PROJECT-BASED LEARNING IN RELATION TO HIGHER ORDER THINKING ABILITIES AND CREATIVITY AMONG UNDER-GRADUATE STUDENTS

ABSTRACT

THESIS SUBMITTED FOR THE AWARD OF THE DEGREE OF

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BY

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Introduction

Globalization on a fast track, economy redefined and the way networked communications has exploded, have all resulted in a change. Global economies need educated people as citizens of today and tomorrow. Learning in the 21st century is definitely a lot different from learning in any other century. How can students be prepared to succeed in the 21st century? This is a question of paramount importance to the country’s educators, employers, parents and the public. Our community vibrancy, personal quality of life, economic viability and business competitiveness depends on a well-prepared citizenry and workforce. Education provides the bedrock from which our national and individual prosperity rise together. The education in science and mathematics that students receive from kindergarten through 12th grade forms the foundation of the nation’s scientific, mathematical, and technological literacy. The nation needs a compelling vision for education that will inspire education leaders, teachers, parents and students alike. Today’s education system needs to bridge the gap between what students learn and how they live. Hence, it is very important to prepare students for the challenges of work and life in the 21st century.

SIGNIFICANCE OF THE STUDY

In project-based learning, all learning activities are anchored to a larger project or problem (Blumenfeld et al., 1991). Project-based learning is closely related to problem-based learning (where learning is driven by challenging, Open-ended problems) and the two terms are occasionally used interchangeably. Both concepts are based upon a constructivist model of human cognition (Savery and Duffy 1994) which
contends that true knowledge lies in our interactions with the environment, rather than in detached or decontextualized "facts". Project-based learning is further motivated by activity theory (Jonassen and Rohrer-Murphy, 1999). Activity theory places learning firmly in the perspective of contextual human praxis, and argues that conscious learning emerges from activity rather than as a precursor to it. Another important motivation for project-based learning is the emphasis it places on teamwork. The ability to work in a team is often cited as the most important skill employers look for in candidate employees. Teamwork in project-based learning can be understood through the concept of distributed cognition (Nardi, 1992). Also, more important, evidence shows that PBL enhances the quality of learning and leads to higher-level cognitive development through students' engagement with complex, novel problems. It is also clear that PBL teaches students complex processes and procedures such as planning and communicating.

TITLE OF THE STUDY

The chosen topic of present study is "Project-Based Learning in relation to higher order thinking abilities and creativity among undergraduate students".

The goals of the research

OBJECTIVE AND HYPOTHESES:

The following are the objectives to study the relationship between instruction method based on project-based learning & the development of students' thinking skills.

1. To study the relationship between instruction method based on project-based learning & promotion of students' thinking skills.
2. To study the relationship between instruction method based on project based learning & promotion students’ creativity.

3. To study the relationship between instruction method based on project based learning & development of skills students’ of problem solving.

4. To study the relationship between instruction method based on project based learning & advancement of skills students’ in team-collaborating.

5. To study the significant difference between girl & boy students in promotion of thinking skills.

6. To study the significant difference between girl & boy students in development of creativity.

7. To study the significant difference between girl & boy students achievement of skill in problem solving.

8. To study the significant difference between girl & boy students advancement of skill in team-collaborating.

9. To study the significance of difference on promotion of thinking skills between experimental & control groups.

10. To study the significance of difference on achievement of creativity between experimental & control groups.

11. To study the significance of difference on promotion of skills in problem solving between experimental & control groups.
2. To study the significance of difference on advancement of skills in team-collaboration between experimental & control groups.

METHODOLOGY

Sampling:

The target population for this study consisted of students, (N=168) from different schools in QOM. In these groups, 84 persons will be in a control group for which no intervention of project based learning training will be provided.

Administration:

The experimental group consists of students who will be selected in order to receive training on project based learning. During the six sessions the classes, students will be engaged in project-based learning. Before the PBL is introduced the student will be given pre-test and after the completion of PBL post-test will be given. The analysis of data will be done. Sampling method used is systematic random sampling and by using T-TEST:

It is an experimental research. This study aims to explore the relationship between instruction method based on project based learning & development of students’ thinking skills.

RESEARCH HYPOTHESE:

1. There is no significant difference between experimental and a control group in the development of student’s thinking skills.
2. There is no significant difference between experimental and control groups in the development of student's creativity.

3. There is no significant difference between experimental and control groups in the development of student's problem solving.

4. There is no significant difference between experimental and control groups in the development of student's team-collaborating.

5. There is no significance of difference in the development of thinking skills among girl & boy students.

6. There is no significance of difference in the development of creativity among girl & boy students.

7. There is no significance of difference in the development of problem solving among girl & boy students.

8. There is no significance of difference in the development of team-collaboration among girl & boy students.

9. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's thinking skills.

10. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's Creativity.

11. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's problem solving.
12. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's team-collaboration.

INSTRUMENT/TOOLS USED:

For collecting relevant information for the present study, four questionnaire researcher-made were used to measure the variables.

PROJECT-BASED LEARNING QUESTIONNAIRE:

The PBL questionnaire has been developed by Barbara A. Soloman and Richard M. Felder (2000) in North Carolina State University on the secondary school. The inventory contains 20 items. It provides 4 separate indicator and dimensions of PBL. It also gives a total PBL score. The test was modified by the researcher to suit visually challenged students.

PROCEDURE:

In each class, the first session was confirmed of familiarizing and introducing researcher and student with each other and the teachers, and then students responded to a pre-test questionnaire which included 20 questions (5 question covered thinking skills, 5 question creativity, 5 question problem solving & the last 5 question team-collaborating). The questionnaire was researcher-made and each question made assessment of a criterion skill. It's necessary to mention that material was changed in the second's lesson in science book. In the first lesson, students learn about materials, molecules, and how to set molecules, and familiarity with scientific methods included: observation, classification, combination, analysis and conclusion.
Conclusion:

Thinking Skills, Creativity, Problem Solving and Team-Collaboration as parameters of PBL method, are considered determinant factor in higher order thinking.

In the first section of this chapter, we stated the relations of PBL parameters in experimental and control groups in comparison with related studies, and tested the hypotheses of this research.

Since in this study, research subjects are dependent on research questions, so in this section by answering the hypotheses of research we try to conclude thesis.

1. There is no significant difference between experimental and control group in the development of student’s thinking skills.

This question is one of the most important effective aspects of PBL on our dependent variable. To answer the first question of our analysis, we conducted the Mann – Whitney U test. According to obtained results from data of experimental and control group, we can concretely state that which degree of our dependent variable variance is determined by independent variable. Tables 4.14, 4.15 and 4.16 show high Mean of scores between two variables in experimental and control groups, and significant level (sig= 0.000) for both groups is acceptable, and result could be generalized to the whole statistical universe. Thus, the null hypothesis is rejected.

2. There is no significant difference between experimental and control groups in the development of student’s creativity.
To respond this question of our research, we conducted the t-test, for experimental and control groups. According to obtained results of experimental and control data, tables 4.17, 4.18 and 4.19 shows a significant difference between Experimental and Control groups in the scores of Creativity. That is experimental group’s score is higher than control group’s score in the development of student’s creativity. Thus, the null hypothesis is rejected.

3. There is no significant difference between experimental and control group in the development of student’s problem solving.

To investigate this hypothesis, we conducted the Mann –Whitney U test. According to obtained results from data of experimental and control, concretely we can state as to what degree our dependent variable variance is determined by independent variable. Tables 4.20, 4.21 and 4.22 show high Mean of scores in the experimental groups which has significant level (sig= 0.000). Thus, the null hypothesis is rejected.

4. There is no significant difference between experimental and control group in the development of student’s Team- Collaboration.

To respond this question of our research, we conducted the t-test, for experimental and control groups. According to obtained results of experimental and control data, tables 4.23, 4.24 and 4.25 shows a significant difference between Experimental and Control groups in the scores of Team- Collaboration. The experimental group’s score is higher than control group’s score in the development of student’s Team- Collaboration. Thus, the null hypothesis is rejected.
5. There is no significant difference in the development of thinking skills among girl & boy student for experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy’s data, tables 4.26, 4.27 and 4.28 shows a significant difference between girls and boys groups in the scores of thinking skills. That is boys group’s score is higher than girls group’s score in the development of student’s thinking skills. Again the null hypothesis is rejected.

6. There is no significant difference in the development of creativity among girl & boy student for the experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy’s data, tables 4.29, 4.30 and 4.31 shows a significant difference between girls and boys groups in the scores of creativity. That is boys group’s score is higher than girls group’s score in the development of student’s creativity. Thus, the null hypothesis is rejected.

7. There is no significant difference in the development of problem solving among girl & boy student for experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy’s data, tables 4.32, 4.33 and 4.34 shows a significant difference between girls and boys groups in the scores of problem solving. That is girls group’s score is higher than boys group’s score in the development of student’s problem solving. Thus, the null hypothesis is rejected.
8. There is no significant difference in the development of team-collaboration among girl & boy student for experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy’s data, tables 4.35, 4.36 and 4.37 shows a significant difference between girls and boys groups in the scores of team-collaboration. That is girls group’s score is higher than boys group’s score in the development of student’s team-collaboration. Again, the null hypothesis is rejected.

in this research besides the gain in formal knowledge, we found that PBL contributed to the experimental group students’ meaningful learning in additional aspects as well: The students considerably expanded and enlarged their content knowledge base; they improved their higher order thinking; the science design process was learnt and developed to significantly high levels; it was for them a very surprising and enjoyable process of learning and doing science. The students’ positive attitudes towards science improved to a large extent.
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ALIGARH (INDIA)

2013
IN THE NAME OF ALLAH
THE BENEFICENT OF THE
MERCIFUL
Certificate

This is to certify that the present Thesis entitled “Project-Based Learning in Relation To Higher Order Thinking Abilities And Creativity Among Under-Graduate Students” is a bonafide work of Sedigheh Sadat Moein Masaleggo who pursued her studies for more than two years under my supervision. It is her original study and to the best of my knowledge, it has not been submitted elsewhere for any other degree.

Dated: 6.11.2013

Research Supervisor
Professor:
ROQUIYA ZAINUDDIN
Dept of EDUCATION
AMU, Aligarh
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CHAPTER 1
INTRODUCTION

Globalization is on a fast track, economy redefined and the way network communications have exploded, all resulted in a change. Global economies need educated people as citizens of today and tomorrow. Learning in the 21st century is definitely a lot different from learning in any other century. How can students be prepared to succeed in the 21st century? This is a question of paramount importance to the country’s educators, employers, parents and the public. Our community vibrancy, personal quality of life, economic viability and business competitiveness depends on a well-prepared citizenry and workforce. Education provides the bedrock from which our national and individual prosperity rise together. The education in science and mathematics that students receive from kindergarten through 12th grade forms the foundation of the nation’s scientific, mathematical, and technological literacy. The nation needs a compelling vision for education that will inspire education leaders, teachers, parents and students alike. Today’s education system needs to bridge the gap between what students learn and how they live. Hence, it is very important to prepare students for the challenges of work and life in the 21st century.

There is a profound gap between knowledge students learn in schools and the skills they need in typical 21st century communities and workplaces. To successfully face rigorous needs of higher education courses, career challenges and a globally competitive workforce, schools must align classroom atmosphere with real world environment by infusing 21st century skills into their teaching and learning process.

In the 21st century, in order to succeed in school, work and life, the core subjects like English, Mathematics, Science, Arts, Civics, History, Economics, Geography etc. must be expanded to include 21st century subjects such as global awareness, civic literacy, health and wellness, business and entrepreneurial literacy.
Traditional teaching is a one-way street, where teachers teach and students learn by rote, with most of the information coming from the teacher. Modern learning theory sees learning as an individual quest for meaning and relevance. Learning needs to move beyond the recall of facts, principles or correct procedures, and into the area of creativity, problem-solving, analysis, or evaluation. It is well known fact that students learn more when they are involved actively in learning than when they are passive recipients of instruction. Therefore teachers need to act as facilitators and partners for teaching and learning, and use flexible teaching strategies to provide an environment wherein learners are comfortable in their learning environment.

Our education system must focus on innovative teaching and learning practices such as inquiry based and project based learning methods etc., so that students connect curricular studies with real life situations, develop higher level thinking skills, work in teams and develop a scientific temperament and attitude. PBL can play a major role in developing such a classroom environment and bringing in a paradigm shift in education practices across the world. (Jamuda, 2007, p9.)

Project-based learning is a dynamic approach to teaching in which students explore real-world problems and challenges, simultaneously developing cross-curriculum skills while working in small collaborative groups.

