MAI THI NHAN

IMPROVING CREATIVE THINKING OF HIGH SCHOOL STUDENTS THROUGH CHEMISTRY TEACHING

THESIS FOR MASTER DEGREE OF CHEMISTRY TEACHING

HANOI – 2015
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Instructor: As. Pro. Dr. Le Kim Long

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Mai Thi Nhan
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ABSTRACT

The 21st century is the age of knowledge economy, thus, to adapt the demands of highly-quality talents, creative thinking are becoming increasingly important. In the explosion of knowledge, education has been seen as central in fostering creative skills of youth. An emphasis on creative problem solving in science education can help to better preparation of students for scientific and technological problem solving and related careers. However, the central concern of most science teachers is a narrow focus of fostering these skills.

The involvement of creativity in education comprises that teachers must understand the core purpose of education - training students ways of thinking. Teachers should give students opportunities to connect and combine; to work with the artistic, scientific, and historical modes of thought; to communicate in verbal, mathematical, kinesthetic, musical, and visual languages; to understand and use frameworks as springboards for their creativity; and to enjoy the fact that many problems with a single answer have multiple solutions, and that many more problems have no universally right or best answer.

Chemistry as a part of science is an essential domain of the school curriculum. The chemistry teaching has the potential to encourage students to think flexibly, thanks to system of theories and problems, in order to increase a variety of approaches to solving problems and, in that way, to contribute to development of learners creative capacities. The assumption that chemistry can stimulate creativity depends on the way chemistry is taught.
# CONTENTS

Acknowledgement...........................................................................................................i

Abstract..........................................................................................................................ii

List of Symbols..................................................................................................................iii

List of Figures....................................................................................................................iv

List of Tables.....................................................................................................................v

List of Graphs...................................................................................................................vi

INTRODUCTION..............................................................................................................1

CHAPTER I: THE MAIN THEORETICAL CONCEPT ..................................................5

1.1 BLOOM’S TAXONOMY AND BLOOM’S REVISED TAXONOMY .... 5

1.3 THE NATURE OF CREATIVITY ...........................................................................11

1.4 IMPORTANCE OF CREATIVE THINKING .........................................................15

1.5 CREATIVITY IN EDUCATION .............................................................................15

1.6 METHODS AND TECHNIQUES FOR TEACHING CREATIVE THINKING SKILLS ......................................................................................................................17

1.6.1 Visualization and creative dramatics techniques ..............................................18

1.6.2 Divergent thinking strategies ...........................................................................22

1.6.3 Mind mapping technique ..................................................................................31

1.6.4 Project-based learning (PBL) method ...............................................................32

1.6.5 Six thinking hats technique ..............................................................................35

1.6.6 Creative questions and problems .....................................................................40

1.7 CREATIVE CLASSROOM ....................................................................................40

1.8 ROLE OF TEACHERS ..........................................................................................42

1.9 CREATIVITY IN CHEMISTRY .............................................................................42
1.10 ACTUAL SITUATION OF TRAINING CREATIVE THINKING THROUGH CHEMISTRY FOR HIGH SCHOOL STUDENTS .......... 43

CHAPTER 2: METHODOLOGY ................................................. Error! Bookmark not defined.

2.1 AIMS OF RESEARCH ............................................... Error! Bookmark not defined.

2.2 RESEARCH PLAN ...................................................... Error! Bookmark not defined.

2.3 OBJECTS OF RESEARCH ......................................... Error! Bookmark not defined.

2.4 POSITION, TARGET AND STRUCTURE OF THE EXPERIMENT LECTURES ........................................ Error! Bookmark not defined.

2.4.1 The position of the experiment lectures ............................................ Error! Bookmark not defined.

2.4.2 Targets of the experiment lectures ................................................. Error! Bookmark not defined.

2.5 EVALUATION METHOD AND DATA TREATMENT OF EXPERIMENT LECTURES ........................................ Error! Bookmark not defined.

CHAPTER III: INTERVENTION, RESULTS AND DISCUSSION ........................................ Error! Bookmark not defined.

3.1 INTERVENTION TO TRAIN CREATIVE THINKING BY CREATIVE TEACHING METHODS AND TECHNIQUES ........................................ Error! Bookmark not defined.

3.1.1 Visualization technique ................................................. Error! Bookmark not defined.

3.1.2 Creative dramatic technique .............................................. Error! Bookmark not defined.

3.1.3 Imagination and illustration technique ............................................ Error! Bookmark not defined.

3.1.5 Mind mapping and group work technique ........................................ Error! Bookmark not defined.

3.2 RESULTS ................................................................................................. Error! Bookmark not defined.

3.2.1 Creative products ................................................................................. Error! Bookmark not defined.

3.2.2 The behavior of students after training creative thinking skill Error! Bookmark not defined.

3.2.3 The results of tests ................................................................................. Error! Bookmark not defined.

3.3 DISCUSSION ................................................................................................. Error! Bookmark not defined.

CONCLUSION AND PETITION ................................................................. 46

REFERENCES ................................................................................................. 48
LIST OF SYMBOLS

Ex: Experiment
PBL: Project-Based Learning
Re: Reference
LIST OF FIGURES

Figure 1.1: Bloom’s Taxonomy and Bloom’s Revised Taxonomy

Figure 1.2: Implicit theories about creativity

Figure 1.3: Questions in Star-bursting session

Figure 1.4: Fishbone Map

Figure 1.5: Example of mind mapping technique

Figure 1.6: Outlining the implementation of Project-Based Learning projects
LIST OF TABLES

Table 1.1: Letter of the SCAMPER acronym

Table 1.2: Synthesis of De Bono’s six thinking hats model

Table 1.3: The investigation results of training creative thinking in chemistry for students.

Table 2.1: School and objects of the research

Table 3.1: Creative products of students about the periodic trend of elements

Table 3.2: The observation results of students’ behaviors.

Table 3.3: The grade distribution of test 1

Table 3.4: The grade rank of test 1

Table 3.4: The probability distribution of test 1

Table 3.5: The statistic parameters and Students t – test distribution of test 1

Table 3.6: The grade distribution of test 2

Table 3.7: The grade rank of test 2

Table 3.8: The probability distribution of test 2

Table 3.9. The statistic parameters and Students t – test distribution of test 2
LIST OF GRAPHS

Graph 3.1: The grade rank of test 1

Graph 3.2: The percentage distribution of grade below $x_i$ for test 1

Graph 3.3: The grade rank of test 2

Graph 3.4: The percentage distribution of grade below $x_i$ for test 2
INTRODUCTION

1. REASON TO CHOOSE THE TOPIC

In the 21st century, the appearance of high technology society and knowledge economy brings human a vast of challenge. To adapt and develop in new society, people must have qualifications as well as abilities which are appropriate to this global change.

In the demand of the information society and knowledge economy, educators should enhance the quality of education, replace the old methods by the new ones. The core purpose of education is that education should train students ways of thinking, enhance independent thinking ... to bring into play students’ ability and creativity.

Teaching chemistry not only enhances the personal knowledge but also applies this learning into real life or forms a new one. Chemistry teachers are instructors who train thinking for students, such as observation ability, problem solving ability, scientific imagination ability … through learning, which nurtures critical and creative thinking skills. Specially, creative teaching methods are the key point for this development.

