigam (2004): in their correlation study on Achievement, Intelligence, and Creativity of Higher secondary students of Jabalpur division, Madhya Pradesh, comprising 750 male and female students of Urban, Rural, and Tribal areas, have revealed that 1. The achievement was a direct correlate of Intelligence. 2. Achievement was a correlate of Creativity (Except in tribal girls). 3. Intelligence was a correlate of creativity (Except in tribal girls). The tools employed in the above study were the Self-prepared test for Achievement, Standard Progressive Matrices by Raven, and Mehdi's Test for Creativity. Some studies aimed at finding out whether or not the students from academic streams, namely, science, arts, home sciences, and commerce differ among themselves concerning Creativity.

2.5.0 STUDIES RELATED TO SYNECTICS MODEL OF TEACHING AND HIGHER MENTAL ABILITY

The researcher could find studies related to Mental Ability, General mental ability, Mental helth, Mental toughness, and Mental stress, but could not find many studies related to

higher mental ability or effect of the Synectics Model of teaching on the mental ability of the learner.

Duckworth,(2005). researched "grit" and found that perseverance and passion for long-term goals were better predictors of academic success than measures of intelligence. Students with higher levels of grit demonstrated higher achievement, better grades, and greater perseverance in the face of challenges.

Dweck,(2007).researched on mindset and highlighted the importance of a growth mindset for academic achievement. Students who believed that intelligence and abilities could be developed through effort and learning showed greater motivation, resilience, and higher academic performance compared to those with a fixed mindset.

Lubinski, and Benbow,(2006) conducted a longitudinal study on mathematically precocious youth. They found that students with high cognitive abilities in mathematics and science achieved exceptional outcomes in these fields later in life, including advanced degrees and significant contributions to research and innovation.

Duckworth and Seligman, (2006). demonstrated that self-discipline was a better predictor of academic performance than IQ. Students with higher levels of self-discipline showed better grades, higher standardized test scores, and greater academic achievement.

Grigorenko, (2005) researched the development of higher mental processes and explored the cognitive abilities and metacognitive skills of students. She found that higher mental abilities, including critical thinking, problem-solving, and metacognition, were positively associated with academic achievement and cognitive development.

2.6.0 STUDIES RELATED TO SYNECTICS MODEL OF TEACHING AND ACADEMIC ACHIEVEMENT

Yousefi, Ali (2014) described the objective to increase the creativity of students. The sample was the seventh-grade students. They were taught science by the Synectics teaching model for a couple of days. An achievement test was administered to test the creativity of students. Comparative analysis was made between the creativity scores of the groups who

were taught by the traditional method and who were taught by this creative method pupils who were trained by the Synectics model were better in terms of their creativity in comparison to the pupils trained by the traditional method of teaching.

Tumangger, Masda, & Ernidawati, Tjut (2012) focused on how to improve learners' speaking ability at the school level with the application of the Synectics model. This classroom action research was applied in the study. All 24 students participated in this research. The data was collected through diary notes, observation, interviews, and questionnaires, and the quantitative data was based on the data collected through the test results. The results showed that the student's performance improved from one cycle to the next cycle. It can be concluded that the application of the Synectics Model for teaching has a significant effect on the speaking ability of learners.

Siddiqui, Hasan (2013) said that creative thinking has improved by the use of synectics specifically in small groups of people. Three kinds of analogies were categorized that were: personal analogy, direct analogy, and compressed conflict. The purposes of applying this model of teaching are: to enhance the creativity of individuals and groups, to develop a problem-solving approach in the behaviour of the students, to develop a feeling of community among students, to develop the self-confidence of the students, to encourage the students to be able to learn about their classmates with understanding their ideas and problems and accepting them as they are, to encourage and it facilitates weaker students, to develop self-consciousness of the students, to encourage discussion among the teacher and the students, to create a fear-free environment for the students, to expand the arena of creativity, to create a community of equals, to help the students to create a design or product of their own, to broaden our perspective of a concept, to explore social problems.

Tajari, & Tajari,(2011) have focused on the effectiveness of synectics teaching with the application of lecture-based methods and how it could help to attain the educational goal and creativity. The experimental method was used. Pre-test and post-test were administered in both groups. A random multi-stage sampling method was selected for the testing purpose. The Image creativity test, Torrance, and verified educational progress test were used in the study. The results concluded that synectics exercises increase abilities like; fluency, elaboration originality, and flexibility as well as increase individual differences.

Chandrasekaran, S. (2014) said that synectics techniques were useful to solve quantitative and qualitative educational problems. A synectics technique develops critical thinking, creative intelligence, and a scientific attitude in learners. It is a student-centered technique. The learners of government schools were selected for the research. The two groups were selected 28 through simple random sampling. Pre-test and post-test were administered in both groups and t-tests were used to analyze the effectiveness of teaching-learning of related subjects. The conclusion of the study was that the application of synectics techniques improved the teaching of zoology.