Because project-based learning is filled with active and engaged learning, it inspires students to obtain a deeper knowledge of the subjects they are studying. Research also indicates that students are more likely to retain the knowledge gained through this approach far more readily than through traditional textbook-centered learning. In addition, students develop confidence and self-direction as they move through both team-based and independent work.
Project-based learning is a teaching and learning strategy that engages students in complex activities. It usually requires several steps and some duration-more than a couple of class days and up to a semester-and cooperative group learning. Projects may focus on the development of a product or performance, and they generally call upon students to organize their activities, conduct research, solve problems, and synthesize information. Projects are often interdisciplinary. For example, a project in which students draft plans for and build a structure, investigate its environmental impact, document the building process, and develop spreadsheets for the associated accounting would involve the use of skills and concepts drawn from courses in English, mathematics, building trades, drafting and/or design, and biology. Although projects as a methodology are not a new concept; it is an approach that supports the many tasks facing teachers today such as meeting state standards, incorporating authentic assessment, infusing higher-order thinking skills, guiding students in life choices, and providing experiences that tap individual student interests and abilities. Furthermore, the student products created during projects provide the means by which teachers can include authentic assessment in their instruction. (Han and Bhattacharya, 2001).

TITLE OF THE STUDY

The chosen topic of present study is “Project-Based Learning in relation to higher order thinking abilities and creativity among under-graduate students”. It has been implemented among under-graduate students which are defined as students of last class (fifth class) in primary school.

This research aims at studying the effect of instruction methods based on project-based learning on the development of student's thinking power.
SIGNIFICANCE OF THE STUDY

In project-based learning, all learning activities are anchored to a larger project or problem (Blumenfeld et al., 1991). Project-based learning is closely related to problem-based learning (where learning is driven by challenging, open-ended problems) and the two terms are occasionally used interchangeably. Both concepts are based upon a constructivist model of human cognition (Savery and Duffy, 1994) which contends that true knowledge lies in our interactions with the environment, rather than in detached or decontextualised "facts". Project-based learning is further motivated by activity theory (Jonassen and Rohrer-Murphy, 1999). Activity theory places learning firmly in the perspective of contextual human praxis, and argues that conscious learning emerges from activity rather than as a precursor to it.

When applied to education, activity theory helps educators to appreciate that the true focus of inquiry should be the everyday activity of persons acting in a setting.

Another important motivation for project-based learning is the emphasis it places on teamwork. The ability to work in a team is often cited as the most important skill employers look for in candidate employees. Teamwork in project-based learning can be understood through the concept of distributed cognition (Nardi, 1992). Distributed cognition is the study of knowledge propagation between different individuals and artifacts. This has important implications for designing a learning environment which trains students to work as professionals in a multidisciplinary team.

Project-based learning encourages students to think analytically and incorporate current technologies in their assignments. It also encourages students to use inquiry to understand the world around them and construct meaning from their own experiences. Project-based learning assignments also do the following:
➢ **Motivate students:** The opportunities and freedom in project-based learning let students explore issues in more depth, satisfying their innate curiosity in a way that traditional learning does not. When students are interested in what they're doing, they are often capable of performing at higher levels.

➢ **Encourage advanced thinking skills:** Traditional methods of teaching do not always address advanced thinking skills. As in the example of the traditional state report assignment, students often just rehash information that they have read or come across online. With project-based learning, students explore issues, solve problems, and collaborate with their peers. Many of the skills that students sharpen through project-based learning are exactly those that today's employers want.

➢ **Promote collaboration:** Students learn how to collaborate with their classmates, with students in other classrooms, or with students halfway around the world. They can also contact area experts by using e-mail, the Internet, and video conferencing. Teamwork and cooperation are keys to success in today's information-rich, highly technical work force.

➢ **Teach the latest technologies:** Project-based learning activities provide the framework for students to tap into their creativity while technology provides them with a means to develop solutions. Computers, the Internet, and programs like Microsoft Office Word 2003 or Microsoft Office PowerPoint 2003 can help students conduct research and produce their final products.

In the process of completing their projects, students also extend their organizational and research skills, develop better communication with their peers and adults, and often work within their community while seeing the positive effect of their work.
Because students are evaluated on the basis of their projects, rather than on the comparatively narrow rubrics defined by exams, essays, and written reports, assessment of project-based work is often more meaningful to them. They quickly see how academic work can connect to real-life issues and may even be inspired to pursue a career or engage in activism that relates to the project they developed.

Students also thrive on the greater flexibility of project learning. In addition to participating in traditional assessment, they might be evaluated on presentations to a community audience they have assiduously prepared for, informative tours of a local historical site based on their recently acquired expertise, or screening of a scripted film they have painstakingly produced.

Project learning is also an effective way to integrate technology into the curriculum. A typical project can easily accommodate computers and the Internet, as well as interactive whiteboards, global-positioning-system (GPS) devices, digital still cameras, video cameras, and associated editing equipment.

Adopting a project-learning approach in your classroom or school can invigorate your learning environment, energizing the curriculum with real-world relevance and sparking students' desire to explore, investigate, and understand their world. Return to our Project Learning page to learn more.

Projects are designed to tackle complex problems requiring critical thinking. The school's strategy is simple:

To learn collaboration, work in teams.

To learn critical thinking, take on complex problems.

To learn oral communication, present.

To learn written communication, write.

To learn technology, use technology.
To develop citizenship, take on civic and global issues.

To learn about careers, do internships.

To learn content, research and do all of the above.

Benefits of Project-Based Learning

Project-based learning offers a wide range of benefits to both students and teachers. A growing body of academic research supports the use of project-based learning in school to engage students, cut absenteeism, boost cooperative learning skills, and improve academic performance (George Lucas Educational Foundation, 2001).

For students, benefits of project-based learning include:

• Increased attendance, growth in self-reliance, and improved attitudes toward learning (Thomas, 2000)

• Academic gains equal to or better than those generated by other models, with students involved in projects taking greater responsibility for their own learning than during more traditional classroom activities (Boaler, 1997; SRI, 2000)

• Opportunities to develop complex skills, such as higher-order thinking, problem-solving, collaborating, and communicating (SRI, 2000)

• Access to a broader range of learning opportunities in the classroom, providing a strategy for engaging culturally diverse learners (Railsback, 2002)

Here, it's necessary to explain the terms project-based learning and problem-based learning are each used to describe a range of instructional strategies. The breadth of their respective definitions, their conceptual similarity, and the use of the shorthand term PBL result in some
confusion in the literature. A brief survey of professional dialogue, Internet postings, and literature on project-based and problem-based learning reveals both similarities and differences between the two.

**Similarities:**

As said above, project-based learning and problem-based learning share several characteristics. Both are instructional strategies that are intended to engage students in authentic, "real world" tasks to enhance learning. Students are given open-ended projects or problems with more than one approach or answer, intended to simulate professional situations. Both learning approaches are defined as student-centered, and include the teacher in the role of facilitator or coach. Students engaged in project- or problem-based learning generally work in cooperative groups for extended periods of time, and are encouraged to seek out multiple sources of information. Often these approaches include an emphasis on authentic, performance-based assessment.

**Differences:**

Despite these many similarities, project- and problem-based learning is not identical approaches. Project-based learning tends to be associated with K-12 instruction. Problem-based learning is also used in K-12 classrooms, but has its origins in medical training and other professional preparation practices. (Ryan et al).

Project-based learning typically begins with an end product or "artifact" in mind, the production of which requires specific content knowledge or skills and typically raises one or more problems which students must solve. Projects vary widely in scope and time frame, and end products vary widely in level of technology used and sophistication. The project-based learning approach uses a production model: First, students define the purpose for creating the
end product and identify their audience. They research their topic, design their product, and create a plan for project management. Students then begin the project, resolve problems and issues that arise in production, and finish their product. Students may use or present the product they have created, and ideally are given time to reflect on and evaluate their work. (Crawford, Bellnet website, Autodesk website, Blumenfeld et al). The entire process is meant to be authentic, mirroring real world production activities and utilizing students’ own ideas and approaches to accomplish the tasks at hand. Though the end product is the driving force in project-based learning, it is the content knowledge and skills acquired during the production process that are important to the success of the approach.

In practice, it is likely that the line between project- and problem-based learning is frequently blurred and that the two are used in combination and play complementary roles. Fundamentally, problem- and project-based learning has the same orientation: both are authentic, constructivist approaches to learning. The differences between the two approaches may lie in the subtle variations. There are at least two possible continua of variation in this type of learning approaches. One is the extent to which the end product is the organizing center of the project. On one end of this continuum, end products are elaborate and shape the production process, such as a computer animation piece which requires extensive planning and labor. On the other end, end products are simpler and more summative, such as a group’s report on their research findings. The former example is best described as project-based learning, where the end product drives the planning, production, and evaluation process. The latter example, where the inquiry and research (rather than the end product) is the primary focus of the learning process, is a better example of problem-based learning.

A second continuum of variation is the extent to which a problem is the organizing center of the project. On one end of this continuum are projects in which it is implicitly assumed that
any number of problems will arise and students will require problem-solving skills to overcome them. On the other end of this continuum are projects that begin with a clearly stated problem or problems and require a set of conclusions or a solution in direct response, where "the problematic situation is the organizing center for the curriculum." Here again, the former example typifies project-based learning, where the latter is best described as problem-based learning.

Also, more important, evidence shows that PBL enhances the quality of learning and leads to higher-level cognitive development through students’ engagement with complex, novel problems. It is also clear that PBL teaches students complex processes and procedures such as planning and communicating. Accomplishing PBL can help you as a teacher create a high-performing classroom in which you and your students form a powerful learning community focused on achievement, self-mastery, and contribution to the community. These goals, however, requires time for both teachers and students to master the behaviors and strategies necessary for successful PBL. In addition to research, convincing reports have come from teachers that PBL is a rigorous, relevant, and engaging instructional model that supports authentic inquiry and autonomous learning for students. Along with encouraging academic proficiency and meeting the traditional goals of education, PBL has important benefits for today’s students.

Teachers report that PBL:

• Overcomes the dichotomy between knowledge and thinking, helping students to both “know” and “do.”

• Supports students in learning and practicing skills in problem solving, communication, and self-management.

• Encourages the development of habits of mind associated with lifelong learning, civic responsibility, and personal or career success.
• Integrates curriculum areas, thematic instruction, and community issues.

• Assesses performance on content and skills using criteria similar to those in the work world, thus encouraging accountability, goal setting, and improved performance.

• Creates positive communication and collaborative relationships among diverse groups of students.

• Meets the needs of learners with varying skill levels and learning styles.

• Engages and motivates bored or indifferent students.

As with any teaching method, PBL can be used effectively or ineffectively. At its best, PBL can help you as a teacher create a high performing classroom in which you and your students form a powerful learning community focused on achievement, self-mastery, and contribution to the community. It allows you to focus on central ideas and salient issues in your curriculum, create engaging and challenging activities in the classroom, and support self-directed learning among your students.

OBJECTIVES

The following are the objectives to study the relationship between instruction method based on project based learning & the development of students' thinking skills.

1. To study the effect of instruction method based on project based learning on promotion of students' thinking skills.

2. To study the effect of instruction method based on project based learning on promotion of students' creativity.

3. To study the effect of instruction method based on project based learning on the development of skills students' of problem solving.
4. To study the effect of instruction method based on project based learning on advancement of skills students' in team-collaborating.

5. To study the significance of difference between promotion of thinking skills among girl & boy student.

6. To study the significance of difference between development creativity among girl & boy student.

7. To study the significance of difference in achievement of skill in problem solving between girl & boy student.

8. To study the significance of difference in advancement of skill in team-collaborating between girl & boy student.

9. To study the significance of difference on promotion of thinking skills between experimental & control groups.

10. To study the significance of difference on achievement of creativity between experimental & control groups.

11. To study the significance of difference on promotion of skills in problem solving between experimental & control groups.

12. To study the significance of difference on advancement of skills in team-collaboration between experimental & control groups.

**HYPOTHESES:**

1. There is no significant difference between experimental and a control group in the development of student's thinking skills.
2. There is no significant difference between experimental and control groups in the development of students' creativity.

3. There is no significant difference between experimental and control groups in the development of students' problem solving.

4. There is no significant difference between experimental and control groups in the development of students' team-collaborating.

5. There is no significant difference in the development of thinking skills between girl & boy students.

6. There is no significant difference in the development of creativity between girl & boy students.

7. There is no significant difference in the development of problem solving between girl & boy students.

8. There is no significant difference in the development of team-collaboration between girl & boy students.

9. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's thinking skills.

10. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's Creativity.

11. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's problem solving.

12. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's team-collaboration.

Organization of the study:

This study has been presented in five chapters. Chapter 1 includes: Introduction, title of the study, significance of the study, objectives & hypotheses and organization of the study.
Chapter 2 provides a review of the literature related to the variables taken in the study. Chapter 3 includes a detailed description of the methodology and strategy for collecting data, procedure and delimitations. Chapter 4 is devoted to the descriptive and inferential analysis and chapter 5 is included overview of the study, discussion, conclusion and recommendations.
CHAPTER 2

THEORETICAL AND EMPIRICAL LITERATURE
This chapter is divided into an introduction & two main parts. The first part includes the subjects of theoretical literature and the second part includes the subjects of empirical literature happened in the fields of project-based learning in schools and students.