On the other hand, chapter 1 (Atom) and chapter 2 (The periodic table and the periodic law) consist fundamental and difficult knowledge in chemistry program which guides students to study other parts of chemistry. Thus, it is the reason why we choose two chapters as the main chemical contents to research the thesis: “Improving creative thinking of high school students through chemistry teaching”
2. SUBJECT AND OBJECT OF THE RESEARCH

2.1 Subject of the research: Teaching process in high school.

2.2 Object of the research: Training creative thinking skill for high school students through creative teaching methods. (Major topics: Atom – The Periodic Table – The Periodic Law, Class 10 Basic Program)

3. PURPOSE OF THE RESEARCH

We apply the creative teaching methods in teaching chemistry in order to improve creative thinking skills for high school students, which nurtures the teaching and learning quality.

4. AIM OF THE RESEARCH

- Investigate the theory relating to the topic: Changing the teaching methods. Training creative thinking for high school students.
- Carry out a survey in high schools to study the use of creative teaching methods in teaching plan and the train of creative thinking skill for high school students.
- Investigate the purpose and contents of chemistry program in high school, especially these topics: Atom – The Periodic Table – The Periodic Law, Class 10 Basic Program.
- Build up creative teaching methods and a system of chemistry questions & exercises to develop students’ creative thinking.
- Evaluate the efficiency of experiment lectures through creative products and the results of tests.
5. **SCIENTIFIC HYPOTHESIS**

If creative teaching methods and a system of chemistry questions & exercises are applied well, creative thinking skill of high school students will be nurtured.

6. **THE NEW POINTS OF THE THESIS**

- Building up some creative chemistry lectures (Major topics: Atom – The Periodic Table – The Periodic Law, Class 10 Basic Program) to teach students in experiment part.
- Collecting and selecting a system of chemistry questions & exercises (Major topics: Atom – The Periodic Table – The Periodic Law, Class 10 Basic Program) to train creative thinking for students.

7. **METHOD OF THE RESEARCH**

7.1. *Theoretical investigation*

- Investigating the theory of creative thinking relating to the topic.
- Collecting and analyzing the theoretical materials.

7.2. *Realistic investigation*

- Carry out a survey in high schools to study the use of creative teaching methods.
- Exchange the views between chemistry teachers about the contents and form of teaching.
- Build up experiment lectures using creative teaching methods and techniques and a system of chemistry questions & exercises

7.3 *Mathematical statistic method to treat data*

- Using the mathematical statistic in educational scientific research to treat the experiment data.

8. **STUCTURE OF THE THESIS**
Introduction

Chapter 1: The main theoretical concept

Chapter 2: Methodology

Chapter 3: Intervention, result and discussion

Conclusion and Petition
CHAPTER I: THE MAIN THEORETICAL CONCEPT

1.1 BLOOM’S TAXONOMY AND BLOOM’S REVISED TAXONOMY

As educators we are all familiar with Bloom’s Taxonomy, created in the 1950’s by Benjamin Bloom, and the more recently revised 2001 version adapted by Lorin Anderson.

The chart shown below compares the original Bloom’s taxonomy with the revised one:

![Bloom's Taxonomy and Bloom's Revised Taxonomy](image)

Figure 1.1: Bloom’s Taxonomy and Bloom’s Revised Taxonomy

This new taxonomy reflects a more active form of thinking and is perhaps more accurate. The new version of Bloom's Taxonomy, with explanations and keywords is shown below:

- **Remembering** – retrieving, recalling or recognizing knowledge from memory. Remembering is when memory is used to produce definitions, facts or lists, or recite or retrieve material.
- **Understanding** – constructing meaning from different types of function be they written or graphic.
Applying – carrying out or using a procedure through executing or implementing. Applying related and refers to situations where learned material is used through products like models, presentation, interviews and simulations.

- Analyzing – breaking material or concepts into parts, determining how the parts relate or interrelate to one another or to an overall structure or purpose. Mental actions include differentiating, organizing and attributing as well as being able to distinguish between components.

- Evaluating – making judgments based on criteria and standards through checking and critiquing ...

- Creating – putting the elements into a new pattern or structure through generating, planning or producing. [26]

Bloom’s Taxonomy categorizes thinking skills from the concrete to the abstract - knowledge, comprehension, application, analysis, synthesis, evaluation. The last three are considered HIGHER-ORDER THINKING Skills.

Bloom’s new taxonomy positions the abilities to analyze, evaluate, and create as upper-level skills in the cognitive domain. Therefore, critical and creative thinking are specific types of higher-order thinking skills that contrast with the lower-order skills of understanding and remembering. Creative and critical thinking are key elements of university life and future career and they are extremely necessary to problem-solve at school and in life, so students need develop both skills gradually over time. The duty of teachers is that they should apply Bloom’s classification as guidance to check the progression of students’ thinking as well as nurture these higher-order thinking skills from early school years.

But, why should students reach to higher-order thinking skills and why should teacher reach to higher-order thinking skills in the classroom? Because higher-
order thinking skills have enormous benefits for students. The reasoning here is similar to the rationale for pushing knowledge into our long-term memory. First, information learned and processed through higher-order thinking processes is remembered longer and more clearly than information that is processed through lower-order, rote memorization. For example, comparing the difference between memorizing a formula and explaining the derivation of the formula, a student who has the latter-type of understanding will carry that knowledge longer. Moreover, the student with the deeper conceptual knowledge will be better able to access that information for use in new contexts. This may be the most important benefit of high-order thinking. Knowledge obtained through higher-order thinking processes is more easily transferable, so that students with a deep conceptual understanding of an idea will be much more likely to be able to apply that knowledge to solve new problems. Ironically, teachers are in complete ignorance of the importance of higher-order thinking skills, they are likely to ask recall questions, which requires only remembering and understanding thinking skill, rather than require higher-order thinking skills in classroom. The reason for the focus on lower-order thinking skills may be very simple, it is because lower-order thinking skills are easier – easier to understand, easier to teach, easier to test, easier to learn.

The level six in Bloom’s revised Taxonomy – creating – is the highest level of thinking as Anderson arrangement. He sees the act of “creating” as combining elements into a pattern that had not existed before and it is the hardest skill for teachers, students to achieve. To succeed at this level, students must be able to synthesize their thinking and make predictions based on knowledge. If students want to achieve them, they should begin to practice this skill from primary school. Specially, by the time students reach high school years, the bulk of class
assessment questions and discussions are great chance to practice creative thinking skill.

Because of the importance of creativity in education and life, the following part will mention to creative thinking skill and how to nurture this skill for further purpose.
1.2 DEFINITION OF CREATIVE THINKING

The concept of creativity has gained importance in recent years and the study of creativity has different perspectives and approaches. A vast amount of management literature has been increasingly focusing on how to enhance creativity in the workplace, in school … in order to cope with changing environments.

By 1999, Sternberg researches the origin of creativity on spirituality. In this way, they think that it is not necessary to study creativity in science: “many people seem to believe, as they do about love, that creativity is something just doesn’t lend itself to scientific study, because it is a spiritual process” [17] [18]. But later “pragmatic approaches on creativity” have been mainly concerned with the development of techniques to promote creative thinking in organizations. Unfortunately, Sternberg shows that the practical approach only mention to enhance creativity, and they are lacking a theory of creativity. Thus, they do not provide a clear idea of what are the characteristics of creativity.