Afshari, Gholamhossein, & Ghaemi, Nasser (2014) have described that this study undertakes the application of Synectics teaching and sees its effectiveness on the academic performance of learners. The simple random sampling method was selected through a lucky draw. The researcher used the quasi-experimental method and pre-test, and post-test were used for this study. The researcher has given the training in ten sessions and devoted forty-five minutes. The traditional method was used for the control group by the researcher. A 28-point scale in the Persian language was developed for data analysis. Findings that were reached through the study show that Synectics training enhances academic performance in the field of writing skills and thus hypothesis was accepted.

Abed, Davoudi, Hosein, Mohammad & Zadeh, (2015) have investigated to see the synectics pattern in relation to the problem-solving and critical thinking skills of learners. The semi-experimental method was used with the administration of pre-test, and post-test in both groups. The sample comprised of 40 students randomly selected. The problem-solving questionnaire of Heppner and Peterson and the critical thinking skills questionnaire were administered for data collection. The findings indicated that the Synectics pattern accelerates the problem-solving skills and critical thinking in students.

3.1.0 RATIONALE OF THE STUDY

On reviewing the research done in synectics, creativity, and achievement in science, the researcher found that there are fewer studies related to fostering creativity and empathy in middle school students which forms the base for higher mental abilities at the higher secondary level. One cannot expect it to develop out of the blue with no base to it – without training the nerves at the formative stages of concept building.

Only a few researchers have studied the impact of the synectics model in developing the academic achievement and achievement motivation of the learner.

Keeping reasons in view, a need was felt for the effectiveness of the synectics model to be tested according to the structure of the model given by Gordon in 1961.

4.1.0 STATEMENT OF PROBLEM

The problem is stated as follows:

A Comparative Study of the Effectiveness of the Synectics Model of Teaching and Traditional Teaching in Terms of Creativity, Empathy, Higher Mental Ability and Achievement in Science at the Middle School Level.

5.1.0 OBJECTIVES OF THE STUDY

The following were the objectives for the present study:

1. To compare the adjusted mean scores of Creativity of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Creativity as covariate.
2. To compare the adjusted mean scores of Empathy of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Empathy as covariate.
3. To compare the adjusted mean scores of Higher Mental Ability of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Higher Mental Ability as covariate.
4. To compare the adjusted mean scores of Achievement in Science of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Achievement in Science as covariate.
5. To study the effect of Treatment, Gender, and their interaction on the Creativity of students by considering Pre- Creativity as covariate.
6. To study the effect of Treatment, Gender, and their interaction on the Empathy of students by considering Pre- Empathy as covariate.

7. To study the effect of Treatment, Gender, and their interaction on the Higher Mental Ability of students by considering Pre-Higher Mental Ability as covariate.
8. To study the effect of Treatment, Gender, and their interaction on Achievement in Science of students by considering Pre- Achievement in Science as covariate.
9. To study the effect of Treatment, Intelligence, and their interaction on the Creativity of students by considering Pre-Creativity as covariate.
10. To study the effect of Treatment, Intelligence, and their interaction on the Empathy of students by considering Pre-Empathy as covariate.
11. To study the effect of Treatment, Intelligence, and their interaction on the Higher Mental Ability of students by considering Pre-Higher Mental Ability as covariate.
12. To study the effect of Treatment, Intelligence, and their interaction on the Achievement in Science of students by considering Pre-Achievement in Science as covariate.
13. To study the reaction of students of the Experimental Group towards the Synectics Model of Teaching.

6.1.0 HYPOTHESES OF THE STUDY

The following hypotheses were formulated for the study:

H01. There is no significant difference in the adjusted mean scores of Creativity of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Creativity as covariate.

H02. There is no significant difference in the adjusted mean scores of Empathy of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Empathy as covariate.

H03 There is no significant difference in the adjusted mean scores of Higher Mental Ability of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre- Higher Mental Ability as covariate.

H04. There is no significant difference in the adjusted mean scores of Achievement in Science of the group taught through the Synectics Model of Teaching and the group

taught through the Traditional Method of Teaching by considering Pre-Achievement in Science as covariate.

H05. There is no significant effect of Treatment, Gender, and their interaction on the Creativity of students by considering Pre-Creativity as covariate.

H06. There is no significant effect of Treatment, Gender, and their interaction on the Empathy of students by considering Pre-Empathy as covariate.

H07. There is no significant effect of Treatment, Gender, and their interaction on the Higher Mental Ability of students by considering Pre-Higher Mental Ability as covariate.

H08. There is no significant effect of Treatment, Gender, and their interaction on the Achievement in Science of students by considering Pre-Achievement in Science as covariate.

H09. There is no significant effect of Treatment, Intelligence, and their interaction on the Creativity of students by considering Pre-Creativity as covariate.