**INTRODUCTION (A BRIEF HISTORY OF PBL)**

Give a man fish, he eats it one day; teach him how to fish and he will never go hungry. This is an oft quoted and very well known saying, which lends itself beautifully to the educational paradigm. If we teach learners how to learn, then they would not be at loss in real life situations, as they would be armed with strategies to deal with whatever comes their way and this is exactly same work PBL will going to do.

For over 100 years, educators such as John Dewey reported on the benefits of experiential, hands-on, student-directed learning. 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.

"Doing projects" is a long-standing tradition in American education. The roots of PBL lie in this tradition. But the emergence of a method of teaching and learning called Project Based Learning. PBL is the result of two important developments over the last 25 years. First, there has been a revolution in learning theory. Research in neuroscience and psychology has extended cognitive and behavioral models of learning—which support traditional direct instruction—to show that knowledge, thinking, doing, and the contexts for learning are inextricably tied. Learning is known as a social activity which takes place within the context of culture, community, and past experiences. This is apparent in research on problem-based learning in the medical field, an important forerunner of PBL. (Markham et al, 2003, p2)

Research shows that learners not only respond by feeding back information, but they also actively use what they know to explore, negotiate, interpret, and create. They construct solutions, thus shifting the emphasis toward the process of learning. In addition, cognitive
research has revealed much more about the nature of problem solving. Education has benefited from this research, as teachers have learned how to effectively scaffold content and activities to amplify and extend the skills and capabilities of students.

Secondly, the world has been changed. Nearly all teachers understand how the industrial culture has shaped the organization and methods of schools in the 19th and 20th centuries, and they have recognized that schools must now adapt to a new century. It is clear that children need both knowledge and skills to succeed. This need is driven not only by workforce demands for high-performance employees who can plan, collaborate, and communicate, but also by the need to help all young people learn civic responsibility and master their new roles as global citizens.

In a sense, the need for education to adapt itself to a changing world is the primary reason that PBL is increasingly popular. PBL is an attempt to create new instructional practices that react the environment in which children now live and learn. As the world continues to change, so does the definition of PBL. The most important recent shift of PBL in education has been the increased emphasis on standards, clear outcomes, and accountability. (Markham et al, 2003, p3)

**Theoretical literature**

The roots of PBL may be found in the writings of many distinguished educators, including John Dewey in the 1930s, Jerome Bruner in the 1960s, and contemporary educators since the 1990s (Krajcik et al. 1999). Project-Based Learning is often applied in the case of complex learning i.e. which aims to make students acquire various linked skills or develop their behavior. In comparison to traditional learning, this type of learning relies on co-development collective responsibility and cooperation. Students are the principal actors of their learning. A significant enrichment arises from their activity, both for them and all the other students. (Ifenthaler et al, 2011, p 49). Constructivism is a theory concerning learning
and knowledge which suggests that the human being is an active learner who constructs his/her knowledge on experiences and on his/her efforts to give meaning to that experience.

In the literature, three modes of constructivism are discussed, namely radical (Glasersfeld 1995) contextual (Coburn 1993), and social (Vygotsky 1986). We focus here on social constructivism. One of the better-known researchers that refers to social constructivism theory in education is Vygotsky (1986), who states that ‘learners construct knowledge or understanding as a result of thinking and doing in social contexts’.

Social constructivism suggests that learners learn concepts or construct meaning about ideas through their interaction with others and with their world, and through interpretations of that world by actively constructing meaning. They cannot do this by passively absorbing knowledge imparted by a teacher. Learners relate new knowledge to their previous knowledge and experience. A social constructivist model of teaching has five characteristics features: active engagement, use and application of knowledge, multiple representations, use of learning communities, and authentic tasks (Krajcik et al. 1999).

According to Krajcik et al. (1999), the PBL approach engages learners in exploring important and meaningful questions through a process of investigation and collaboration. Students ask questions, make predictions, design investigations, collect and analyze data, use technology, make products, and share ideas. Thomas (2000) also tries to define this approach and emphasizes that in the PBL environment students are, in fact, investigating solutions to a problem. They build their own knowledge by active learning, interacting with the environment as suggested by the constructivist approach, working independently or collaborating in teams, while the teacher directs and guides and they make a real product.

Green (1998) noted that learning by means of a project is likely to increase motivation and give the students a sense of satisfaction. PBL is also helpful for developing long-term learning skills. Krajcik et al. (1999) suggested that four benefits for the students. Firstly,
learners develop deep, integrated understanding of content and process. Secondly, students learn to work together to solve problems. Collaboration involves sharing ideas to find answers to questions. In order to succeed in the real world, students need to know how to work with people from different backgrounds. Thirdly, this approach promotes responsibility and independent learning. As a final benefit, this approach actively engages students in various types of tasks; thereby meeting the learning needs of many different students.

Orevi and Danon (1999) also listed the advantages of PBL from the students' point of view—it develops collecting and presenting data skills, develops thinking skills, suits personal learning styles, enhances motivation, and develops independent learners.

So far we have discussed the advantages to the student. Krajcik et al. (1999) also suggested three possible advantages for the teacher. Firstly, the teacher may find the work enjoyable, interesting and motivating, since teaching will vary every year as he/she will be exploring new projects with each new group of students. Secondly, in project-based teaching, the teacher continually receives new ideas, thus becoming a ‘lifelong learner’. Thirdly, classroom management is simplified because when students are interested and involved, there are likely to be fewer disciplinary problems. When students learn by engaging in real world projects, nearly every aspect of their experiences begins to change. The teacher's lead, learners pursue their own questions to create their own meaning. (Boss & Krauss, 2007, p 2).

Project-Based Learning (PBL) is a model that organizes learning around projects. According to the definitions found in PBL handbooks for teachers, projects are complex tasks, based on challenging questions or problems, that involve students in design, problem-solving, decision making, or investigative activities; give students the opportunity to work relatively autonomously over extended periods of time; and culminate in realistic products or presentations (Jones, Rasmussen, & Moffitt, 1997; Thomas, Mergendoller, & Michaelson, 1999). Other defining features found in the literature include authentic content, authentic
assessment, teacher facilitation but not direction, explicit educational goals, (Moursund, 1999), cooperative learning, reflection, and incorporation of adult skills (Diehl, Grobe, Lopez, & Cabral, 1999). To these features, particular models of PBL add a number of unique features.

Definitions of "project-based instruction" include features relating to the use of an authentic ("driving") question, a community of inquiry, and the use of cognitive (technology-based) tools (Krajcik, Blumenfeld, Marx, & Soloway, 1994; Marx, Blumenfeld, Krajcik, Blunk, Crawford, Kelly, & Meyer, 1994).

Project-Based Learning is a student-centered, instructional model. It develops content area knowledge and skills through an extended task that promotes student inquiry and authentic demonstrations of learning in products and performances. Project-based curriculum is driven by important Curriculum-Framing Questions that tie content standards and higher-order thinking to real-world contexts.

Project-based units include varied instructional strategies to engage all students regardless of their learning style. Often students collaborate with outside experts and community members to answer questions and gain deeper meaning of the content. Technology is used to support learning. Throughout project work multiple types of assessment are embedded to ensure that students produce high quality work. Project-based learning frequently includes teams of students engaged in cooperative learning and collaborative problem solving as they work to complete a project. Cooperative learning has been shown to be effective in improving academic and social skills; however, successful cooperative learning requires careful organization, and sometimes explicit training in collaboration and communication (Johnson & Johnson, 1989). Project-based learning provides an authentic environment in which teachers can facilitate students increasing their skills in cooperative learning and collaborative problem solving.
Project-based learning offers rich opportunities for providing instruction in specific thinking skills and strategies while emphasizing subject area learning in authentic contexts. By teaching 10-15 minute mini-lessons on skills while students are working on projects, teachers can organize instruction so students can immediately apply what they have learned in meaningful contexts. Effective explicit instruction generally consists of six components:

1. Selection of an appropriate skill or strategy for instruction
2. Labeling and categorizing of the skill
3. Modeling of the skill through a think-aloud
4. Guided practice of the skill with a partner or small group
5. Explanation of how and when to use the skill or strategy. (Beyer, 1987)

Due to the fact that PBL is a new concept in education there are some misconceptions to the understanding of the concept of PBL. Therefore, it is necessary to explain them briefly. Many teachers, administrators, parents and the general public have the wrong impression of PBL. They might get that impression from seeing poor examples of it, or from listening to supporters of other instructional methodologies presumed to be in competition with PBL. Some misconceptions about what PBL is, and what it is appropriate for, lead teachers to reject its use in their classroom. However, we think there is a place for PBL in every school, in every grade, and it should be part of opportunities to learn given to every student.

**PBL MISCONCEPTIONS**

**Misconception 1**

PBL isn't standard-based. It focuses on “soft skills” such as critical thinking and collaboration, but ignores content.

**Fact Check:** Among PBL practitioners, different models exist and the focus on standards varies. The BIE model for PBL is standards based. Driving Questions are aligned with or
even derived from content standards. The major products students create require a demonstration of knowledge and understanding of important concepts, and should be assessed in terms of standards. PBL links the teaching of critical thinking skills with rich content, because students need something to think critically about — it cannot be taught independent of content.

**Misconception 2**

Young children are not ready for rich content. There isn’t enough instructional time for science and social studies-focused projects. We need to teach basic literacy and math skills first.

**Fact Check:** Knowledge plays an important role in early literacy. To build reading comprehension skills children need to develop broad content knowledge across domains, including science and social studies. In elementary school, content-rich projects build background knowledge that influences comprehension. Additionally, projects can increase student motivation to read, write, and learn mathematics because they are engaged by the topic and have an immediate, meaningful reason to apply these skills. Literacy skills can be taught in the context of a project, especially reading and interpreting non-fiction — an area in which many students typically underperform on standardized tests.

**Misconception 3**

PBL is the same as “making something”, “hands-on learning” or “doing an activity.”

**Fact Check:** PBL is often focused on creating physical artifacts, but the artifacts are not as important as the intellectually challenging tasks that led to them. For example, it is not truly PBL if students are simply making a collage about a story, constructing a model of the Egyptian pyramids, or analyzing water samples from a lake. These artifacts and activities could be part of a rigorous project if they help students meet a complex challenge and address a driving Question. Some people may also think PBL is like the Montessori Method, which is
based on self-directed learning, but a project is an extended experience with activities connected by a driving Question and coached by teachers.

**Misconception 4**

A project takes too much time.

**Fact Check:** It is true that projects take time, but it is time well spent. A project is not meant to "cover" a long list of standards, but to teach selected important standards in greater depth. The key is to design a project well, so it aligns with standards, and manage it well, so time is used efficiently.

Some teachers are concerned that planning a project takes too much time. PBL does require advance preparation, but it gets easier the more you do it, especially if you can run the same project year after year.

**Misconception 5**

PBL is only for older students...or fluent English speakers...or those who don't have learning disabilities.

**Fact Check:** Teachers of all students, from preschool through graduate school, have used PBL effectively. You just have to make adaptations based on your students' needs. For example, first graders will need more direction from the teacher than fourth graders. Doing a project is a natural way to learn, so why deny this to young children? Their inborn sense of curiosity makes inquiry a powerful and engaging learning process. Projects are effective for English Learners because reading and writing is purposeful and connected to personally meaningful experiences. For students with disabilities, use the same support strategies during a project as you would use in other situations, such as differentiation, modeling, and providing more time and scaffolding. Since projects involve more work in small groups, it provides with better opportunities to meet individual student needs. Finally, projects can
provide English Learners and students with disabilities with chances to show their strengths and feel included in the classroom.

Misconception 6

PBL is too hard to manage, and/or it doesn’t fit with my teaching style.

Fact Check: Some teachers find project work to be “messy”—they aren’t in total control of their students’ every step during project work. One does need to be comfortable with a certain amount of lively interaction and out-of-their-seats activity in the classroom (or outside of it!).

A project is never fully predictable, and can evolve while you are in the middle of it, so you have to be flexible and ready to make adjustments. For teachers only used to direct instruction, it may be challenging at first to manage students working in teams and handle the open-endedness of PBL, but with more experience it gets easier. If you need to conduct a project with more structure or prefer a looser approach, either way is OK. What is important is that students are learning as a result of participating in the project. (Hallerman, et al, 2011). Whatever forms a project takes; it must have these essential elements to meet our cognitive & definition of PBL:

ESSENTIAL ELEMENTS OF PBL

➢ Significant Content. At its core, the project is focused on teaching students important knowledge and skills, derived from standards and key concepts at the heart of academic subject areas.

➢ 21st Century Skills. Students build skills valuable for today’s world, such as critical thinking/problem solving, collaboration, and communication, which are taught and assessed.