On the other hand, Sternberg also refers to psychometric approaches to creativity. They have been mainly focused in developing tests to measure creativity. Plucker and Renzulli (1999) differentiate four areas where psychometric methods have been applied in creativity research: creative process, personality and behavioral correlates, characteristics of creative products, and attributes of creative fostering environments. The psychometric approach will be treated in more detailed later.’ [5]

There are a lot of definitions of creativity. Sternberg presents that creativity “involves thinking that aims at producing ideas or products that are relatively
novel and that are, in some respect, compelling” [21]. Other experts define creativity as involving the creation of something new and useful.

In the UK, the National Advisory Committee on Creative and Cultural Education (NACCCE) published in 1999 a report where they provided a more elaborated, but similar definition of creativity. [8]

They maintain that creativity processes have four characteristics:

- It is imaginatively, it always involves imagination, since it is the process of generating something original.
- It is purposeful: it is imagination put into action towards an end.
- It produces something original in relation to one’s own previous work, to their peer group or to anyone’s previous output in a particular field.
- And finally, it has value in respect to the objective it was applied for.

Creativity involves not only the generation of ideas, but also the evaluation of them, and deciding which one is the most adequate one.

Major features of creativity are listed below:

- Creativity involves the consistent use of basic principles or rules in new situations.

- Creativity involves discovering and solving problems. Innovative approaches are used to accurately evaluate short comings, and actions are taken to remedy those weaknesses.

- Creativity involves selecting the relevant aspects of a problem and putting pieces together into a coherent system that integrates the new information with what a person already knows. In a basic sense, it involves a series of decision-making choices between “two or more competing alternatives of action” each having “several pros and cons associated with it”.
- Creativity overlaps with other characteristics, such as “intelligence, academic ability, dependability, and independence” and can “evolve within each of the seven intelligences”.

- Creativity requires many of the same conditions for learning as other higher order thinking skills. The learning processes are enhanced by supportive environments and deteriorate with fears, insecurities, and low self-esteem.

1.3 THE NATURE OF CREATIVITY

Creativity is a habit [21], so it can either be encouraged or discouraged. For example, if people want to encourage creativity, they should promote the creativity habit and stop treating creativity as a bad habit. Sternberg also suggests that creativity is not isolated to a gifted. Instead, he suggests that creativity is a choice that anyone can make. Sternberg’s investment theory of creativity states that anyone can be creative if they are willing to invest the necessary time and effort into the creative process. This time and effort requires that we invest in six areas needed to realize creativity.

THE INVESTMENT THEORY OF CREATIVITY

Sternberg has proposed an investment theory of creativity as a means of understanding the nature of creativity [16]. According to this theory, creative people are ones who are willing and able to “buy low and sell high” in the realm of ideas. According to the investment theory, creativity requires a confluence of six distinct, but interrelated, resources: intellectual abilities, knowledge, styles of thinking, personality, motivation, and environment. Although levels of these resources are sources of individual differences, often the decision to use the resources is the more important source of individual differences. Ultimately, creativity is not about one thing, but about a system of things.
Aspects of the Investment Theory

Intellectual Abilities

It is generally acknowledged that Intellectual Abilities are necessary but not sufficient for creativity. Three intellectual skills are particularly important:

(a) The synthetic ability to see problems in new ways and to escape the bounds of conventional thinking.

(b) The analytic ability to recognize which of one’s ideas is worth pursuing and which are not.

(c) The practical–contextual ability to know how to persuade others of-to sell other people on the value of one’s ideas.

The confluence of these three abilities is also important. Analytic ability used in the absence of the other two abilities results in powerful critical, but not creative, thinking. Synthetic ability in the absence of the other two abilities results in new ideas that are not subjected to the scrutiny required to make them work. And practical–contextual ability in the absence of the other two may result in the transmittal of ideas not because the ideas are good, but, rather, because the ideas have been well and powerfully presented. To be creative, one must first decide to generate new ideas, analyze these ideas, and sell the ideas to others.

Knowledge

On the one hand, knowledge about a field is extremely necessary to move this field forward or not. On the other hand, knowledge about a field can also result in a closed and entrenched perspective, resulting in a person’s not moving beyond the way in which he or she has seen problems in the past. Thus, one needs to decide to use one’s past knowledge, but also decide not to let the knowledge become a hindrance rather than a help.
Thinking Styles
Thinking styles are preferred ways of using one’s skills. In essence, they are decisions about how to deploy the skills available to a person. With regard to thinking styles, a legislative style is particularly important for creativity [17], that is, a preference for thinking and a decision to think in new ways. This preference needs to be distinguished from the ability to think creatively: Someone may like to think along new lines, but not think well, or vice versa. It also helps to become a major creative thinker, if one is able to think globally as well as locally, one can recognize which questions are important and which ones are not. In our research [17], we found that legislative people tend to be better students than less legislative people, if the schools in which they study value creativity. If the schools do not value or devalue creativity, they tend to be worse students. Students also were found to receive higher grades from teachers whose own styles of thinking matched their own.

Personality
Numerous research investigations have supported the importance of certain personality attributes for creative functioning. These attributes include, but are not limited to, willingness to overcome obstacles, willingness to take sensible risks, willingness to tolerate ambiguity, and self-efficacy. In particular, buying low and selling high typically means defying the crowd, so that one has to be willing to stand up to conventions if one wants to think and act in creative ways. Note that none of these attributes are fixed. One can decide to overcome obstacles, take sensible risks, and so forth.

Motivation
Intrinsic, task-focused motivation is also essential to creativity. Others have shown the importance of such motivation for creative work, and has suggested that people rarely do truly creative work in an area unless they really love what they are doing and focus on the work, rather than the potential rewards. Motivation is not something inherent in a person: One decides to be motivated by one thing or another.

**Environment**

Finally, one needs an environment that is supportive and rewarding of creative ideas [16]. One could have all of the internal resources needed to think creatively, but without some environmental support (such as a forum for proposing those ideas), the creativity that a person has within him or her might never be displayed. Different cultures support creativity differentially and may even have different conceptions of what constitutes creativity so it is important to take the environment into account when assessing creativity.

**Confluence**

Concerning the confluence of components, creativity is hypothesized to involve more than a simple sum of a person’s level on each component. First, there may be thresholds for some components (e.g., knowledge) below which creativity is not possible, regardless of the levels on other components. Second, partial compensation may occur in which strength on one component (e.g., motivation) counteracts a weakness on another component (e.g., environment). Third, interactions may also occur between components, such as intelligence and motivation, in which high levels on both components could multiplicatively enhance creativity. Creative ideas are both novel and valuable. Creativity thus cannot be understood fully outside its societal context. From the investment view, then, the creative person buys low by presenting a unique idea and then
attempting to convince other people of its value. After convincing others that the idea is valuable, which increases the perceived value of the investment, the creative person sells high by leaving the idea to others and moving on to another idea. People typically want others to love their ideas, but immediate universal applause for an idea usually indicates that it is not particularly creative. [16]

1.4 IMPORTANCE OF CREATIVE THINKING

According to Sternberg, the abilities necessary for continual advancement and future achievements, participation in and contribution to public and social life, are the result of a symbiosis, i.e., the unification of intelligence, creativity and wisdom, referred to as Wisdom, Intelligence, Creativity, Synthesized (WICS). The abilities necessary for making various choices are controlled by individual elements of the WICS model or their combinations. Creativity is necessary, among others, for the manifestation of initiative, imagination and originality, to connect scientific achievements and practice, for the manifestation of the potential for the organization and realization of innovative research, for dedication to creative solutions, achievements and the visionary spirit. Therefore, creativity is the result of the simultaneous and joint functioning of all skills, i.e., without creativity, there is no promotion of good and useful ideas. [3]

1.5 CREATIVITY IN EDUCATION

In education, the term creativity is often used. As one experts points out, teachers might ask students to use their creativity in the design of a project, or might refer to a student's response as creative, without explaining what they mean.