H10. There is no significant effect of Treatment, Intelligence, and their interaction on the Empathy of students by considering Pre-Empathy as co-variate.

H011 There is no significant effect of Treatment, Intelligence, and their interaction on the Higher Mental Ability of students by considering Pre-Higher Mental Ability as covariate.

H012. There is no significant effect of Treatment, Intelligence, and their interaction on the Achievement in Science of students by considering Pre-Achievement in Science as co-variate.

7.1.0 METHODOLOGY OF THE STUDY

In the present study, the researcher used an experimental design to investigate the comparative effectiveness of the Synectics Model of teaching and the Traditional Method

of teaching on Creativity, Empathy, Higher Mental Ability, and Achievement of students at the Middle School level. The researcher conducted the experimental study in a CBSE School in Indore. The Researcher conducted the study in the same Institution where she was serving as an Academic Coordinator for grades VI to VIII. This facilitated the researcher to conduct the experimental study with the least limitations due to the support from the school management.

The steps followed are described as under:

7.2.0 SAMPLE OF THE STUDY

The sample for the study was selected using a purposive sampling technique.

The population of the study is the students of class VIII of a CBSE school in Indore City.

The CBSE School is situated in Jhalaria village close to Indore city. The School has about 3200 students with affiliation No. 1030239. About 140 students were selected for the data collection. The students who stayed absent on various grounds or missed either the pre-test or post-test, their scores were not considered

7.3.0 EXPERIMENTAL DESIGN

Keeping the objectives of the study in mind the researcher employed experimental research. The non-equivalent control group design was used. As per Campbell and Stanley (1963), the layout of the design is given below

O X O

.....

O O

X- Treatment through the Synectics Model of Teaching

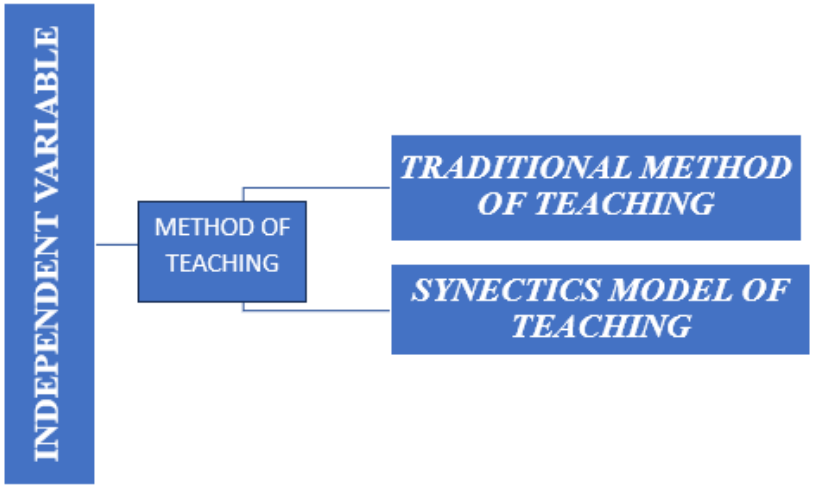
O Observation

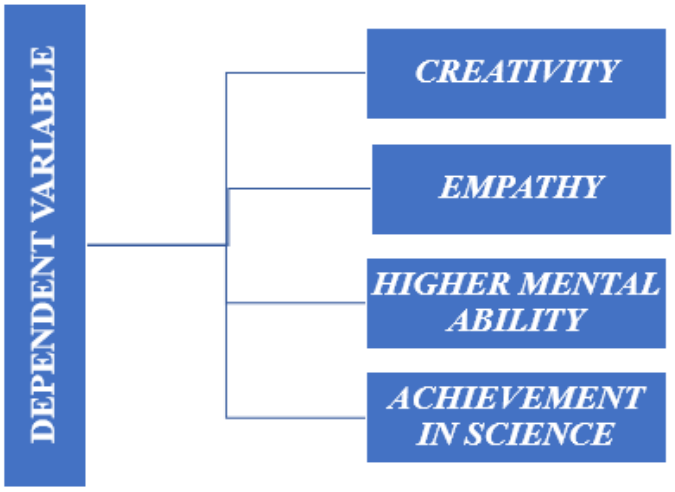
…… The dotted line indicates non-equivalent groups

Of the four sections chosen from grade VIII, two sections of grade VIII were designated as the experimental group, and the other two sections of grade VIII as the control group. The Four sections were randomly chosen from the seven different sections of grade VIII of the selected School. The concepts taught in all four sections of grade VIII, were the same, per the syllabus to be transacted during the period.