➢ In-Depth Inquiry. Students are engaged in a rigorous, extended process of asking questions, using resources, and developing answers.
➢ **Driving Question.** Project work is focused by an open-ended question that students explore or that captures the task they are completing.

➢ **Need to Know.** Students see the need to gain knowledge, understand concepts, and apply skills in order to answer the driving Question and create project products, beginning with an Entry Event that generates interest and curiosity.

➢ **Voice and Choice.** Students are allowed to make some choices about the products to be created, how they work, and how they use their time, guided by the teacher and depending on age level and PBL experience.

➢ **Revision and Reflection.** The project includes processes for students to use feedback to consider additions and changes that lead to high-quality products, and think about what and how they are learning.

➢ **Public Audience.** Students present their work to other people, beyond their classmates and teacher.(Larmer & Mergendoler, 2010, p2-4)

After recognizing the essential elements of PBL, now we can capture the uniqueness of project-based learning with the following set of criteria. These criteria do not constitute a definition of PBL but rather are designed to answer the question «what must a project have in order to be considered an instance of PBL?»

**CRITERIA OF PBL**

The five criteria are centrality, driving question, constructive investigations, autonomy, and realism.

1. PBL projects are central, not peripheral to the curriculum. This criterion has two corollaries. First, according to this defined feature, projects are the curriculum. In PBL, the project is the central teaching strategy; students encounter and learn the central concepts of the discipline via the project. There are instances where project work follows traditional instruction in such a way that the project serves to provide
illustrations, examples, additional practice, or Practical applications for material taught initially by other means. However, these "application" projects are not considered to be instances of PBL, according to this criterion. Second, the centrality criterion means that projects in which students learn things that are outside the curriculum ("enrichment" projects) are also not examples of PBL, no matter how appealing or engaging.

2. PBL projects are focused on questions or problems that "drive" students to encounter (and struggle with) the central concepts and principles of a discipline. This criterion is a subtle one. The definition of the project (for students) must "be crafted in order to make a connection between activities and the underlying conceptual knowledge that one might hope to foster." (Barron, Schwartz, Vye, Moore, Petrosino, Zech, Bransford, & The Cognition and Technology Group at Vanderbilt, 1998, p. 274). This is usually done with a "driving question" (Blumenfeld et al., 1991) or an ill-defined problem (Stepien and Gallagher, 1993). PBL projects may be built around thematic units or the intersection of topics from two or more disciplines, but that is not sufficient to define a project. The questions that students pursue, as well as the activities, products, and performances that occupy their time, must be "orchestrated in the service of an important intellectual purpose" (Blumenfeld et al., 1991).

3. Projects involve students in a constructive investigation. An investigation is a goal directed process that involves inquiry, knowledge building, and resolution. Investigations may be design, decision-making, problem-finding, problem-solving, discovery, or model-building processes. But, in order to be considered as a PBL project, the central activities of the project must involve the transformation and construction of knowledge (by definition: new understandings, new skills) on the part of students (Bereiter & Scardamalia, 1999). If the central activities of the project
represent no difficulty to the student or can be carried out with the application of already-learned information or skills, the project is an exercise, not a PBL 4 project. This criterion means that straightforward service projects such as planting a garden or cleaning a stream bed are projects, but may not be PBL projects.

4. Projects are student-driven to some significant degree. PBL projects are not, in the main, teacher-led, scripted, or packaged. Laboratory exercises and instructional booklets are not examples of PBL, even if they are problem-focused and central to the curriculum. PBL projects do not end up at a predetermined outcome or take predetermined paths. PBL projects incorporate a good deal more student autonomy, choice, unsupervised work time, and responsibility than traditional instruction and traditional projects.

5. Projects are realistic, not school-like. Projects embody characteristics that give them a feeling of authenticity to students. These characteristics can include the topic, the tasks, the roles that students play, the context within which the work of the project is carried out, the collaborators who work with students on the project, the products that are produced, the audience for the project's products, or the criteria by which the products or performances are judged. Gordon (1998) makes the distinction between academic challenges, scenario challenges, and real-life challenges. PBL incorporates real-life challenges where the focus is on authentic (not simulated) problems or questions and where solutions have the potential to be implemented. Accordingly this review covers research and research-related articles on "project-based learning," "problem-based learning," "expeditionary learning," and "project-based instruction" that conform to the criteria above. The review is focused, primarily, on published research conducted at the elementary and secondary level. In the interest of constructing a concise summary of current research activity, the review does not
include attention to similar models of instruction such as "active learning," "contextual learning," "design-based modeling," "collaborative learning," "technology-based education," and "design experiments," although some of the research in these areas is likely to be relevant to PBL.

Also Thomas (2000) lists five criteria of project-based learning:

- Projects are central, not peripheral to the curriculum;
- Projects are focused on questions or problems that drive learners to encounter and struggle with the central concepts and principles of a discipline;
- Projects involve learners in a constructive investigation or goal-directed process that includes inquiry, knowledge building and resolution;
- Projects are conducive to student autonomy, choice, and allow unsupervised work time, and;
- Projects are realistic, not school-like, focusing on authentic challenges where the solutions have the potential to be implemented. (Kidd, 2010, p 271)

In this research, is considered influence instructional method based on project-based learning in related to century 21 skills. In following these skills involved (thinking skills, creativity, problem solving & team-collaborating) will explain in detail.

THINKING SKILLS

"Thinking skills" is a catchall phrase. It ranges from very specific to very general abilities, from proficiency in logical reasoning to the witty perception of remote resemblances, from the capacity to decompose a whole into parts to the capacity to assemble random words or things to make them well-fitting parts of a whole, the ability to explain how a situation may have come about to the ability to foretell how a process will likely eventuate, from a proficiency in discerning uniformities and similarities to a proficiency in noting dissimilarities and uniqueness, from a facility in justifying beliefs through persuasive reasons
and valid arguments to a facility in generating ideas and developing concepts, from the power of discovering alternative possibilities to the power of inventing systematic but imaginary universes, from the capacity to solve problems to the capacity to circumvent problems or forestall their emergence, from the ability to evaluate to the ability to reenact – the list is endless, because it consists of nothing less than an inventory of the intellectual powers of humankind (Lipman, 2003, pag, 162).

Recent reviews of thinking distinguish, between a general definition of thinking that includes all intelligent cognitive activities and a more specific definition that includes only the most complex form of cognitive activities, such as reasoning, decision making, and problem solving. (Sternberg, 1994, p35) The mind shapes higher order skills only when higher order performance is demanded. More than we have been accustomed to think, minds are what their mentors make of them. Teachers who don't believe that thinking skills can be taught will tend to sanction and confirm the condition of the minds they confront. Teachers who believe such skills can be taught will tend to transform those minds. (Woditsch and Schmittroth, 1991, p9) In so far as each intelligent human activity is different, it involves a different assemblage of thinking skills – differently sequenced, synchronized, and orchestrated.

The dream of constructing a curriculum that would nurture and sharpen such an array of skills must certainly be considered quixotic:

There are four major varieties of thinking skills. For educational purposes, the most relevant skill areas are those relating to inquiry processes, reasoning processes, information organizing, and translation. It is likely that very small children possess all of these skills in a rudimentary way. Education is therefore a matter not of cognitive skill acquisition but of skill strengthening and improvement. In other words, children are naturally disposed to acquire
cognitive skills, just as they naturally acquire language, and education is needed to strengthen the process. (Lipman, 2003, pag, 175)

> Inquiry skills

By "inquiry," is meant self-correcting practice. Inquiry skills, like the other varieties of cognitive skills, are continuous across age levels. The differences, from childhood to old age, are much more of degree than of kind. It is primarily through inquiry skills that children learn to connect their present experiences with what has already happened in their lives and with what they can expect to happen. They learn to explain and to predict and to identify causes and effects, means and ends, and means and consequences, as well as to distinguish these things from one another. They learn to formulate problems and to estimate, measure, and develop the countless proficiency that make up the practice associated with the process of inquiry. (Lipman, 2003, pag, 176)

> Reasoning skills

Knowledge originates in experience. One way of extending knowledge, however, without recourse to additional experience, is through reasoning. Given what we now, reasoning permits us to discover additional things that are the case. In a soundly formulated argument, where we begin with true premises, we discover an equally true conclusion that "follows from" those premises. Our knowledge is based upon our experience of the world; it is by means of reasoning that we extend that knowledge and defend it.

One of the merits of logic is almost purely educational. To students eager to vaunt their newfound relativism, it provides a superb reminder that what may be true for one may not be true for all, which not everything follows from everything else, and that relativism does not necessarily exclude objectivity. What logic does beautifully is demonstrate to incredulous students that rationality is possible, that there is such a thing as logical correctness or validity, and that some arguments are better than others. In Plato's day, inference had something living
and fresh and surprising about it, and we have attempted to explain this away by saying that it must have been because to Socrates and Plato logic was so new. But this was only part of the matter. The vitality of reasoning then was much more closely connected to the nature of dialogue. When we think by ourselves, rather than in conversation with others, our deductions are derived from premises we already know. As a result, the conclusion we infer is totally unsurprising. But when no person knows all the premises, as is often the case in dialogue, the reasoning process has much more vitality, and the conclusion can come with considerably more surprise. (Lipman, 2003, pag, 177)

➢ Information-organizing skills

For purposes of cognitive efficiency, we have to be able to organize the information we receive into meaningful clusters or units. These conceptual clusters are networks of relationships, and since each relationship is a unit of meaning, each of the alternative networks or clusters is a web of meanings. Three basic types of informational clustering are the sentence, the concept, and the schema. There are, however, also organizational processes that are not merely parts or elements of a larger whole but are global ways of formulating and expressing what we know. (Lipman, 2003, pag, 178)

➢ Translation skills

Translation is not limited to transmission of meaning from one natural language to another. It can occur among different modes of expression, as when a composer attempts, by means of a tone poem, to tender literary meanings in musical form, or a painter tries to give a title to her work that will be true to the painterly content. No doubt all translation involves an element of interpretation; preservation of meaning is not always assigned the highest order of priority by those doing the translating. But the fact remains that translating skills enable us to shuttle back and forth among languages, and this may be no less important than discovering or constructing meanings within a given language.
One of the values of learning formal logic is that it requires the learning of rules for the standardization of everyday language so that the complexities of ordinary discourse can be reduced to the simplicities of logical language. This does considerable damage to meaning, but it demonstrates to students that natural language has an underlying musculature that makes possible such pushing's and pulling as are involved in inference, causal expressions, and the like, and that Natural language can be translated into this rudimentary but powerful logical language. Thus the rules of logical standardization form a paradigm of translation as well as a model that encourages students to carry their thinking proficiencies over from one discipline to the next.

When thinking is understood as a kind of productivity, then translation can be understood as a form of exchange. When we translate from poetry into music, as a composer does in writing a tone poem, or from body language into ordinary language, we are exchanging and preserving meanings. Indeed, just as reasoning is that form of thinking that preserves truth through change, so translation is that form that preserves meaning through change. (Lipman, 2003, pg. 180)

**Teaching of Thinking**

Complex projects require many different kinds of thinking, and a teacher must be judicious in selecting those to target during explicit instruction. Barry Beyer in his book *Practical Strategies for the Teaching of Thinking* suggests asking the following questions when choosing skills to target for instruction.

- Will the students have reason to use the skill in their everyday lives outside of the classroom?
- Will the skill have frequent, practical use in learning many subject areas?
- Will the skill build on skills students have already learned and/or lead to more complex skills they will need in the future?
• Can the skill be easily integrated into subject-matter instruction?
• Are the students ready to learn the skill with explicit instruction and appropriate effort?

When selecting a skill, a good place to start is with the higher levels of the revised Bloom’s Taxonomy or the comprehension and analysis portions of Marzano’s New Taxonomy. Within the skills, select sub-skills that are as narrow and specific as possible. Instructions to “think more deeply” or “use higher-order thinking” are about as much use to students as the admonition to “try harder” is to an athletic team. Without directions on what to do exactly, many students, especially those who struggle, will have difficulty learning new skills. For example, instead of teaching a lesson on a skill like “analysis,” teach students how to make inferences about point of view in a first-person account of a historical event. In a later lesson, students could learn to make inferences about assumptions behind a government press release. By repeating lessons on inferences with different kinds of information and different sub-skills, students can build an understanding of how to apply a thinking skill in different situations.

Students in primary grades are capable of learning a great number of skills, some of which are precursors to more advanced thinking in later grades. The following skills are appropriate for young children.