The disciplinary theories on creativity do not help to frame the issue, as they often focus on outstanding performances, thus reinforcing the link between natural ability and creative achievements. Research has demonstrated that creative
eminent people have in common several personality traits; however this does not mean that creativity is limited to natural ability or talent. On the contrary, creative traits should be identified and studied in order to be able to duplicate and teach them.

The first step towards creative learning and innovative teaching requires an understanding of the meaning of creativity for education and its implication. This entails a threefold procedure:

1) a de-construction of several current myths about creativity which are leading to a shared misunderstanding of the issue
2) a discussion and framing of the implications of "newness and value" in the educational context
3) an emphasis on the process instead of the product

**Implicit theories or myths about creativity**

As Runco suggests, teachers, parents, children and other educational actors hold a tacit knowledge about creativity manifested in opinions and expectations, which are in sharp contrast with what the research is showing – and which can have detrimental effects on any attempts to foster creativity in schools. This tacit and shared knowledge builds up a series of "implicit theories", which account for how ordinary people think about creativity. These theories differ from the ones held and scientifically tested by researchers, which Runco calls "explicit theories" [2]. Figure 1.2 shows a series of implicit theories – or myths, about creativity and the opposite findings of scientific research.
Product or process?

Another aspect of the definition of creativity concerns the emphasis on the process instead of the product. If we look at products and achievements, children will seldom have an opportunity to be judged or to judge themselves creative when compared to adults. The focus on the development of thinking skills can be understood as a priority of the process over the product. This line of research has been exploited in particular by the aforementioned cognitive approaches. Moreover, learning is a process. Fostering creativity in learning certainly requires assuming a process-oriented approach. [2]

1.6 METHODS AND TECHNIQUES FOR TEACHING CREATIVE THINKING SKILLS

Many methods or techniques for creative thinking have been designed to assist individuals in generating original ideas. The use of the methods or techniques develops attitudes or habits of mind that make possible creativity. Practice with creative thinking skills does not mechanically consequence in the transfer of such skills to other circumstances.
The important role of teacher is to choose which strategies fit most smoothly with the content and the developmental level of the students. Although many techniques, such as SCAMPER, brainstorming, can be used at almost any level, others, such as some of the more sophisticated uses of project-based learning, are best for students with more highly developed abstract thinking abilities. Only the teacher can determine which ideas are best for his or her students, how they can be adapted, and which areas of the students' lives may provide the best opportunities for transfer. Teachers must teach students the general techniques that involve them: how to use them, when to use them, and under what circumstances they might be useful. Students should practice techniques in various circumstances and discuss their application with teachers, which can enhance the possibility that they will be seen in life's situation.

The following are the major methods or strategies for creative thinking skills which are designed to help generate new ideas. These techniques describe how they work and how they might be used with students. They also offer suggestions for helping students transfer the techniques from classroom exercises to real-life habits of mind.

1.6.1 Visualization and creative dramatics techniques

Both these techniques involve bringing ideas to life, one in the imagination and the other in physical activity.

1.6.1.1. Visualization technique

Visualization plays a crucial role in creating mental images of something that cannot be seen or does not exist. In fact, for many of us, images probably are laden with emotion. In either case, a mental image demonstrates one
characteristic of visualization: clear visual images are frequently accompanied by powerful corresponding emotions. This combination can make visualization a potent learning tool, but one that must be used with caution and sensitivity.

To reinforce course content visualization can be used. Students will need previous knowledge and careful guidance if their images are to increase their content knowledge effectively. Visualization assisted in this way is sometimes called guided imagery. To be most effective in stimulating this type of visualization, the teacher should have a script, written or mental, of the images to be portrayed. When the teacher guides them through the content, students can be encouraged to sit in a comfortable position, usually with their eyes covered or closed. The descriptions and suggestions should be presented slowly and clearly, with time approved for students' images to develop.

Another asks participants to visualize aspects of the situation enacted by an animal. The visualization, in each case, is used to activate new ideas and points of view. Finke is one of the more interesting results of research was that subjects, generally college undergraduates, were more successful at devising creative inventions when the task was somewhat restricted. Subjects given a large range of shapes from which to create any creation were less creative in their responses than those given a limited number of images from which to work and a particular category of object to create. Surprisingly, subjects also had more original ideas when they generated a pre inventive form combining images into an interesting and potentially useful shape before identifying the category of object to be devised instead of trying to sketch a form to suit a particular division. [10]

Doing research with variations on Finke's techniques with younger students would be fascinating. They could be given specific geometric forms to visualize,
control mentally, and use to create new ideas for inventions. It also may be useful to consider if the notion of controlled tasks could be precious in teaching other creative thinking techniques.

1.6.1.2 Creative Dramatics technique

In creative dramatics, students have the opportunity to be someone or something else in a safe and accepting situation. Students are asked to explore ideas with their bodies as well as their minds through problem-solving activities. This method can be valuable for developing concentration, sensory awareness, self-control, empathetic understanding, and a sense of humour.

Creative dramatics activities can be classified into three stages. They are:
- warm-up
- dramatic activities
- debriefing.

- Warm-up exercises are used to warm up both brain and body. Warm-ups can include the following:
  Mirrors: Each student requires a partner. One person becomes a mirror, reflecting each movement the partner makes. Mirrors work most easily with slow, smooth movements. Occasionally students may be focused to switch roles without trouble making the flow of the movement.
  Relaxing: Students lie on the floor and relax one group of muscles at a time.
  Stretching: Students draw out all their muscles from the head down. Students should be cued to draw out as many muscles separately as possible.
  Walking: Students walk in place under a variety of circumstances: through the jungle, on hot sand or going to school when their homework is not done.
Catch: Students play catch with a variety of imaginary balls. They should try switching from a soft ball to a beach ball to a bowling ball.

- Dramatic activities may include movement exercises, sensory-awareness exercises, pantomime, and other forms of storytelling. Movement exercises are designed primarily to aid the students gain command of their bodies and become aware of how their bodies move. Other movement activities could include the following:

  Animals: Students mimic animals’ movements and mannerisms. Secondary students may develop human characters based on some aspect of the chosen animal.

  Puppets: Students feign to be pulled by strings connected to various parts of their bodies.

  Tug-of-war: Students are separated into teams pulling an imaginary rope over an imaginary line.