7.4.0 TOOLS FOR DATA COLLECTION

The variables of the study were as under





The different tools that were used for the comparative study of the effectiveness of Synectics Model of teaching and Traditional Method of teaching on the creativity, empathy,

Higher Mental Ability,Achievement of Students in Science and the reaction of students towards the Synectics model of teaching were tested using standardized and non-standardized tools

Summary of tools used in the study for various variables

Variables	**Tool**	**Author**	**Year**	**Duration**	**Reliability**
Creativity	Verbal Test for Creative Thinking Verbal and Non-verbal (English/ Hindi)	Baqer Mehdi	1973 Revised 1985	30 -48 mins	Range- 0.89 to 0.95
Intelligence	Standard Progressive Matrices (non-verbal)	J.C.Raven et al	1976 Revised 1998	45 mins	Test-Retest Reliability= 0.90
Empathy	Empathy Situational Test	Dubey and Tandon	2014	25 mins	Test-Retest Reliability = 0.899
Higher Mental Ability	Test for Higher Mental Ability in Science	Sansanwal and Joshi	1989	—--------	Test-Retest Reliability = 0.816
Achievement	Achievement in Science	Researcher	2022	35 mins	-
Reaction Scale	Reaction towards the Synectics Model of Teaching	Researcher	2022	20-25 mins	-

7.5.0 PROCEDURE FOR DATA COLLECTION

Selection of School

For the selection of the school, few CBSE schools of the Indore district were listed which satisfied the following criteria:

- The school should have the strength of at least 120 students per class in different sections.
- The school should draw a good number of students of both genders from the town population.
- It should have a laboratory facility.
- The Head of the Institution should be inclined to allow the researcher to experiment and collect data.
- It should have regular science educators teaching grade VIII.

The sample school, The Shishukunj International School, Jhalaria Campus, Indore, Affiliation No.1031254, met the criteria mentioned above and was selected. The School selected has been ranked the number one School in Madhya Pradesh by the C-fore survey for the 15th consecutive year. It ranks as the 60th Best CBSE School out of the 5595 CBSE Schools at the All India Level. It has also been awarded the title of 'Hub of Super Thinkers', Silver Category and then the Gold Category. Last, but not least, it is Asia's Fastest 100-growing Schools.

Selection of Class

The Synectics model of teaching treatment involves the use of analogies and metaphors.

The selected students for sampling were required to have a fairly good vocabulary, an equal reasoning ability for suggesting analogies, comparing metaphors, and being able to have a free flow of thoughts and express themselves.

Grade VIII students under the age group of 13 to 15 years fall into the category of Piagetian formal operational stage. At this stage, the students can hypothesize, reflect, think logically

as well as irrationally, and relate real-life examples to scientific concepts. The study intends to investigate the effect of the synectics model of teaching on the development of creativity, empathy, and achievement in science, the grade VIII students are found to be an appropriate sample for the study.

Treatment-wise, Section-wise / Gender-wise Distribution of Sample

Treatment	Name of the School	Class /section	Girls	Boys	Total
Experimental Group (Synectics Model of Teaching)	The Shishukunj International School, Jhalaria Campus, Indore	VIII F	16	12	28
		VIII G	11	17	28
	Total		**27**	**29**	**56**
Control Group (Traditional Method of Teaching)	The Shishukunj International School, Jhalaria Campus, Indore	VIII B	14	24	38
		VIII E	17	16	33
	Total		**31**	**40**	**71**
Grand Total			**58**	**69**	**127**

The sample for the experimentation comprised 140 students of different sections of grade VIII from The Shishukunj International School, Jhalaria campus, Indore. Out of the four sections of grade VIII, two sections for the experimental group comprised a total of 56 students of which 27 were girls and 29 were boys- taught by the Researcher. The other two sections for the control group consisted of 71 students of which 31 were girls and 40 for boys- taught by the regular Science Teacher. The students who stayed absent on the grounds of medical reasons, representing the School at the State, and the National level, for different co-curricular activities, were either present for the pre-test or post-test, their

scores were not considered. The age group of the sample was between 13 to 15 years. The medium of instruction for the students was English throughout.

Schematic Presentation of the Experimentation

Phase	**Experimental Group (n=56)**	**Control Group (n=71)**	**Duration**
I	**<u>Pre-Test</u>** 1. Verbal Test of Creative Thinking 2. Empathy Situational Test 3. Higher Mental Ability in Science 4. Achievement in Science	**<u>Pre-Test</u>** 1. Verbal Test of Creative Thinking 2. Empathy Situational Test 3. Higher Mental Ability in Science 4. Achievement in Science	1. 45 mins 2. 45 mins 3. —-- 4. 45 mins
II	**<u>Testing of Co-variates</u>** 1. Raven's Standard Progressive Matrices (Intelligence Test)	1. Raven's Standard Progressive Matrices (Intelligence Test)	1. 45 mins
III	Treatment through Synectics Model of teaching- taught by Researcher	Treatment through Traditional Method of teaching- taught by a Regular teacher	5 months

IV	**Post-Test** 1. Verbal Test of Creative Thinking 2.Empathy Situational Test 3. Higher Mental Ability in Science 4. Achievement in Science 5. Reaction towards Synectics Model of Teaching	**Post-Test** 1. Verbal Test of Creative Thinking 2.Empathy Situational Test 3. Higher Mental Ability in Science 4. Achievement in Science —----------	1. 45 mins 2. 45 mins 3. —--- 4. 45 mins 5. 20 mins
The Total Duration of the Experimentation was 5 months			

7.6.0 ANALYSIS OF DATA

The objective-wise statistical analyses are given as follows:

1. One-way ANCOVA was used for comparing the adjusted mean scores of Creativity of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Creativity as covariate.