• Determining differences and similarities/comparing and contrasting
• Categorizing
• Deciding if something is good evidence
• Differentiating between fact and opinion, science and fantasy
• Understanding different points of view
• Giving reasons for opinions
• Goal-setting
Critical thinking

Critical thinking is the skill of making decisions based on good reasons. Learning to think critically is one of the most valuable skills one can acquire because it is reflective, analytical, and evaluative aspects can be brought to bear on any problem or issue. (Rainbolt and Dwyer, 2012, p5) One reason of critical thinking is the art argument is that finding arguments isn’t a mechanical process. It isn’t like finding the answer to a long division problem. (Rainbolt and Dwyer, 2012, p13) Paul and Elder state that critical thinking is the art of analyzing and evaluating thinking with a view to improving it. Critical thinking is, in short, self-directed, self-disciplined, self-monitored and self-corrective thinking. (Paul and Elder, p4) Critical thinking has its roots in the Socratic Method. Plato described Socrates as someone who encouraged his students to reflectively question common beliefs, analyze basic concepts and to carefully distinguish beliefs that are reasonable and logical from beliefs that lack rational foundation (Paul, Elder, & Bartell, 1997). Klein, Spector, Garbowski, and de la Teja (2004) suggest that Socrates challenged his students with probing questions to reveal inconsistencies in their thinking. John Dewey, an American philosopher, psychologist, and educator is widely accepted as the ‘father’ of modern critical thinking (Fisher, 2001). Dewey called it reflective thinking any defined it as: Active, persistent, and careful consideration of any belief or supposed form of knowledge in the light of the grounds that support it and the further conclusions to which it tends (Dewey, 1933, p.118).

Dewey emphasized reflective thinking as being active rather than passive and stressed the importance of questioning the basis of supposed forms of knowledge. Dewey (1933)
suggests that reflection involves an active exploration of experiences to gain new or greater understanding.

Today, definitions of critical thinking abound. The Delphi Report (1990), compiled by a panel of more than forty of the world's leading critical thinking experts, defines critical thinking as: purposeful, self-regulatory judgment which results in interpretation, analysis, evaluation, and inference, as well as explanation of the evidential, conceptual, methodological, criteria logical, or contextual considerations upon which that judgment is based. While definitions of critical thinking are the subject of academic debate, there appears to be a consensus of agreement surrounding the dispositions of critical thinkers. (Ifenthaler et al, 2011, p 145)

Most educators understand that higher order thinking, although abstract, is necessary for students in classrooms. However, it is equally important to understand that higher order thinking is necessary for students outside classroom as well. Higher order thinking skills are not just important for getting through school (which goal for some students generates a so what? attitude) but also are critical for getting through life. Critical thinking is the disciplined art of ensuring that you use the best thinking you are capable of in any set of circumstances. The general goal of thinking is to figure out the lay of the land. (Williams, 2003, p8)

The ability to think critically that comes with having the tools for higher order thinking can help students for into their future not only grasp new information and material but also figure out how to change and adapt to new situations. (Williams, 2003, p3) The exploded theory of faculty psychology underpins notions of general power of the mind and the existence of general thinking skills. Such as: observation, judgment, imagination and critical thinking. This leads to the view that someone can think critically, solve problems or be imaginative, regardless of context or situation. (Johnson and Siegel, 2010, p16) Critical thinking organizers can help students improve math skills by analyzing and judging their answers and
reflecting on assumptions. The goal is to have students become independent of the graphic organizers able to engage in the high-level critical and creative the skills that the organizers are intended to facilitate. (Drapeau, 2009, p9)

**Thinking through Assessment**

Thinking through Assessment is an approach to teaching thinking that aims to set standards for the specific thinking and understanding performances we want students to make, and then make those standards crystal clear to students. Traditional assessments often do not promote significant or meaningful thinking or understanding. They rarely tell us anything about our students' thinking skills, dispositions, or inclinations. Recognizing that what we test often drives what we teach, the Thinking Classroom begins to broaden the assessment spectrum to include thinking-centered tools and techniques that function as an integral part of shaping students' inclinations and abilities. The Thinking through Assessment approach offers information, illustrations, and insight into the development and use of thinking-centered assessments in the classroom.

Some examples of critical and creative characterizations of creative thinking are:

1. **Originality.** Thinking for which there are no clear precedents. Originality alone is not sufficient to establish the merit of a passage of creative thinking. Some such passages may be highly original but otherwise eccentric or irrational. This is one reason why a quorum of criteria generally needs to be invoked.

2. **Productivity.** Productive thinking is thinking that, when applied in problematic situations, generally brings forth successful results. This is a value-concept that is heavily reliant upon sequentiality considerations.

**Imagination.** To imagine is to envisage a possible world, or the details of such a world, or the may one may take to reach such a world. To have other worlds in which to dwell — and to ce them available to others to dwell in also — is no mean feat. What matters is that those who
explore the realms of possibility must retain as much as possible their sense of fact, just as those
who explore the perceivable world must keep their imagination about them.

e. **Experimentation.** Creative thinking is hypothesis-guided rather than rule-guided thinking.
The hypotheses, moreover, need not be fully formed: They may be inchoate or rudimentary.
There are trial plans, provisional schemes for proceeding; there are “trial facts.” Creative
thinking involves a constant trying out, or testing, as well as a searching for firm support. The
emerging character of the whole, in creative thinking, plays an important role in determining the
progressive selection of additional parts. The finished product is therefore always a texture of
part–whole relationships and means–end relationships that provide the product with its
idiosyncratic meanings. What is not immediately given is the extent to which the “whole” is
identical with the “primary aspect.”

f. **Expression.** Creative thinking is expressive of the thinker as well as of that which is thought
about. To think creatively about a tree that one perceives reveals the character of the tree and
that of the thinker. This is because creative thinking wrings the expression out of the experience
in which the tree is perceived.

h. **Self-transcendence.** The restlessness of creative thinking reveals itself in a striving to go
beyond its previous level. Every artist is aware that each successive work is a response to all
those that were produced earlier. Not to endeavor to go beyond previous achievements is to risk
engaging in a form of inquiry that lacks integrity.

I. **Surprise.** The meaning of originality lies in its consequences, and surprise is one of those
consequences, when the originality is not merely novel but fresh. Although theoretical thinking
seeks understanding, creative thinking defies it, thereby generating astonishment and wonder.

j. **Generatively.** Creative thinking not only is a stimulus to satisfaction, pleasure, joy, and
delight in others, but it in some cases stimulates other’s creativity. This must be construed
cautiously, however, since it may sometimes inhibit creativity in others. For example, the
teacher who thinks creatively is a precious model for her students. However, brilliant lecturers can provide their audiences with very few clues as to how this profusion of glittering ideas came into being. But if a teacher is concerned with encouraging students to think for themselves, she will seek to create the problem conditions that the students will have to think through themselves if they are to become independent and creative thinkers.

**k. Maieuticity** (from “maieutic”). Maieutic persons think and act in a manner calculated to bring forth the best in the world. Such persons are like midwives, bringing human or intellectual offspring to birth, or helping nature in its efforts to do so. Maieuticity is a way of characterizing the thinking of the teacher concerned to bring out the thought and expression of her students. (Lipman, 2003, pages 243,247)

**Creativity**

**Definitions of Creativity**

There are many definitions of creativity. Most definitions have two major criteria for judging creativity: novelty and appropriateness. For example, Perkins (1988a) defined creativity as follows: “(a) a creative result is a result both original and appropriate. (b) A creative person—a person with creativity—is a person who fairly routinely produces creative results”. Although Perkins’ propositions are broad, they tie together the concepts of creative people and creative activities in a neat practical package. Even so, each aspect of this simple definition poses questions. (Starko, 2010, p6) Also Croply(2001) states: Creativity, involves departing from the facts, finding new ways, making unusual associations, or seeing unexpected solutions. By contrast, as cause creativity is a constellation or cluster of psychological factors within individual people that gives them the capacity or potential to produce products with properties such as those just outlined, but does not guarantee their emergence. It is thus a necessary but not sufficient cause for creative product. This psychological constellation
involves abilities, knowledge, skills, motives, attitudes and values as well as personal properties such as openness, flexibility or courage. (Cropley, p 6, 2001)

In recent years people in many sectors of society have expressed disquiet about a lack of creativity in the curriculum. Writers, performers, teachers, psychologists, philosophers and representatives of the cultural and commercial industries have warned against the consequences of constraining children and young people’s creative potential.

Creativity can be regarded as not only a quality found in exceptional individuals, but also as an essential life skill through which people can develop their potential to use their imagination to express themselves, and make original and valued choices in their lives. Societies of the 21st century require active participation in the fast-changing ‘Knowledge Age’ in which there is an interaction between people, communities, creative processes, knowledge domains and wider social contexts.

Creativity can be promoted and extended with the use of new technologies where there is understanding of, and opportunities for the variety of creative processes in which learners can engage.

What Is The Role of Creativity In Education?

The British Government responded to the debates about creative and cultural education to meet the economic, Technological and social challenges of the 21st century by initiating a range of projects to enhance learners’ creative experiences. The potential of digital technologies to enable new forms of engagement, access and educational achievement is recognized in the development of proposals such as ‘Culture Online’ - a service offering interactive access to national arts and cultural resources through the internet and digital television.

Understandings of the nature of creativity have changed in scope and depth over the last hundred years. Many have focused on the characteristics of exceptional individuals in our culture, from Van Gogh, Molavi Rumi, and Einstein. More recently there has been an acknowledgement of
the creative potential of all individuals in different knowledge domains, or subjects not confined to traditional definitions of the ‘arts’ or ‘sciences’.

Creativity can now be recognized and valued at the level of individuals, peer-groups or the wider society and considered as an essential element in participating in and contributing to the life and culture of society. There have been many attempts to define ‘creativity’ and useful theoretical frameworks have been formulated which describe the interaction between qualities in people and communities, creative processes, subject areas and social contexts. The National Advisory Committee on Creative and Cultural Education (NACCCE) draws upon a range of conceptualizations of creativity and presents a definition which is a useful framework for educators - ‘imaginative activity fashioned so as to produce outcomes that are both original and of value’. This definition is helpful in that it expresses five characteristics of creativity: using imagination; a fashioning process; pursuing purpose; being original and judging value.

Creativity in education can encompass learning to be creative in order to produce work that has originality and value to individuals, peers and society.

The focus of the review is on the interaction between characteristics of creativity in people, communities, subject domains and social contexts, and features of digital technologies which make a distinctive contribution to those processes. The term ‘creativity’ had been defined in wide-ranging ways. These include descriptions of creative processes as ‘spiritual paths’ (Nachmanovitch 1990); or a seeming mystery and paradox which needs to be ‘tamed’ in order to be understood as the computational Psychology of Artificial Intelligence (Boden 1992); or reflected in neurobiological processes (Zeki 2001).

Bold claims are made for the expression of creativity in children and young people through the use of new technologies, from mobile phones to digital video and music. International governments’ policies reflect a priority for the use of ICT in the spheres of education and culture.
(Sharp and Le Metais 2000), and awards are granted to individuals and organizations that use technology creatively to benefit society (Rosencrance 2000). Commentators on the convergence of digital technologies in entertainment such as TV and video games state that audiences are getting new creative options (Fishcetti 2000), and computer games are an emerging art form (Jenkins 2000). Sectors of the creative industries are able to draw upon the ease and availability of digital production, reproduction and distribution, and consumers of cultural ‘products’, from texts to performances, can also be potential producers (Blythe 2001). Yet some critics assert that the presence of computers stifles children’s experiences of play, community and creativity and constrains opportunities for physical development.

**What are some key themes in defining creativity?**

The development of different perspectives in describing creativity has been traced, from the concerns of the 1950s to 1970s in areas of personality, cognition and the stimulation of creativity in individuals, to the awareness in the 1980s and 1990s of the influence of environments and social contexts on the creativity of individuals, groups and organizations (Rhyammar and Brolin 1999). Cropley (2001) reviews a range of attempts to classify creativity: from Guilford’s address to the American Psychological Association in 1949 in which he called for attention to ‘divergent’ thinking in human psychology, to the imperative to consider the role of creativity in successful technological and economic ventures after the shock to the US of Sputnik in 1957. He identifies common elements to the variety of discussions of creativity - novelty, effectiveness and ethicality - and focuses his approach to creativity on people demonstrating characteristics and interacting with others in environments congenial to creativity.

Jeffrey and Craft argue that thinking about the concept of creativity has changed in recent years and suggest that current creativity discourse also encompasses:

- operating in the economic and political field
- acting as a possible vehicle for individual empowerment in institutions and organizations; and
being used to develop effective learning'. (Jeffrey and Craft 2001, p3)

There have been several recent reviews of the literature which help to describe and theoretical understandings of the nature of creativity (Yeomans 1996; Dust 1999; Rhyammar and Brolin 1999; Sternberg 1999; Beattie 2000; Craft 2000; Edwards 2000 - 2001; Cropley 2001). Dust's review (1999) draws upon the work of a number of researchers such as Barron, Gardner and Csikszentmihalyi to discuss the processes and levels of creativity, the characteristics of creative individuals and the role played by the domain of endeavor and the wider society. The review addresses the stated aims of the National Endowment for Science, Technology and the Arts (NESTA), making recommendations for achieving the objectives of exploration, exploitation and explanation in order to fulfill the main aim to promote talent, innovation and creativity in the fields of science, technology and the arts. Craft reminds us that much of the work cited in the literatures has been undertaken in the US, UK and Europe and the debate needs to acknowledge the possibilities of 'cultural saturation' in western concepts of creativity which might limit our understandings of creativity in other cultures (Craft et al, 2000, p14).