Sensory-awareness exercises are the exercises which are precisely designed to boost students' awareness of their five senses. The teacher may ask his or her students to eat imaginary food, listen to imaginary sounds, or feel imaginary textures. He may find that limiting one of the senses can enhance the others. These may range from simple activities to complex problem-solving scenarios. More complex dramatic activities may require a planning phase as well as an acting stage.

- Debriefing

A debriefing discussion enhances the most creative dramatics activities. Students may talk about what they did, how it felt, what worked, what did not, and what they might try another time... These discussions make it clear that creative
dramatics activities. They are kinaesthetic activities that can bring insight into a variety of situations. [10]

1.6.2 Divergent thinking strategies

Many techniques of creative thinking are designed to enhance students' divergent thinking or their ability to think of many different responses to a given situation. The most prevalent meaning of divergent thinking includes: fluency (thinking of many ideas), flexibility (thinking of different divisions or points of view), originality (thinking of unusual ideas), and elaboration (adding detail to improve ideas). The four crucial areas in this explanation indicate that fluency often is the basis of activities designed to improve divergent thinking. “Trying to think of ideas that solve the problem in a different way encourages flexibility” [10]. Try to think of something no one else will think of are designed to elicit originality, whereas “how can we build on this idea?” encourages elaboration. Thus, assisting students see how divergent thinking fits into the whole of creative thinking is very important. It is not creativity if divergent thinking alone is employed. Finding a problem or issue worth addressing, generating ideas for addressing it and evaluating the ideas generated all are involved in creativity.

1.6.2.1 SCAMPER technique

SCAMPER is a mnemonic acronym that provides a structured way to assist students and teachers with understanding creative problem solving and developing extension-building activities based on prior ideas and processes. First proposed by Alex Osborne in 1953, this thinking strategy was further developed by Bob Eberle and noted in his 1971 book, SCAMPER: Games for Imagination Development. Eberle states that much as the word SCAMPER suggests “running playfully about as a child”, the strategy SCAMPER may also evoke the need “to
run playfully about in one’s mind in search of ideas”. Why is creative problem solving useful to teach? Assisting ourselves and our students’ to be creative and critical thinkers are key goals of any teacher or school. Yet, you may ask, why is SCAMPER so useful? Creative problem solving strategies involve “a system, a method, a plan for dealing with perplexing situations”.

The SCAMPER technique offers a systematic and practical way to stimulate divergent thinking, imagination, originality, and intuition while scaffolding students’ creative thinking for independent use on other tasks and assignments. Besides, the acronym SCAMPER can be an useful tool for many creative endeavours other than visual imagery as it is easy to remember, it can assist children as well as adults in using the idea-spurring questions that can help them generate diverse ideas. Each of the letters in the acronym SCAMPER stands for a stage in the process. They include the following elements:

The S in SCAMPER denotes SUBSTITUTE. Substitutions is a trial-and-error method where you can try things out, see if it works, then try something different.

The C indicates COMBINE. Combining involves synthesis, the process of combining previous ideas or things together to create something new. For example, Picasso used this technique to recombine elements of figures or objects that had been taken apart. For new story ideas, characters from diverse literary forms could be combined.

The A stands for ADAPT. Think about what is already known about the problem and how others are solving it. Become aware of the process others are using. For instance, to solve the problem, many computerized communication programmes
for individuals without speech began as adaptations of boards that allowed the user to point (or blink) at the desired word.

The M indicates MODIFICATION. When you modify and alter something, you reflect on what is needed to support and make it better, greater, simpler, or even more complex. Magnifying will concentrate on making things bigger, thicker, stronger, or more intense. Minifying will concentrate on makings lighter, slower, less frequent, or reduced in some capacity.

The P stands for PUT to other uses. Consider ways that the target can be used other than originally intended. Using resalable food storage bags to organize a suitcase, planting flowers in an old wheelbarrow, and recycling plastic milk jugs as part of a stage set all are examples of putting materials to use other than those for which they were planned.

The E is for ELIMINATE. Elimination means removal or omittance part or all of a particular quality. If using elaborate, to add more details. In some schools, efforts to lessen cafeteria clamour were eliminated when would-be problem solvers determined that as long as students can hear emergency signals over the cafeteria noise, it may be good for students to talk in the cafeteria, or that the energy spent trying to keep them from doing so could more profitably be spent in a different place.

The R indicates REARRANGE or REVERSE. When using rearrange, consider how the change of order or sequence would affect the target or challenge. When using reverse, focus on the opposite or contrary meaning.
Next, go through each letter of the SCAMPER acronym using helper questions. Ask yourself questions for each SCAMPER letter in order to gain perspective and practice in creative thinking.

<table>
<thead>
<tr>
<th>S</th>
<th>Substitute</th>
<th>What or who can be used instead? What other ingredients, place, or time? Other material? Other Process? Other power? Other place? Other approach? Other sounds?</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>Combine</td>
<td>What materials, features, processes, people, products, or components can be combined?</td>
</tr>
<tr>
<td>A</td>
<td>Adapt</td>
<td>Is there anything that can be changed? What else is like this? What could be copied?</td>
</tr>
<tr>
<td>M</td>
<td>Modify</td>
<td>Can you change the meaning, color, motion, sound, smell, form, or shape? Can you distort it?</td>
</tr>
<tr>
<td>P</td>
<td>Put to Other Uses</td>
<td>Are there new ways to use or reuse it? Is there another market?</td>
</tr>
<tr>
<td>E</td>
<td>Eliminate</td>
<td>Can you reduce time, effort, or cost? Can you remove part of it?</td>
</tr>
<tr>
<td>R</td>
<td>Rearrange Reverse</td>
<td>Can you interchange components or patterns? Can you change the pace or schedule? Can it be reversed?</td>
</tr>
</tbody>
</table>

Table 1.1: Letter of the SCAMPER acronym

The most crucial understanding is that all or parts of the SCAMPER acronym can be employed any time teachers/students need to generate many ideas or solve a problem. They do not have to sit and wait for ideas to explode into their heads, but can use the SCAMPER questions to help the ideas come.

1.6.2.2 Brainstorming technique
Brainstorming is probably the most familiar thinking strategy among all the strategies for generating ideas. The process of brainstorming strives for a non-judgmental helpful mood in which idea production can increase.

Brainstorming can be an appropriate strategy any time a student wishes for a large number of ideas. This occurs most often when he needs to solve a problem or come up with a new, original idea. Students could brainstorm synonyms for an overused word, characteristics for the school newspaper, new endings for a story, options for making a graph, strategies that might have aided a historical figure, options for making a graph, variables for a possible science experiment, or strategies for reducing cafeteria noise.

STARBURSTING (5W’s and 1H)

Starbursting is a form of brainstorming that focuses on generating questions rather than answers. It can be used iteratively, with further layers of questioning about the answers to the initial set of questions.

How to use this tool?

The best way to see the power of this simple but effective technique is to think of a product, challenge or issue to work on, and follow these steps:

- **Step 1**: Take a large sheet of paper, draw a large six-pointed star in the middle, and write your idea, product or challenge in the centre.
- **Step 2**: Write the words "Who", "What", "Why," "Where," "When," and "How" at the tip of each point of the star.
- **Step 3**: Brainstorm questions about the idea or product starting with each of these words. The questions radiate out from the central star. Don't try to answer any of the questions as you go along. Instead, concentrate on thinking up as many questions as you can.
• **Step 4:** Depending on the scope of the exercise, you may want to have further starbursting sessions to explore the answers to these initial questions further.