   2. One-way ANCOVA was used for comparing the adjusted mean scores of Empathy of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Empathy as covariate.

3. One-way ANCOVA was used for comparing the adjusted mean scores of Higher Mental Ability of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Higher Mental Ability as covariate.

4. One-way ANCOVA was used for comparing the adjusted mean scores of Achievement in Science of the group taught through the Synectics Model of Teaching and the group taught through the Traditional Method of Teaching by considering Pre-Achievement in Science as covariate.

5. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Gender, and their interaction on the Creativity of students by considering Pre- Creativity as covariate.

6. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Gender, and their interaction on the Empathy of students by considering Pre- Empathy as covariate.

7. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Gender, and their interaction on the Higher Mental Ability of students by considering Pre- Higher Mental Ability as covariate.

8. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Gender, and their interaction on Achievement in Science of students by considering Pre-Achievement in Science as covariate.

9. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Intelligence, and their interaction on the Creativity of students by considering Pre-Creativity as covariate.

10.. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Intelligence, and their interaction on the Empathy of students by considering Pre-Empathy as covariate.

11. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Intelligence, and their interaction on the Higher Mental Ability of students by considering Pre-Higher Mental Ability as the covariate.

12. A 2x2 factorial design ANCOVA was used for studying the effect of Treatment, Intelligence, and their interaction on the Achievement in Science of students by considering Pre-Achievement in Science as the covariate.

13. The reaction of students of the Experimental Group towards the Synectics Model of Teaching was analyzed on the basis of percentage and the coefficient of variance.

7.7.0 FINDINGS OF THE STUDY

1. The Synectics Model of Teaching was found to be significantly superior in comparison to the Traditional Method of Teaching for facilitating Creativity in students when Pre-Creativity is taken as a covariate.
2. The Synectics Model of Teaching was found to be significantly superior in comparison to the Traditional Method of Teaching for facilitating Empathy in students when Pre-Empathy is taken as a covariate.
3. The Synectics Model of Teaching was found to be significantly superior in comparison to the Traditional Method of Teaching for improving the Higher Mental Ability of students when Pre-Higher Mental Ability is taken as covariate.
4. The Synectics Model of Teaching was found to be significantly superior in comparison to the Traditional Method of Teaching for improving the Achievement of students when Pre-Achievement is taken as a covariate.
5. The Creativity of the students was found to be significantly independent in terms of Gender when Pre-Creativity is taken as Covariate. Also, it can be concluded that the Creativity of the students was found to be significantly independent in terms of interaction between Treatment and Gender when Pre-Creativity is taken as a covariate.

6. The Empathy of the students was found to be significantly independent in terms of Gender when Pre- Empathy is taken as Covariate. Also, it can be concluded that the Empathy of the students was found to be significantly independent in terms of interaction between Treatment and Gender when Pre- Empathy is taken as a covariate.

7. The Higher Mental Ability of the students was found to be significantly independent in terms of Gender when Pre-Higher Mental Ability is taken as covariate.

   The Higher Mental Ability of the students was found to be significantly independent in terms of interaction between Treatment and Gender when Pre-Higher Mental Ability is taken as covariate.

8. The Achievement of the students was found to be significantly independent in terms of interaction between Treatment and Gender when Pre-Achievement is taken as a covariate. Also, it can be concluded that the Male students were found to have significantly higher Achievement in comparison to Female students when Pre-Achievement was taken as a covariate.

9. The Creativity of the students was found to be significantly independent in terms of Intelligence when Pre-Creativity is taken as a Covariate. Also, it can be concluded that the Creativity of the students was found to be significantly independent in terms of interaction between Treatment and Intelligence when Pre-Creativity is taken as a covariate.

10. The Empathy of the students was found to be significantly independent in terms of Intelligence when Pre- Empathy is taken as Covariate. Also, it can be concluded that the Empathy of the students was found to be significantly independent in terms of the interaction between Treatment and Intelligence when Pre- Empathy is taken as a covariate.

11. The Above Average Intelligent students were found to have significantly higher Higher Mental Ability in comparison to Below Average Intelligent students when Pre-Higher Mental Ability is taken as covariate.