A key issue in discussing and defining creativity is whether the focus is upon exceptional creative individuals, such as Albert Einstein or Charlie Parker, who shift paradigms in society's ways of knowing, or upon all individuals and their potential for self-actualization through 'little creativity' or 'possibility thinking' supporting people in making choices in everyday life (Craft et al, 2000).

Creativity in individual

A useful starting point for considering frameworks for creativity is to consider characteristics in individuals. Examples of personal qualities of creative individuals have been collated by Shallcross (1981) and described as: openness to experience; independence; self-confidence; willingness to take risk; sense of humor or playfulness; enjoyment of experimentation; sensitivity; lack of a feeling of being threatened; personal courage; unconventionality;
flexibility; preference for complexity; goal orientation; internal control; originality; self-reliance; persistence (Craft et al, 2000, p13).

Another perspective on the personal qualities of creative individuals is described in Sternberg and Lubart’s ‘confluence model’, in which six resources converge: intellectual abilities; knowledge; styles of thinking; personality; motivation and environment (Sternberg and Lubart 1999). Gardner presents a pluralist theory of mind which recognises multiple intelligences in individuals (Gardner 1983; Gardner 1996). Csikszentmihalyi identifies a common characteristic of creative people as ‘flow’ - the automatic, effortless, yet highly focused state of consciousness when engaged in activities, often painful, risky or difficult, which stretch a person’s capacity whilst involving an element of novelty or discovery (Csikszentmihalyi 1996). He elaborates the description of this characteristic in identifying nine Elements which such activity provides:

- Clear goals
- Immediate feedback
- Balance between challenges and skills
  - merging of action and awareness
- Elimination of distractions
- Lack of fear of failure
- Lack of self-consciousness
- Distortion of sense of time
- Auto telic activity (enjoyment for its own sake).

Individual states of intuition, rumination, reverie, even boredom play a role in creativity and problem-solving, and some studies indicate how creativity is enhanced in a state of reverie and imagery (Lynn and Rhue 1986; Claxton 1999; Claxton 2000). Such states are not just ‘letting it flow’ or ‘leaving it to luck’, but acknowledging a way of knowing which is not necessarily
conscious and draws upon resources of knowledge, skill and experience in order to make new combinations, explorations and transformations (Boden 2001).

Creativity in subjects

A different conceptual framework for describing creativity acknowledges the influence of a range of researchers in the field, yet presents a holistic view of people, processes and domains (Craft 2000). She asserts that creativity involves people having agency over their environment, being able to make and act upon choices to be creative and inventive. People can adapt to existing problems and find ways of getting round them, or innovate and do things differently. Creativity involves being in relationship with oneself, other people and with subject domains, and such relationships can also be reflected in the need for an audience and feedback for the outcomes of creative activity. She also includes discussion of people's multiple facets of mind or intelligences, including unconscious intelligence and 'flow' as well as essentialist personality factors. The description of creative processes in Craft's framework identifies the impulse or source of creativity which feeds the unconscious, intuitive, spiritual and emotional levels, which in turn support levels of imagination, problem-solving and divergent thinking. Being able to take risks is the next level in which the person engages in the 'creativity cycle' of preparation, letting go, germination, assimilation, completion and preparation. These processes express, shape and encourage creativity as an approach to life. Domains are suggested in her framework as a way of describing ways of knowing beyond rigid subject definitions, and open up the consideration of creativity in all areas of knowledge, not just the traditional 'arts' or 'creative subjects'. The term 'creative subjects' refers to curriculum areas broadly corresponding to Bell's framework for 'Education through the Arts' (Bell 2000, p11):

- Visual and performing arts, minimally music/art/drama including dance
- Designing and making, minimally three-dimensional design including crafts, technology and the built environment.
• written arts, minimally poetry-making, creative writing and more broadly the literary arts including story-telling.

Such a conceptualization of creativity highlights the interactions of personal qualities and creative processes within subject domains and areas of the curriculum. Beattie (2000) cites Fishkin's use of the term 'germinal creativity' to describe young people's creative potential as they develop their knowledge and understanding of particular domains (Fishkin 1998).

**Creativity as a social practice**

The importance of the social and cultural context in which people demonstrate creativity must also be considered. Recent research in communities of practice also presents a view of learning as social, situated and characterized by interaction and communication between individuals (Lave and Wenger 1991; Wenger 1998). Leach (2001) cites examples of creative individuals, such as Nobel Prize winners or musicians, who benefited from association with other creative people within their communities which supported and celebrated the creative process. (Feldman et al, 1994).

Feldman (1994) proposed that creativity arises from the interaction between the 'intelligence' of individuals, the domain or areas of human endeavor, disciplines, crafts or pursuits, and the field, such as people, institutions, award mechanisms and 'knowledgeable others' through which judgments of individual performances in society are made.

Csikszentmihalyi (1996) developed his discussion of the field as a component of creativity wherein other individuals act as 'gatekeepers' to a domain by recognising, preserving and remembering creative outcomes. He presented a systems model in which creativity is in the interaction between a person's thoughts and actions, their knowledge and skills within a domain and a socio cultural context which can encourage, evaluate and reward. In such a systems model, the recognition and value of creativity is related as much to the wider context of domains and fields as to individuals. This has important implications for thinking about creativity and
learning, where the context could be a school classroom or a large corporation which can either nurture or dismiss the development of creative individuals, groups and communities.

What is the place of creativity in education?

'Creativity is an essential life skill, which needs to be fostered by the education system(s) from the early years onward' (Craft 1999, p137). Such a statement emphasizes the importance of playfulness, imagination and creativity in learning for children, young people and adults and the role that schools might play in promoting these qualities in learning experiences (Amning 1994; Shagoury-Hubbard 1996; Whitaker 1997). The National Advisory Committee on Creative and Cultural Education (NACCCE) responded to the 1997 UK Government White Paper 'Excellence in Schools' by presenting a report that argued for a national strategy in creative and cultural education to ensure a broad and flexible education that recognized the talents of all children. The report, 'All Our Futures', defined creativity as, 'imaginative activity fashioned so as to produce outcomes that are both original and of value' (NACCCE 1999, p29). This definition is helpful in that it expresses five characteristics of creativity:

- using imagination - the process of imagining, supposing and generating ideas which are original, providing an alternative to the expected, the conventional, or the routine.

- A fashioning process - the active and deliberate focus of attention and skills in order to shape, refine and manage an idea.

- pursuing purpose - the application of imagination to produce tangible outcomes from purposeful goals motivation and sustained engagement are important to the solving of the problem.

- being original - the originality of an outcome which can be at different levels of achievement: individual originality in relation to a person's own previous work; relative originality in relation to a peer group; and historic originality in relation to works which are completely new and unique.
judging value - the evaluative mode of thought which is reciprocal to the generative mode of imaginative activity and provides critical, reflective review from individuals and peers.

The NACCCE framework and report raises questions about the nature and purposes of creative experiences for learners in schools and communities, and the distinction between teachings for creativity and creative teaching (Jeffrey 2000; Prentice 2000; Joubert 2001). The five elements arising from the NACCCE definition can be used with the interactive dimensions of people and communities, processes, domains, and fields, discussed in the definitions of creativity in Section 2.1, to provide a framework to describe the contribution of ICT to creativity in learning.

3. What are the potential roles of digital technology in supporting creativity?

The use of the term ICT as a single term is inadequate to describe the range of technologies and the wide variety of settings and interventions in which they are used. McFarlane (2001) argued that there was a need for a more detailed and developed discourse to reflect the relationship between a form of ICT, the way in which it was used and any impact it might have on the users, from using word processors for Writing letters to monitoring and measuring environmental changes with sensors. Tolmie (2001) also drew attention to the need to consider the complexities of the contexts in which ICT resources were used, rather than expect a blanket take-up which produced uniform outcomes for all pupils in all situations. Kennewell (2001) considered the analysis of the effects of ICT in combination with other factors and described a framework for using affordances and constraints of ICT in educational settings. In this paper, the use of the term ICT implies the broad range of information and communications technologies which can be used for different purposes by learners and teachers in many situations.

Levels of Creativity

Before going further, it is important to acknowledge that the term “creativity” can be used to describe acts at several different levels. The everyday creativity described in above is certainly different in scope, if not necessarily in process, from the world-changing efforts of DaVinci or
Einstein. Writers sometimes distinguish between “Creativity, with a big C” that changes disciplines and “creativity with a little c,” the more commonplace innovations of everyday life. Necka distinguishes among fluid, crystallized, mature, and eminent creativity (Necka, Grohman, & Slabosz, 2006). Fluid creativity is typical of every human being and characterizes such basic acts as composing original sentences.

It lasts only a few moments. In this model, crystallized creativity is synonymous with problem solving. It can vary a great deal depending on the complexity of the problem to be solved. Mature creativity addresses complex problems with originality, usually requiring a depth of expertise in the problem area. Eminent creativity differs from mature creativity in that it addresses problems substantial enough to cause a shift in the discipline being addressed. It also requires acceptance and recognition within a field. Sternberg (2003) proposed eight types of creative contributions, varied by their impact on a discipline. These ranged from replication to the integration of two formerly diverse ways of viewing a phenomenon. In this text we will include in our discussions all types of creativity, from the everyday to the once-a-generation varieties. It will become clear that some theorists deal primarily with one, some primarily with the other. Certainly the kind of creativity we hope to enhance in our students is likely to be, at least for the moment, of the “little c” variety, but we hope that understanding the bigger picture and wider goals can make us better stewards of the talents in our midst.

The processes of building cognitive structures underlie all learning. The development of expertise in an area might be seen as developing spaces or ties in the cognitive structure into which new information can fit. An expert’s framework parallels the structure of his or her subject, allowing the expert to fit new information easily in the appropriate place, just as a builder with framing in place and a blueprint in hand deals more easily with a new piece of plasterboard than a builder newly arrived on the construction site. Helping students become more expert entails assisting them in putting up the framework.
Expertise ... involves much more than knowing a myriad of facts. Expertise is based on a deep knowledge of the problems that continually arise on a particular job. It is accumulated over years of experience tackling these problems and is organized in the expert's mind in ways that allow him or her to overcome the limits of reasoning. (Prietula & Simon, 1989, p. 120) To me, it is fascinating that multiple paths seemingly lead to very similar recommendations. Our understanding of neuropsychology is in its infancy, yet it appears to lead us to conclusions very similar to those derived from learning theory.

Studies in this area begin with the brain and its development. Many of our neural pathways are already established at birth (e.g., those that control breathing and heartbeat) but many more are created through interaction with our environment. Each interaction uses and strengthens neural connections. The more we use particular connections, the stronger they become. As we create new connections, we build the capacity for more flexible thought.

We always have the ability to remodel our brains. To change the wiring in one skill, you must engage in some activity that is unfamiliar, novel to you but related to that skill, because simply repeating the same activity only maintains already established connections. To bolster his creative circuitry, Albert Einstein played the violin. Winston Churchill painted landscapes. (Ratey, 2001, p. 36)

The brain was designed for survival (Pinker, 1999). Survival is based on the brain's ability to make meaning of the outside world and respond appropriately. The brain constantly receives sensory input and builds neural connections based on the way the input relates to prior experiences. In its efforts to make sense of the deluge of information presented moment by moment, the brain creates patterns. If input fits neatly into an existing pattern, it is accepted and the pattern is reinforced. If input is so foreign that it fits no existing pattern, it can be rejected without meaningful learning.
If input is novel but can be connected to some existing pattern, new connections are established, with the old pattern both stretched and reinforced. Psychiatrist John Ratey (2001) stated:

Every time we choose to solve a problem creatively, or think about something in a new way, we reshape the physical connection in our brains. The brain has to be challenged in order to stay fit, just as the muscles, heart, and lungs must be deliberately exercised to become more resilient. (p. 364)

It is precisely such stretching of patterns that we hope to achieve when we teach in ways that enhance creativity. Students think about content from different points of view, use it in new ways, or connect it to new or unusual ideas. These associations strengthen the connections to the content as well as the habits of mind associated with more flexible thinking. In fact, creative thinking is one core component of contextual teaching and learning, a system of instruction designed to help students see meaning in academic material then learn and retain it by connecting it to their daily lives (Johnson, 2002). In this system, creative thinking is promoted as one of the key strategies to help students learn.