Figure 1.3 below shows some of the questions you might generate in a short starbursting session, focused on the skates mentioned above.

![Figure 1.3 Questions in Starbursting session](image)

**1.6.2.3 Negative (Reverse) brainstorming technique**
Negative brainstorming or reverse brainstorming is another way to brainstorm. Negative brainstorming applies the same basic rules as in regular brainstorming, but it analyzes the negative aspects of a problem or more precisely the negative results of a product or an important decision. [1]

Regular brainstorming identifies different solutions for a problem, but in the case of negative brainstorming, it identifies the problems that are difficult to solve by direct solutions.

A negative brainstorming session could start out by turning the problem upside down, meaning if we want to produce a new product in the case of brainstorming we would try to figure out what new product we should create and every member of the team would come up with different ideas. In the case of negative brainstorming every member of the team would focus on finding ideas regarding the products that we shouldn’t create or produce for various reasons.

Negative brainstorming is mainly used as a strategy to promote critical thinking and to focus on the tasks. It is useful to verify a new proposal or to evaluate tactics, practices, and it can be used in any situation, not only when we talk about difficult or important decisions or products.

By using the negative or reverse brainstorming we become more conscious of the negative aspect of the problem, especially of the risk that may occur during the process (a new product, a new partnership) we want to start.

Using the negative brainstorming method involves three stages:

First stage
After issuing a promising ideas (or clarify an existing practice or strategy), the team searches for issues or negative consequences. Brainstorming should be as bold as its positive alternative from the classical approach. The intention is to get a list of all the negative elements of the idea or strategy, no matter how unfounded or exaggerated they may seem.
Second stage
The team's members choose four or five of the strongest criticisms and examine them in detail. At least one of them would prove to be unfounded or exaggerated.

Third stage
The team examines how the idea or existing practice could be modified to resist, in turn, to each higher criticism. This stage is essentially constructive, as the group tries to shape the strategy to prevent major shortcomings. It can happen to identify but a difficulty or a fundamental disadvantage which the group can’t discard. In this case the idea or the practice should be abandoned. However, such a story is good, helping us to discover in time the negative aspects of an approach or proposal.

Reverse brainstorming is useful when an idea has reached the stage of adoption and implementation in the decision making process. In addition to reporting weaknesses of the project, before the implementation of the strategy, encourages the trial design. People are afraid not to offend anyone and therefore retain their criticisms. The mentioned approach clarifies that members criticize ideas and practices. As a result of the common practice of this method, people come to accept the idea that "expressing criticism is a manner to improve different views and opinions that sometimes might be incorrect, and so a fresh mind can help.

1.6.2.4 Fish bone technique
The fishbone technique uses a visual organizer to identify the possible causes of a problem. This technique discourages partial or premature solutions and demonstrates the relative importance of, and interactions between, different parts of a problem.

On a broad sheet of paper, draw a long arrow horizontally across the middle of the page pointing to the right. Label the arrowhead with the title of the issue to be explained. This is “backbone” of the “fish”. Draw “spurs” from this “backbone” at about 45 degrees, one for every likely cause of the problem that the group can think of, and label each. Sub-spurs can represent subsidiary causes. The group considers each spur/sub-spur, taking the simplest first, partly for clarity but also because a simple explanation may make more complex ones unnecessary. Ideally, the fishbone is redrawn so that position along the backbone reflects the relative importance of the different parts of the problem, with the most important at the head.

![Fishbone Map](image)

Figure 1.4: Fishbone Map
1.6.3 Mind mapping technique

Mind mapping is a powerful graphic technique which is developed by Tony Buzan in the late 1960’s. This technique helps individuals express the knowledge and concepts visually through images, drawings and pictures.

Mind mapping is claimed to get students to learn meaningfully. Individuals may use their brain wholly, retrieve their acquired knowledge and reflect the current knowledge through mind mapping. Moreover, through this technique learners mind correct their contextual mistakes and make necessary amends. In this study, tries to tackle the mind mapping technique effective in students’ recalling their knowledge, their connecting the previous knowledge to the new one, releasing meaningful learning, determining the current fallacies and overcoming them through exemplifications. [25]

By using such pictorial and graphical design flourishes, mind mapping can make learning and teaching more vivid and thus can promote memory retention as well as enhance the motivation of the learners. It is also believed that there are no limits on the ideas and links that can be made, and it is not necessity to retain an ideal structure or format. Thus, mind mapping promotes creative thinking, and encourages brainstorming.

Many teachers have seen difficulties in teaching their course effectively while many students have also faced difficulties in learning the course taught. Some experts also mention that mind mapping have been widely used in education in brainstorming ideas, training and development, organizing ideas and problem solving. Based on these, we conceive that mind mapping has positive effect on teaching and learning.
The mind mapping has four essential characteristics: The subject attention is crystallized in a central image, the main themes of the subject radiate from the central image as branches, branches comprise a key image or key word printed on an associated line, and the branches form a connected nodal structure.

1.6.4 Project-based learning (PBL) method

As early as 1900s, John Dewey, the father of progressive education supports ‘learning by doing”; he promotes teaching strategies that helped students actively engaged in learning about topics relevant to their lives. From that, most teachers, knowing the value of engaging, challenging projects for students, have planned field trips, laboratory investigations, and interdisciplinary activities that enrich and extend the curriculum. It means that “Doing projects” is a long-standing tradition in American education. Over the last 40 years, educators have developed teaching/learning strategy and designed curriculum which is problem-based learning (PBL). It is a model that organizes learning and teaching around projects which are complex tasks, based on challenging questions or problems.
Blumenfeld puts forward an important definition of PBL: “PBL is a comprehensive, deep learning approach to classroom teaching and learning that engages students in the investigation of authentic problems”. He also points out the important characteristic of PBL: doing being center on real-life problems which capture students’ interest. [11]

PBL contains most of the principles which educators need to improve skills for students. PBL also focuses on real life’ situations and promotes higher order thinking, such as: problem solving, analysis, decision making, critical thinking and creative thinking.

PBL approach engages students in exploring important and meaningful questions through a series of investigations and collaborative activities. These students ask questions, collaborate with each other in designing their investigation activities, collect and analyze data, share ideas, draw conclusions and create final products. These active investigations enable them to learn concepts, and apply information in creating their final products which is vital in constructing new knowledge. And the below flowchart show the steps to design a project:
Figure 1.6: Outlining the implementation of PBL projects

As a student-center approach, the role of teacher or lecturer in PBL shifts from “sage-on-the stage” to “guide-on-the-side”. This can create new challenges for the lecturer, requiring additional training, support and resources. A common description of the teachers’ role in the PBL literature is that of “facilitator” or “mentor”. It means that “The teacher’s role changes from a distributor of knowledge to a process manager, helping students in their learning process by initiating reflection processes and supporting them, if necessary, on substantive matters”. [1]
The new role of students is encouraged to take more responsibility for their own learning, decide on topic & methods and determine their own learning needs. Projects are largely “student-driven” in which students are independence and responsibility for their own learning as the key characteristic of PBL.