    The Higher Mental Ability of the students was found to be significantly independent in terms of interaction between Treatment and Intelligence when Pre-Higher Mental Ability is taken as covariate.

12. The Achievement of the students was found to be significantly independent in terms of interaction between Treatment and Intelligence when Pre-Achievement is taken as a covariate.

    The Achievement of the students was found to be significantly independent in terms of Intelligence when Pre-Achievement is taken as Covariate. Also, it can be concluded that the Achievement of the students was found to be significantly independent in terms of interaction between Treatment and Intelligence when Pre-Achievement is taken as a covariate. Also, the Male students were found to have significantly higher Achievement in comparison to Female students when Pre-Achievement was taken as a covariate.

13. The Reaction of students of the Synectics Model Group were found to be favourable towards different aspects of the Synectics Model.

7.8.0 DELIMITATIONS OF THE STUDY

The delimitations of the study are as follows:

1. **Spatiotemporal:** The study has a spatial delimitation that is, it was confined to the Indore city only. The study has a temporal delimitation, that is, it was completed in a duration of 5 months.
2. **Procedural:** The study has a procedural delimitation that the syllabus prescribed by the CBSE was followed. The study was confined to selected topics that were prescribed in the school's syllabus only for the academic session in grade VIII.

   The mode of communication was English. Of the two strategies of the Synectics model of teaching, *Making Familiar Strange* and *Making Strange Familiar*, only Strategy-II, *Making Strange Familiar* was used.

3. **Sampling:** The study has sampling delimitations as the researcher took the students of grade VIII of a private school.

7.9.0 EDUCATIONAL IMPLICATIONS IN THE STUDY

In the present study, the Synectics model of teaching was found to be significantly effective in the development of Creativity, Empathy, and Achievement in Science. After analysis of

the Data, the following implications could be drawn from the study for various stakeholders in education. These have been discussed under different heads.

1. **For Students:**

   The Synectics Model of Teaching has been found significantly effective over the traditional Method of Teaching as by implementing the Synectics Model of teaching, the students can

- develop creativity and innovative thinking skills.
- enhance critical thinking and problem-solving abilities.
- promote collaborative skills and teamwork.
- foster imagination and metaphorical thinking.
- increase engagement and motivation in learning.
- cultivate effective communication and presentation skills.
- encourage interdisciplinary learning and knowledge integration.
- build confidence and self-expression.

2. **For Teachers:**

   The Model of teaching can be adopted by educators that are well-versed in the strategies of the Synectics Model of Teaching. Effective adoption of the model depends on the skills of the trained facilitator. The teachers should adopt the method of teaching that has been proven to develop creativity in the students. Incorporating the method in teaching on regular classroom teaching can

- provide a structured framework for creative teaching strategies.
- enhance the instructional design and lesson planning.
- promote student-centered learning and active participation.
- cultivate a supportive and inclusive classroom environment.
- develop facilitation skills to encourage student creativity.
- encourage professional growth and continuous learning.
- foster collaboration among teachers for idea sharing and innovation.
- support differentiated instruction and personalized learning approaches.

3. **For Teacher Educators:**

Teacher educators are the ones who are responsible for setting a trend in the educational institution that they join in the later stages. The Synectics method of teaching should be taught in a better and more elaborated manner and the lesson plans that the Teacher educators make during their regular training process should be based on the Synectics Model of Teaching, Strategy- II, Making Familiar Strange. The Subject educators should give them a model demonstration lesson and should make it mandatory for the teacher educators to have the maximum number of chapters taught by the method in the subjects possible. They should be well acquainted with the advantages of the method over the Conventional Method of Teaching as it can

- offer a pedagogical model for training future teachers.
- promote creativity and innovative teaching methodologies.
- enhance teacher candidates' critical thinking and problem-solving skills.
- encourage the use of diverse instructional strategies.
- support reflective practice and self-assessment.
- cultivate a research-oriented mindset among educators.
- provide opportunities for collaboration and mentoring.
- encourage the integration of technology in teaching practices.

4. **For School Counsellors:**

The School Counsellors require to deal with many cases wherein they are required to deal with students with problems in not being able to cope with the heaviness of the Syllabus. During the Counselling sessions they are expected to guide the student to reach the solution to the problem, With the Synectics model of teaching, the counselors can help students make use of analogies and metaphors to gain conceptual clarity. It can also help the School Counsellors to

- support the development of creative problem-solving skills in students.
- enhance critical thinking and decision-making abilities.
- cultivate empathy and active listening skills.
- encourage self-expression and self-reflection.
- provide techniques for managing stress and emotions.
- promote conflict resolution and interpersonal skills.
- support career exploration and decision-making.
- develop coping strategies and resilience.

5. For School Administrators:

School Administrators need to be updated with the Models of Teaching through compulsory in-service training and workshops as the individuals at the apex, with their

responsibilities, monitor educators only on the basis of the class conduct and the achievement scores. They can arrange weekend classes for the educators to train them on making lesson plans and teaching through the Synectics model of teaching.