Researchers are just beginning to try to identify the areas of the brain active in creative thinking (Haier & Jung, 2008). Some educators studying neural research have attempted to draw conclusions regarding classroom teaching and learning. Although it is important to recognize the tentative nature of such inferences (see Sternberg, 2008), many recommendations made by writers addressing “brain-based curriculum” are consistent with the approaches to learning rooted in cognitive psychology: students’ active engagement in learning, clear organization of content, and involvement in complex activities (Jensen, 2008; Scherer, 2000). Similar recommendations are made based on studies directly investigating teaching methods.

When researchers attempt to delineate teaching strategies that are most effective in supporting student learning, such lists typically include the activities required for finding and solving problems.
For example, generally conservative William Bennett (1986) included the use of experiments in his list of “What Works,” along with more traditional strategies such as direct instruction and homework.

Marzano (2003) attempted to synthesize multiple meta-analyses of effective instructional strategies into nine categories of effective practice. One those is “generating and testing hypotheses” (p. 83). Additionally, several of his other categories include activities that reflect strategies recommended in this text. For example, his “nonlinguistic representations” category (p. 82) includes visual imagery and role play. The category of “identifying similarities and differences” (p. 82) includes the use of metaphors and analogies. Mansilla and Gardner (2008), when discussing optimum strategies to develop understanding of disciplines, include the inquiry strategies that are at the root of creative endeavors. When Wiggins and McTighe (2008) discuss strategies to develop in-depth understanding, they state “If we don’t give students sufficient ongoing opportunities to puzzle over genuine problems, make meaning of their learning, and apply content in various context, then long-term retention and effective performance are unlikely” (pp. 37-38). All of these strategies are discussed in chapters 7 and 8.

How, in the end, do these recommendations tie to creativity? Simply stated, if we want to teach effectively, the strategies that support creativity will help us do so. Giving students opportunities to be creative requires allowing them to find and solve problems and communicate ideas in novel and appropriate ways. Learning takes place best when learners are involved in setting and meeting goals and tying information to their experiences in unique ways. Students develop expertise by being immersed in problems of a discipline. Creativity aside, we know that raising questions, solving problems, tying information to personal and original ideas, and communicating results all help students learn. How much better it is, then, to find and solve problems in ways that facilitate original ideas, and to give students tools for communicating
novel thinking. Structuring education around the goals of creativity is a wonderful two-for-one sale—pay the right price for the learning and you may get creativity free.

Teaching for Creativity versus Creative Teaching

Structuring teaching for creativity can be a slippery goal. I once attended a class in which graduate students demonstrated lessons designed to enhance creative thinking. One activity particularly stands out in my memory. The teacher of the lesson took the class outside, a welcome break from the stuffy college classroom. She then brought out a parachute and proceeded to show us how the chute could be used to create various forms—a flower, an ocean wave, and other shapes. We were taught a specific, tightly choreographed series of moves to tie one form to the next in a story line.

As the teacher narrated, we marched and ducked and raised our arms so that the parachute was transformed into various shapes to accompany the story. We acquired an audience of passersby, and the striking visual effect we created earned us hearty applause. We enjoyed the exercise and activity, especially the break from the usual routine and the enthusiastic acceptance by our audience. When we finished, however, I was struck by a clear question. Who was being creative? The living sculpture of the parachute activity certainly seemed original, and it communicated in novel and effective ways. Yet, as a participant, my thoughts were not on communication or originality, but on counting my steps and remembering when to duck—hardly the chief ingredients of creative thought. A teaching activity that produces an enjoyable, or even creative, outcome does not necessarily enhance creativity unless the students have the opportunity for creative thinking. The parachute activity might be considered creative teaching because the teacher exercised considerable creativity in developing and presenting the exercise. However, creative teaching (the teacher is creative) is not the same as teaching to develop creativity.
This distinction becomes clearer when books of so-called creative activities are examined. In some cases, the illustrations are adorable and the activities unusual, but the input from students is fairly routine. For example, a color-by-number dragon filled with addition problems may have been an original creation for the illustrator, but completing the addition problems and coloring as directed provide no opportunities for originality among the students. A crossword puzzle in the shape of a spiral was an original idea for its creator, but it still requires students only to give accurate responses to the clues and fill in the correct spaces. In these cases, those who created the materials had the opportunity to be creative. The students do not. In other cases, classroom teachers may use enormous personal creativity in developing activities that allow few opportunities for students to be original. Teaching for creativity by contrast, was seen as forms of teaching that are intended to develop young people's own creative thinking or behavior. (Craft, 2005, p41) Creative teaching is focused on the teacher's practice. Teaching for creativity may be more focused on learner empowerment than on effective teaching. (Craft, 2005, p42)

Teaching for creativity entails creating a community of inquiry in the classroom, a place in which asking a good question is at least as important as answering one. Building this climate includes organizing curriculum around the processes of creativity, providing students with content and processes that allow them to investigate and communicate within disciplines, teaching general techniques that facilitate creative thinking across disciplines, and providing a classroom atmosphere that supports creativity. The term 'thinking skills' can also be discussed in a broad term to describe a wide range of different capabilities and activities. It can include:

- Specific skills relating to creative and critical thinking
- Strategies for improving memory, understanding, and problem solving
- Processes such as 'think-pair-share' and the community of enquiry approach to discussion and debate.
• The use of open questions to extend and improve pupils’ thinking
• Procedures for helping pupils to reflect on their own thinking

Teachers and schools seem to have one or more of the following aims in mind when developing pupils’ thinking. These involve introducing skills, strategies, activities and programmes that will help pupils to:
• put forward their own ideas, views and arguments
• think more deeply about content and concepts
• develop skills and strategies
• reflect on their own thinking and learning.

The four purposes are not mutually exclusive. The ability to express ideas, views and arguments will be aided by acquiring certain skills and strategies. Part of what is meant by thinking more deeply will be putting forward ideas, views and arguments. Strategies that pupils learn for improving memory, understanding and creativity will help to achieve deeper thinking. All of these may involve opportunities for reflection.

Some of the key skills of creative thinking are:
• generating ideas
• making connections
• altering perspectives
• applying imagination
• fashioning outcomes.

The techniques and strategies for developing creative thinking include:
• Organizing brainstorming sessions so that pupils can generate and develop ideas, and make connections.
• engaging pupils in activities that encourage them to see things from different points of view, for example imagining themselves in another person's shoes, adopting various roles, Collaborative group work.

• providing opportunities for pupils to develop their abilities for imagination and visualization, for example predicting outcomes, anticipating consequences, visualizing goals, situations and problems.

• providing opportunities for pupils to be involved in activities of creating and designing, especially in the expressive and visual arts and in technology.

• introducing pupils to strategies that develop the three dimensions of divergent thinking - Fluency, flexibility and originality.

Among the skills important in the development of critical thinking are:

• interpreting information

• assessing evidence

• identifying assumptions and errors in reasoning

• presenting arguments

• drawing conclusions.

Critical thinking skills can be developed by:

• asking questions that encourage pupils to express their views and develop their ideas.

• providing opportunities for pupils to discuss open-ended issues and prepare arguments.

• Providing opportunities for pupils to take part in collaborative talk to figure things out solve problems and make decisions.

• directing teaching at specific skills, for example classifying, analyzing, evaluating, drawing conclusions.

• teaching some of the principles of logical thinking and giving practice at identifying the flaws in logical arguments.
Teaching to enhance creativity has a different focus. The essential creativity is on the part of the students. If the students develop parachute choreography or a new form of crossword puzzle, they have the opportunity to exercise creative thinking. Creativity also can be developed as students devise their own science experiments, discuss Elizabethan England from the point of view of a woman at court or a farm woman, or rewrite “Snow White” as it might be told by the stepmother. When teaching to enhance creativity, we may well be creative as teachers, but we also provide students the knowledge, skills, and surroundings necessary for their own creativity to emerge. The results may not be as flashy as those in the parachute story, but they include real problem finding, problem solving, and communication by students.

Problem solving

Another skill that needs consideration is problem solving. A problem is a situation that confronts the learner, that requires resolution, and for which the path to the answer is not immediately know. (Posamentier and Krulik, 2009, p2) Psychologists have examined problems and problem solving fairly extensively, beginning with information-processing theories. A problem, from an information-processing perspective, consists of sets of initial states, goals states, and path constraints. Solving a problem means finding a path through the problem space those stats with initial states passing along paths that satisfy the path constraints and ends in the goal state. (Jonassen, 2001, p2) Given Scandura’s (1977) definition of problem solving as the generate on and selection of discretionary actions to ing about a goal state, it becomes apparent that creative thought represents a form of problem solving. (Runco, 1994, p4). The most famous problem solving method is belonging George Polya. The foundation of polya’s method is a four-step procedure that can be used organize the problem solving process. It is not a specific prescription that works for all problems, but it is a useful set of guidelines. Polya strongly believed that the skill of problem solving could and should be taught - it is not something that you are
born with. He identifies four principles that form the basis for any serious attempt at problem solving:

1. Understand the problem

2. Devise a plan

3. Carry out the plan

4. Look back (reflect)

1. Understand the problem

· What are you asked to find out or show?

· Can you draw a picture or diagram to help you understand the problem?

· Can you restate the problem in your own words?

· Can you work out some numerical examples that would help make the problem more clear?

2. Devise a plan

A partial list of Problem Solving Strategies includes:

<table>
<thead>
<tr>
<th>Guess and check</th>
<th>Solve a simpler problem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Make an organized list</td>
<td>Experiment</td>
</tr>
<tr>
<td>Draw a picture or diagram</td>
<td>Act it out</td>
</tr>
<tr>
<td>Look for a pattern</td>
<td>Work backwards</td>
</tr>
<tr>
<td>Make a table</td>
<td>Use deduction</td>
</tr>
<tr>
<td>Use a variable</td>
<td>Change your point of view</td>
</tr>
</tbody>
</table>

3. Carry out the plan

· Carrying out the plan is usually easier than devising the plan

· Be patient - most problems are not solved quickly or on the first attempt

· If a plan does not work immediately, be persistent
Do not let yourself get discouraged

If one strategy isn’t working, try a different one

4. Look back (reflect)

· Does your answer make sense? Did you answer all of the questions?

· What did you learn by doing this?

· Could you have done this problem another way - maybe even an easier way? (Briggs, 2005, p8)

Authentic Problems and Processes structuring education around the goals of creativity involve shifting our visions of teachers and learners. Learning activities designed to foster creativity cast students in the roles of problem solvers and communicators rather than passive acquirers of information. Problem solving is a practical skill that is fairly general, that can be learned, and that consist of four phases or principles: (a) understand the problem (the goal, what is known, what is not known), (b) devise a plan or solution approach, (c) implement the plan and confirm correctness of the implementation, and (d) examine the solution, confirm the result, and consider whether alternate solutions are possible. (Ifenthaler et al, 2011, p. 2). Problem solving can be thought of in several different ways. First of all, Problem Solving may be considered a topic of instruction. That is Problem Solving is a subject in the mathematic curriculum that must be taught to the children in the same way that multiplication, long division, percents, and so on are taught. Second, Problem Solving may also be considered a mode of instruction. We can teach our mathematics class using Problem Solving as the underlying thread to unite all the mathematics we teach. Problem Solving provides a rationale for teaching the skills of arithmetic. Finally, Problem Solving is a way of thinking. That is students cannot expect to learn to be problem solvers without careful structure of the process. Our students must be taught how to think, how to reason, and how to problem solve. (Posamentier and Krulik, 009, p2) Teachers, in turn, are transformed from founts of all wisdom to problem setters, problem seekers, coaches, audience, and sometimes publicity agents. If students are to solve real
problems, teachers have the responsibility not only to teach them the necessary knowledge and skills, but also to set problems for which the teachers have no answers and to work together with students to find the solutions. If students are to communicate, teachers must help them find ideas worth sharing and audiences with whom to share them. These are fundamentally different processes from those most of us experienced as learners in school. This type of restructuring also has major implications for the content in curriculum areas to be addressed. by training the students representational flexibility, they may become more skilled in finding the best representation for solving specific tasks or problems and, thus, become more creative and flexible in their thinking and problem solving by combining the right structures with the right procedures. (Jong and Elen, 2010, p33)

It is essential to understand that restructuring curriculum does not mean eliminating it. Students can and should learn required content while also enhancing their creative thinking—the two should be inextricably entwined. One cannot solve problems involving plants without knowledge of botany, and teachers have the responsibility to help students gain that knowledge.

Contrary to some quickly turned phrases, sometimes the sage should be on the stage. In fact, the processes of identifying and solving problems form an effective context in which to gain content knowledge. But students who are to be taught strategies for finding and solving problems and for communicating information must be taught not just the what, but also the how of the disciplines in the curriculum.