1.6.5 Six thinking hats technique

The Six Thinking Hats “thinking strategy” was developed by Edward de Bono (1987). This popular strategy is used to promote parallel thinking and to help students look at a problem or decision from many different perspectives. It is used in education and a variety of industries and businesses for training and decision making.

The Six Thinking Hats strategy uses the metaphor of “put on your thinking hat” to mimic a change of thought processes as one puts on or takes off a hat. Each colored hat represents a specific area to focus on when focus to consider ranging from looking at topic for new ideas, from a neutral and objective perspective, while taking an alternative perspective, with opportunity in mind, while focusing on emotions, or to consider the overall issue at hand [4].

De Bono has designed a very simple model but when applied correctly, it can augment creative thinking and create opportunities for solving any problems that might be confronted. The model reflects De Bono’s belief that “simple methods used effectively are more valuable than complicated methods that are difficult to understand and confusing to use” [4]

Table 1.2: Synthesis of De Bono’s six thinking hats model.

<table>
<thead>
<tr>
<th>Colored Hat</th>
<th>Conceptual Meaning of Each Colored Hat</th>
<th>Bloom Taxonomy</th>
</tr>
</thead>
</table>
| Black hat thinking | • Cautious critical thinking  
• Questioning, checking and checking out the feasibility of alternative approaches to problem | Caution, Risks, Judgment |
<table>
<thead>
<tr>
<th>Colored Hat</th>
<th>Conceptual Meaning of Each Colored Hat</th>
<th>Bloom Taxonomy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>solving</td>
<td>(Bloom’s analysis and evaluation)</td>
</tr>
<tr>
<td></td>
<td>▪ Assessing situation being confronted</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Trying to identify what’s wrong so as to fix it.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Examining the weaknesses in suggested approaches.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Evaluating and passing judgment about bad points.</td>
<td></td>
</tr>
<tr>
<td>Blue hat thinking</td>
<td>▪ Organizational critical thinking.</td>
<td>Thinking about thinking, Metacognition, Summarizing (Bloom’s comprehensio n and application)</td>
</tr>
<tr>
<td></td>
<td>▪ Metacognition</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Questioning organizational thinking to problem solving</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Assessing past performance</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Analysis of our situation:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Where have we been? Where are we now?</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Where do we want to be? How do we get there?</td>
<td></td>
</tr>
<tr>
<td>Green hat thinking</td>
<td>▪ Creative, critical thinking and problem solving</td>
<td>Creativity, New Ideas, Brainstorming, Predicting (Bloom’s synthesis)</td>
</tr>
<tr>
<td></td>
<td>▪ Coming up with the ideas to advance understanding</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Critical analysis of alternative ways to solve current problem.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Envisioning new ways to solve problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ Coming up with hitherto non-considered proposals</td>
<td></td>
</tr>
<tr>
<td></td>
<td>▪ How about trying this new approach to problem</td>
<td></td>
</tr>
<tr>
<td>Colored Hat</td>
<td>Conceptual Meaning of Each Colored Hat</td>
<td>Bloom Taxonomy</td>
</tr>
<tr>
<td>-----------------------</td>
<td>-------------------------------------------------------------------------------------------------------</td>
<td>----------------------------------</td>
</tr>
</tbody>
</table>
| Red hat thinking      | ▪ Critical thinking expressing personal feeling emotions  
▪ Being intuitive as we approach a problem to solve  
▪ Drawing upon personal feelings and hunches  
▪ Allowing feelings to be expressed without need for justification  
▪ It is okay to fell different. | Feelings, Emotions, Intuition  
(Bloom’s evaluation) |
| White hat thinking    | ▪ Calling for information that facilities problem solution  
▪ Gathering data to understand the issue or problem to solve  
▪ Asking questions about available evidence  
▪ Raising questions about additional data needed to get to the truth.  
▪ What information do we already have? What does it tell us about the problem?  
▪ What more information do we need to solve this problem? | Facts, Information, Data, Research needed  
(Bloom’s knowledge) |
| Yellow hat thinking   | ▪ An optimistic approach to problem solving  
▪ Here are the good points in our favor as we approach this problem.  
▪ These are our strengths that we can use to solve this problem.  
▪ We can do this because of these reasons  
▪ This alternative approach will enable us to solve | Benefits, Good, Value, Strengths  
(Bloom’s analysis and evaluation) |
Planning for Instruction

At the beginning, before using the strategy, you may want to consider the following regarding planning for instruction:

- The hats may be used one after another in a sequence. They should not be used at the same time.
- Any hat may be used as often as you like. Students can use a hat during one part of the assignment and then move onto another hat, but still come back to their original hat, and other used hats, later on.
- Blue hats are often used before reading/assignment and after a reading/assignment.
- If this is your first time using the strategy you will want to model it using the entire class before moving into smaller groups.
- Remember to use a variety of texts with the strategy.
- Allow for time and practice so that students develop ownership of each type of "thinking".

Procedure

- Determine a topic that would offer the opportunity for students to apply multiple perspectives. Consider using a reading to go along with the topic.
- As the teacher, activate prior knowledge on the topic with the class. You may want to start with blue hat within the large group to go over what might already be known about the topic.
- Take time to model the strategy if this is the first time students are using it or if they need more support. Modeling is very important; model what kind of
thinking is involved with each hat first and provide guided support as students apply what they learned.

- Pass out the six hat strategy sheet. While completing the reading assignment students should consider each hat’s focus and write down notes, thoughts, and opinions they derived from the reading.

- In small groups have students listen to the thoughts each one has on the topic, each taking turns “wearing” the different hats. Each person should only wear a hat for approximately one minute dependent on group size and during that time they should discuss their findings. Remember, hats should be worn one at a time, but can be taken on and off as needed if something needs to be reviewed or reconsidered.

- As each participant gives their input on the topic, the facilitator of the group should take notes on a six hat handout.

- When everyone has given input, the group can come up with further questions to challenge and explore the ideas they’ve presented to each other. The blue hat should be revisited and a summary created.

- Students should then come together as a class to discuss the topic and findings.

As illustrated in Table 1.2, wearing the green hat brings the perspective of organizational creative thinking and meta-cognition. This makes green hat thinking different from all the other hats because while the other hats are concerned with thinking about how to solve a particular problem, green hat thinking is focused on creating something new, approaching new ideas thinking about thinking that will lead to a solution. Thus, De Bono justifies its color as follows:

- Creativity, New Ideas, Brainstorming, Predicting (Bloom’s synthesis)
- Creative, critical thinking and problem solving
- Coming up with the ideas to advance understanding
- Critical analysis of alternative ways to solve current problem.
- Envisioning new ways to solve problems
- Coming up with hitherto non-considered proposals

1.6.6 Creative questions and problems

System of questions and exercises are the requirement of teachers to apply lessons into solving problems. According to some educational consultants, students can understand the lessons as well completely and clearly understand the knowledge because of answering the questions and doing the exercises.

System of questions and exercises are one of the best teaching way, which leads to the development of imaginable ability, real applications and solving problem skills for students. The affect of questions and exercises are:

- Expand and test the knowledge of students
- Review, cultivate and systemize the knowledge
- Practice and test skills
- Improve the cognition and creative thinking for students. Some exercises are required solving by various methods, which gives students the change to increase skills and the creative thinking.
- The new points are also investigated by exercises and questions, which is conducive to the active and creative thinking of students.