The District Education Office can organize a summer training program for the School Head and Teachers for training them with different models of teaching especially the Synectics Model of Teaching The NCERT, SCERT, and DIET should take up the responsibility of developing instructional material to develop creativity and empathy among students and educators of different levels by introducing them the Synectics Model of Teaching. Teaching through the Synectics Model of Teaching should be encouraged as it can

- promote a culture of innovation and creativity in the school.
- support professional development opportunities for teachers.
- encourage collaborative teaching practices and interdisciplinary approaches.
- enhance student engagement and motivation.
- support the integration of creativity across the curriculum.
- promote a positive and inclusive school climate.
- encourage research and evidence-based practices.
- foster a supportive and conducive learning environment.

6. For Textbook Writers:

Many textbooks are written by various Authors and published for School Students. On reviewing the textbooks every year, it has been found that there are hardly a few textbooks that quote analogies in the content and they are able to quote it for a few concepts for limited chapters. The textbook writers need to review the content, update themselves, and try to modify the expression for explaining the concepts in different chapters by using analogies as specified in Strategy-II Making Strange Familiar of the Synectics Model of Teaching. This can

- encourage the inclusion of creative and interactive activities.
- support the development of critical thinking and problem-solving questions.
- promote the integration of real-world examples and case studies.
- provide opportunities for student engagement and exploration.
- encourage the use of visuals, analogies, and metaphors to enhance understanding.
- support interdisciplinary connections and cross-curricular approaches.
- incorporate opportunities for reflection and self-assessment.
- integrate technology-enhanced learning resources.

7. For Curriculum Designers:

It has been observed that the curriculum planners take it on low priority in enhancing creativity through the curriculum. In collaboration with the CBSE, the curriculum planners can organize workshops, Seminars, and capacity-building programs for the in-service training of the teachers of different schools. The changes in the curriculum can be incorporated into the teacher-education curriculum first and then into the school curriculum.to bring about the desired changes that can

- encourage the integration of creativity and innovative thinking skills across subjects.
- support the development of interdisciplinary curriculum frameworks.
- promote the inclusion of creativity and critical thinking tasks.
- provides guidelines for the design of interactive and engaging learning experiences.
- support the incorporation of real-world applications and examples.
- encourage the development of creativity assessment methods.
- foster the alignment of curriculum with 21st-century skills.
- promote flexibility and adaptability in curriculum design.

8. For Digital Content Developers:

There are many a concept that is designed by digital content developers for teaching concepts in Science. These developed packages are given to Schools on a rental basis either annually or more. Some content is also uploaded on various websites. The content developers can design the concepts to be explained on the Synectics Model of Teaching, for it can

- support the design of interactive and multimedia-rich learning materials.
- promote the development of creative and engaging online activities.
- encourage the integration of digital tools for creative thinking.
- provide guidelines for the creation of collaborative platforms and virtual classrooms.
- support the development of simulations and virtual reality experiences.
- promote the incorporation of visual and auditory stimuli to enhance learning.
- foster the integration of technology in assessment and feedback processes.
- encourage the creation of adaptive and personalized digital resources.

7.10.0 SUGGESTIONS FOR FURTHER RESEARCH

Based on the present study, the Researcher has put forth certain suggestions for further research that may be worth reflecting upon for the research scholars.

1. A comparative study of the effectiveness Model of teaching and traditional teaching in terms of different variables can be carried out on a larger sample with more reliable results.

2. Exploratory inquiry into the attitude of teachers towards the Synectics Model of Teaching for developing creativity, empathy, and problem-solving ability

3. A comparative study of the effectiveness of the Synectics Model of Teaching and other models of teaching can be compared.

4. The same study may be carried out with samples from the primary, upper primary, and higher secondary levels.

5. With the Synectics Model of Teaching, higher mental abilities of students at various levels can be compared.

6. The study can be replicated for other subjects to confirm the generalisability of the result.

7. A comparative study of students' willingness to study using other strategies like drill and practice, computer-assisted studies, etc. and the Synectics Model of Teaching can be compared.

8. The similar experimental design can be used with different tools for assessing creativity, problem-solving ability, reasoning- ability, and higher mental ability in the subject domain.

9. For subject-specific nurturant and instructional effects assessment of the Synectics Model of teaching, tools can be developed.

10. The effect of the Synectics Model of teaching on capacity-building programs for teacher trainees in terms of the interest and ability to develop, plan and teach content can be found.

REFERENCES AND WEBLINKS

Ahuja, S.(2013). *A Study of Creative Thinking among Navodaya Vidyalaya Students in Relation to Socio-demographic Variables Locus of Control Emotional Intelligence and Personality Types* [Ph.D. thesis, Himachal Pradesh University]. Shodhganga, http://hdl.handle.net/10603/127844

Ayub, G. (2017). *Effectiveness of life skills training on psychological distress balanced emotional empathy and autonomy among adolescent students* [Ph.D. thesis, University of Mysore] Shodhganga, http://hdl.handle.net/10603/201645.

Ajatha S.(1993).*Effect of inquiry training model of teaching science on science process skills, creativity and curiosity of secondary school students*(Unpublished Doctoral Dissertation).Karnatak University, Dharwad.

Argyle, M.(1984). The Psychology of Interpersonal Behaviour. Penguin Books Ltd.
Buch, M.B. (ed.): Second Survey of Research in Education, National Council of Educational Research and Training, New Delhi, 1972-78.

Buch, M.B. (1985): Third Survey of Research in Education(1979-82). National Council of Educational Research and Training, New Delhi.
Basker, S. (1981).*A study of the effectiveness of verbal creativity instructional material at the school stage*. (Unpublished doctoral dissertation). Maharaja Sayajirao University, Baroda.

Biles,B.R.(1976). Creative problem-solving training in elementary schools in Brazil. *The Journal of Experimental Education*, 44, 23-27.
Buch, M.B.(1990), Fourth Survey of Research in Education (1983-88). NCERT, New Delhi.

Buch, M.B. (1994). Fifth Survey of Research in Education (1988-92) NCERT, New Delhi.

Buchanon, L. J. Jr. and H. C. Lindgrar (1973), Brainstorming in large groups as facilitation of children creativity responses, Journal of Psychology, 82, 117-122.
Cattell, R. B. (1959). The personality and motivation of the researchers from measurements of contemporaries and from biography.

Cherry, B.S. (1972). *A strategy for developing creative thinking (Torrance Model) in trainable mentally retarded children through - A program of attention and concentration and open-ended methods*.(Unpublished doctoral dissertation) Miami University.Ohio.

Crow and Crow (1973). *Educational psychology*, RE Eurasia Publishing House, 309-314.
DE BONO, EDWARD. - Six Thinking Hats." Penguin Books Ltd., England 1987

Dubey Archana. (1988) - Effectiveness of Training Strategy for Developing Feedback Giving and Feedback Receiving Competence in Relation to the Selected Organismic Variables of Student Teachers." Ph.D. Thesis, School of Education, Indore.

Good, T.L., &Brophy, J.E.(1973), Looking in Classrooms, New York, Harper & Row

Gordan, W. J. J.(1961), Synectics, New York: Harper. GO, Gordon, W. J. J.(1961a), Synectics, New York: Harper & Row. GO

Gordon, W.J.J.: POZE, T. - " Synectics and Gifted Education Today." Gifted Child Quarterly: Vol.24, No.4.P: 14751 Fall 1980

Guilford, J. P. (1968), The nature of human intelligence, New York: McGraw-Hill, p. 509.

Guilford, J. P. (1985), General Psychology (2nd Ed.), New York: Van Nostrand Reinhold Company.

Joyce, B. and Weil, M. (1980), Models of teaching, New Jersy: Columbia University Teachers College, 2nd Ed.

Joyce, B., and Weil, M. (1997), Models of teaching (5th Ed.), New Delhi: Prentice Hall of India Private Ltd.

Kavita (2011). *A study of the effect of training in the classroom questioning behaviour of student teachers on teaching competency, self-concept, and attitude towards teaching* [Ph.D. thesis Maharshi Dayanand University]. Shodhganga. http://hdl.handle.net/10603/6869

Mangala, S. K. (1989), Educational psychology (8th Ed.), Ludhiana Prakash Brothers.

Mangala, S. K. (1990), Advanced educational psychology (8th Ed.), Ludhiana Prakash Brothers.

Maslow, A. H. (1962), Towards a psychology of being, Princeton, M. J. Van Nostrand.

Mehdi, B. (1985), Manual - Verbal test of creative thinking, Agra: National Psychological Corporation.

NCERT, Fifth Survey of Education Research, 1988-1992 Abstract Vol. I-II. 352

Prashanth, M. S. (2006).Effect of Synectics Model of Teaching on creativity, problem-solving ability and attitude towards science at the secondary level. University of Mysore http://hdl.handle.net/10603/38475

Raven, J. C., Court, J. R. and Raven, J. (1988), Manual for Raven's progressive matrices vocabulary scores (Standard Progressive matrices). London: H. K. Lewis Co. Ltd.

Ravens (1960), Standard progressive matrices, London.

Sansanwal, D.N &Joshi, A, Manual for the Test of Higher Mental Ability in Science., Agra: National Psychological Corporation., 1989

Torrance, E. P. and Gupta, B. (1964), Programmed experiences in creative thinking, Minneapolis Bureau of Educational Research, University of Minnesota. 355

Wallas, G. (1926), The Art of Thought, New York: Harcourt.