1.7 CREATIVE CLASSROOM

One of the easiest ways of introducing creativity in the classroom is by posing questions which, apart from knowledge of facts, require analytical and divergent thinking, building self-efficiency, defining and redefining problems, encouraging idea generation and allowing for making mistakes. Besides, creativity could be
stimulated in practice by encouraging students to ask more questions in the course of acquiring new scientific notions, or questions arising out of personal interests. Students should also be encouraged to investigate the reasons for their personal observations, to propose solutions to situations and problems from everyday personal or social life, to experiment and try things in safe surroundings.

When educators plan for teaching and learning which encourages creative thinking, they must be themselves thinking creatively. The essence of creative thinking is a questioning and challenging approach to knowledge and a list of components that need to be present in a creative classroom at which creative thinking takes place. The creative model is seen as ‘creative ecosystem’ which consists of the following interrelated elements:

- Opportunity for play and experimentation/exploration
- A non-threatening atmosphere in which learners are secure enough to take risks and make mistakes
- Activities presented in exciting or unusual contexts
- Opportunity for generative thought, where ideas are greeted openly
- Opportunity for critical reflection in a supportive environment
- Children given a sense of engagement and ownership of ideas and tasks
- Respect for difference and the creativity of others
- Choices given to children in terms of resources and methods.
1.8 ROLE OF TEACHERS

The teachers’ important role in creative education is to promote creative thinking and encourage students to express innovative ideas. Educators must prepare the younger generation to think for themselves so they can solve new and challenging problems and adapt to our ever changing world. To be successful, individuals must be able to understand the process, and synthesize information into unique ideas, purposes, and products. Teachers (in a creative education program) should be open-minded, seek imaginative solutions to problems, and encourage students to do their own thinking. They should also value originality, mention that several solutions may exist for any given problem, and engage the class in meaningful activities that incorporate individuals’ abilities, interests, and backgrounds.

1.9 CREATIVITY IN CHEMISTRY

Chemistry as a part of science is an essential domain of the school curriculum. The chemistry teaching has the potential to encourage students to think flexibly in order to increase a variety of approaches to solving problems and, in that way, to contribute to development of learners creative capacities. The assumption that chemistry can stimulate creativity depends on the way chemistry is taught. [5]

The chapters about Atom and periodic table are the first knowledge in the high school. That knowledge keeps the important role in chemistry subject in high school because these chapters contain the basic necessary theory and directs the next parts of chemistry. It is the most difficult part which consists of the abstract knowledge with the various definitions. So, the teachers are easy to get little trouble when studying these parts and students are also hard to deeply understand.
With the purpose of practicing leaner’s logic, we use the vast creative teaching method in order to make the lessons for these of two chapters. I admit that there are many mistake in my thesis, after all I want to receive much advice from you, which results in a better document.

1.10 ACTUAL SITUATION OF TRAINING CREATIVE THINKING THROUGH CHEMISTRY FOR HIGH SCHOOL STUDENTS

1.10.1 Purpose and investigation method:

- Purpose: Have a thorough grasp of the real situation in teaching creative thinking for high school students.
- Method:
  - Collecting opinions from chemistry teachers in high schools: finding out the practical method and evaluation method which chemistry teachers use to train creative thinking.
  - Communication with other chemistry teachers in high school: making the relation with teachers and students in order to deeply understand the teaching creative thinking for students.

1.10.2 Results

This investigation is carried out in 2 schools in Hanoi with 20 chemistry teachers. The results are showed below:

<table>
<thead>
<tr>
<th>Categories</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Agree</td>
</tr>
<tr>
<td>The behavior of students about</td>
<td>50.0%</td>
</tr>
</tbody>
</table>
Table 1.3: The investigation results of training creative thinking in chemistry for students.

<table>
<thead>
<tr>
<th>creative thinking ability</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>The level of teaching creative thinking for students</td>
<td>40.0%</td>
<td>60.0%</td>
</tr>
<tr>
<td>The evaluation method of creative thinking ability from teachers</td>
<td>50.0%</td>
<td>50.0%</td>
</tr>
</tbody>
</table>

[Result]

- Almost teachers think that students may contain the behavior of creative ability. (90%).
- A few teacher focuses on innovating the teaching method which concentrates on training creative thinking for students. However, they realize that there are many skills on the lessons which prevent teachers helping students in creative thinking.
- Although the teachers also think that the creative thinking ability of students is necessary but difficult; so few teachers only test this ability in program and educational system.
- In briefly, despite the important role of creative thinking, the improvement of this ability for students in chemistry is still not the first priority.
BRIEF CONCLUSION OF CHAPTER I

In chapter 1, we deeply investigate the basic theory and actual event of this topic. In detail:

- Bloom’s Taxonomy và Bloom’s Revised Taxonomy. The role of creative thinking in this Bloom’s Taxonomy and Bloom’s Revised Taxonomy.
- Creative thinking: definition, the nature of creativity and the importance of creative thinking.
- Creative thinking in education, and the method as well as the technique in teaching creative thinking skill. In addition, the roles of teachers in teaching creative thinking are also mentioned.
- The real situation (methods and techniques) in teaching creative thinking through out chemistry in high schools in Hanoi.

All above results is the base for us to highly study and make advanced idea in methods and techniques in teaching creative thinking for high school students with the most effective.
CONCLUSION AND PETITION

CONCLUSION

Depending on the purpose, aim and the results of research, this thesis mostly completes its’ tasks. For more detail:

1. Investigating the rationale about creative thinking: definition, the nature of creative thinking, methods to train the skill for high school students and how to evaluate creative thinking in education.
2. Studying the basic chemistry program in the first year of high school, especially chapter 1 and chapter 2.
3. Investigating the trend and innovation of teaching methods in recent years. Moreover, we also investigate about training creative thinking through chemistry teaching for students in high schools.
4. In each lesson, we give a variety of relative examples which improve the creative thinking for students. Beside, the students also summarize the lesson by a story, mind map or others in order to memory the lesson and apply that knowledge in the real situation. Moreover, 80 questions and exercises in two chapters: chapter 1 (Atom) and chapter 2 (The periodic table and the periodic law) are given to improve the creative thinking of students. Thanks to these, the
students are encouraged to solve the exercises by multiple solutions as well as the most creative way.

5. Two 10 class in one school is chosen for experiment. Basing on the good results of the experiment class, we believe that the scientific hypothesis of this thesis is possible.

PETITION

A good teaching method depends on many factors such as the skills of teacher, the equipments ... We have some petition which may support to apply creative thinking method into high school much better:

1. Equipped schools with complete tools for subjects. Each class should serve from 25 to 30 students, which give a big change for teachers to help all students in learning and students can also raise the sense of initiative and creative.

2. TeacherS should show the relationship between the chesmistry and the real world. Thanks of these, students can apply the lesson into the real world.

3. The co-operation between all teachers is really necessary in order to set up a system of creative data bases (teaching plans, questions and exercises). Thanks to this co-operation, other teachers and students can improve their creative thinking.
REFERENCES