For example, students who are to be problem solvers in history must know not only facts, concepts, and generalizations about history, but also how history works and what historians do. How does a historian decide on an area for study? What types of problems do historians find and solve? How do they gather information? Learning as much as possible about the authentic methodology of the disciplines allows students to become seekers and solvers of real or authentic problems while learning content about history in more complex ways.
The investigation of authentic problems was espoused by educators such as Dewey (1938) and Renzulli (1977) throughout much of the 20th century. Such problems were emphasized in literature on authentic learning (Brandt, 1993), situated learning (Brown, Collins, & Duguid, 1989), and problem solving ranging from opportunities for astronomical data gathering (Bollman, Rodgers, & Mauller, 2001) to solving dilemmas of real-world businesses (Holt & Willard-Holt, 2000).

How should students solve problems?

Suggest a conceptually oriented model for solving story problems. According to this approach, transferring story problem-solving skills depends on students constructing a conceptual model of the story problems they are required to solve and accessing that model when they are required to solve structurally congruent problems. When parsing the problem statement, students should search for an appropriate conceptual model of the problem. To do that, students must identify the sets of values presented in the problem and determine their situational and structural characteristics and associate them with problems schemas. Searching for a problem schema involves identifying the sets or elements contained in the problem, identifying the relationship among those elements, and identifying the situational characteristic. When an appropriate problem schema is accessed, the student can the successfully classify the type of problem. (Jonassen, 2001, p29)

Team-Collaboration

What is a team? If you take a group of people and put them into matching shifts and shorts, do you have a team? Patently not. In a team, everyone knows where the goal is and how to get to it, each member knows his place in the scheme of things, a good team player is willing to allow other people credit sometimes, rather than always wanting to hog the limelight; team member may not always like each other but there is mutual respect for each other's skills; similarly they may sometimes dislike the team captain intensely for the way he/she's driving them, but they
In Collaborative learning students are working together, usually in small groups, on a shared activity and with a common goal. It has been widely recommended in recent years as a strategy to enhance mathematics learning for all students. Small-group discussions enable all students to be involved in the co-construction of "common knowledge." However, a relatively small percent of the studies have attempted to study the interactions that take place during cooperative work to determine how various academic, social, or psychological effects are produced. (Davidson & Kroll, 1991, p. 36).

**Student Team Learning (collaboration)**

STL techniques were developed and researched at Johns Hopkins University in the United States. All co-operative learning methods share the idea that students work together and are responsible for one another’s learning as well as their own. In Student Team Learning the important thing is not to do something together but to learn something as a team.

Three concepts are central to all Student Team Learning methods: team rewards, individual accountability and equal opportunities for success.

In classes using Student Team Learning, teams earn certificates or other team rewards if they achieve above a designated criterion. "Individual accountability" means that the team’s success depends on the individual learning of all team members.

This focuses team activity on explaining concepts to one another and making sure that everyone on the team is ready for a quiz or other assessment that they will be taking without teammate help. With equal opportunities for success, students contribute to their teams by improving over their past performances, so that high, average and low achievers are equally challenged to do their best and the contributions of all team members are valued.
The findings of experimental studies indicate that team rewards and individual accountability are essential elements for enhancing basic skill achievements (Slavin, 1995, 2009). It is not enough simply to tell students to work together. They must have a reason to take one another’s achievement seriously. Further, if students are rewarded for doing better than they have in the past, they will be more motivated to achieve than if they are rewarded based on their performance in comparison to others – rewards for improvement make success neither too difficult nor too easy for students to achieve. (Dumont et al, 2010, p, 163).

Team-working promotes the distribution of students and roles within the team, which led to self-commitment in tasks according to each student’s personality and capabilities. In most cases this led to enthusiastic engagement in self-learning and research activities. Collaborative learning, although highly demanding in terms of time and interpersonal interactions, was welcomed by most of students. (Marco et al 2009, p.12). Working collaboratively has also been seen as especially beneficial for girls. Reasons given are that most girls prefer collaboration to competition; girls generally have good communication skills and benefit from and enjoy discussion; small collaborative groups facilitate “connected” learning and support and encourage risk taking; and collaboration helps to create a more egalitarian environment.

In a comparative study of two schools, Jo Boaler (1997a, 1997b, 1997c) found that girls in a school that used an approach based on collaboration and open-ended inquiry reported increased confidence and enjoyment of mathematics. Girls in a school with a similar population that used a traditional textbook-based approach reported widespread disaffection, lack of confidence, and the feeling that they were not being given a chance to understand. For people concerned with gender equity, another potential benefit of the collaborative approach is that boys may play a less dominant role in small-group discussions than they do in whole-class teaching. Studies of the latter have consistently found that a disproportionate number of
teacher-student interactions are with boys. Collaborative work in small groups may allow more students the opportunity to articulate their ideas than would be possible in whole-class teaching, and so may have the effect of counteracting the tendency for a few males to dominate classroom interactions.

Although many studies of gender and classroom interaction, such as those cited earlier, have looked at the context of whole-class instruction, relatively few have investigated the influence of gender on interaction in a collaborative inquiry context.

(Multiple Perspectives on Mathematics Teaching and Learning, Jo Boaler, 2000, pages 156-157)

Learning is collaborative

Cooperative learning is an efficient and dynamic method in which small teams use a variety of learning activities to understand a subject and its member is responsible for studying a section. Afterwards, each student explains to the remaining members of the group the material that he/she has studied.

The value of group work gets more evident day by day, improving high-order skills and helping to reach learning goals. Consequently, the formation of efficient groups has great importance.

(Garcia et al 2006-2007, p 2)

The collaborative nature of learning is closely related to the situated perspective that stresses the social character of learning. Effective learning is not a purely solo activity but essentially a distributed one, involving the individual student, others in the learning environment and the resources, technologies and tools that are available (Salomon, 1993). The understanding of learning as a social process is also central to socio-constructivism, and despite the almost idiosyncratic processes of knowledge building, it means that individuals nevertheless acquire shared concepts and skills (Ernest, 1996). Some consider social interaction essential, for instance, for mathematics learning as individual knowledge construction occurs through
interaction, negotiation and co-operation (Wood, Cobb and Yackel, 1991). The available literature provides substantial evidence supporting the positive effects of collaborative learning on academic achievement (Lehtinen, 2003; Salomon, 1993; van der Linden, Erkens, Schmidt and Renshaw, 2000). It suggests that a shift toward more social interaction in classrooms would represent a worthwhile move away from the traditional emphasis on individual learning. It is important to avoid going too far to the opposite extreme, however: the value for learning of collaboration and interaction does not at all exclude that students develop new knowledge individually. Distributed and individual cognitions interact during productive learning (Salomon and Perkins, 1998) and there remain numerous unanswered questions relating to collaborative learning in small groups (Webb and Palincsar, 1996) for instance, we need a better understanding of the ways in which small-group activities influence students' learning and thinking, of the role of individual differences on group work and of the mechanisms at work during group processes (van Der Linden et al., 2000).

The Structure and Balance of the Curriculum: 5-14 National Guidelines1 and Curriculum Design for the Secondary Stages, Guidelines for Schools2 both include 'learning and thinking skills' in their lists of important skills. A survey of curricular guidelines reveals a wide range of cross-cutting skills that fall into this category for example:

- identify and select relevant information
- plan how to carry out tasks and investigations
- sort, order and classify information
- clarify and reflect on ideas, experiences and opinions
- generate ideas, questions and hypotheses
- give reasons for opinions, actions and decisions
- draw conclusions informed by reasons or evidence
- identify problems and discuss possible ways of solving them

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• judge the value of ideas, outcomes and solutions and discuss possible improvements
• make evaluations of own and other’s work.

PBL is an approach to instruction that teaches curriculum concepts through a project. The project is guided by an inquiry question that drives the research and allows students to apply their acquired knowledge.

Co-operative learning methods are among the most extensively evaluated alternatives to traditional instruction in use today. Use of co-operative learning almost always improves affective outcomes. Students love to work in groups and they feel more successful and like subjects taught co-operatively. They have more friends of different ethnic groups and are more accepting of others different from themselves. Regarding achievement, however, outcomes depend a great deal on how co-operative learning is used. In general, two elements must be present if co-operative learning is to be effective: group goals and individual accountability. That is, groups must be working to achieve some goal or to earn rewards or recognition, and the success of the group must depend on the individual learning of every group member. (Dumont et al, 2010, p, 170)

EMPIRICAL BACKGROUND OF RESEARCH

Shui-fong Lam Rebecca Wing-yi. Cheng William Y. K. Ma examined the relationship between teacher and student intrinsic motivation in project-based learning. The participants were 126 Hong Kong secondary school teachers and their 631 students who completed evaluation questionnaires after a semester-long project-based learning program. Both teachers and students were asked to indicate their motivation in the program, and students were also asked to report the instructional support they received from their teachers. The results of hierarchical linear modeling analyses showed that teacher intrinsic motivation predicted student intrinsic motivation directly as well as indirectly through the mediation of instructional support. When teachers
reported higher intrinsic motivation in the program, their students tended to perceive receiving more support from them and to report higher intrinsic motivation in the learning experience.

Silvia Di Marco, Antonio Madeira, Paulo Ribeir (2004), M.J.P. described a science and technology course in the University Nova de Lisboa (Portugal), and its evolution towards a blended-learning format and a constructivist instructional design based on collaborative projects. The core of their work was to identify critical points and recommendations concerning the use of e-learning and project-based learning in an Applied Optics course where laboratory activities are relevant parts of the curriculum. Asynchronous and synchronous e-learning tools and strategies were adopted in 2004 (interactive learning units, tests for self-assessment and online sessions for collaborative problem-solving), and later on, in 2007, they reorganized the course around collaborative real-life projects aiming for a constructivist teaching-learning model. Overall, collaborative projects were positively rated by students, who appreciated experiencing a real-life “R&D” situation, and said that it enhances knowledge acquisition. Professors observed that this teaching method promotes stronger participation and a more proactive attitude. Furthermore, it was confirmed that well designed e-learning tools and activities are useful in supporting self-learning, a precondition for a creative approach to lab activities and projects. Synchronous online sessions for problem-solving were highly appreciated, because they allow software sharing and immersive remote communication. On the contrary, web-forums did not reach the expected results.

The conclusion is that e-learning and experimental collaborative activities can be successfully combined to foster meaningful learning, although this is demanding in terms of effort and time. Collaborative projects and rich learning environments are
two key features in constructivist instructional design and help students to develop a
proactive attitude towards learning, as they have to deal with many kinds of resources
instead of receiving a closed set of information, and this requires knowledge
management skills. Furthermore, students need to put in place knowledge and skills to
implement the project within a group. This implies the possibility to learn together
with the others in a dynamic process, but also the need to explain, share and possibly
defend particular ideas within the work-group.

➢ It is well known that using computer games as educational materials for computer
programming and Software engineering education effectively motivates students. For
this purpose in Konan University, researchers have practiced project-based learning
to develop game programs. From instructional practice in Konan University to date,
it was concluded that more specialized game contents are needed in order to better
motivate the students. On the other hand, in character design training in Osaka
University of Arts, it has been expected that showing students a goal where their
characters are animated in game system effectively motivates the students. However,
to develop game system, high level programming skill is needed. To address these
problems, researchers propose a collaborative project-based learning approach which
can be practiced in cooperation with a faculty of computer science and a faculty of
arts. In the learning process, program codes are developed by the computer science
students and game contents are created by the arts students. The process also includes
online meetings to coordinate their work. Through the project, students would not
only improve their expertise but learn unprofessional knowledge, experience
collaborative work and improve communication skill.

➢ Naoya Nitta, Yasuhiro Takemura, Izuru Kume(2009), showed propose a PBL method
(CPBL: Collaborative Project-Based Learning) which can be practiced in cooperation with a faculty of computer science and a faculty of arts. In the last year, they practiced a CPBL to develop a 3D fighting game from a collaboration of a PBL course which had been offered in the faculty of Intelligence and Information in Konan University and character design training courses which have been offered in the faculty of Arts in Osaka University of Arts. In the practice of CPBL, 13 senior students of Konan University and 75 sophomore students of Osaka University of Arts participated. The specification of the 3D fighting game was initially developed by the student of Konan University and reviewed by the students of Osaka University of Arts. The game system was designed and implemented by the students of Konan University using Java and Java3D. All game characters and their 3D data were designed and modeled by the students of Osaka University of Arts using Met sequoia.

In this study, they proposed CPBL, and reported and evaluated the practice.

➢ The Project Work (PW) initiative was introduced by the Ministry of Education, Singapore, to provide students with the opportunities to foster collaborative learning skills, to improve both oral and written communication, to practice creative and critical thinking skills, and to develop self-directed inquiry and life-long learning skills (Ministry of Education, 1999). Although PW had been introduced for a few years, there has not been much research done in the Singapore context, especially in terms of its effect on students' motivation. To fill the empirical gap, this study examined the extent in which PW promoted students' intrinsic motivation, as well as satisfied students' needs for competence, choice and relatedness. Specifically data was collected from 7 classes of Secondary 2 students with the use of a modified version of the Intrinsic Motivation Inventory (IMI, McCauley, Duncan, & Tammen, 1989) to assess students' intrinsic motivation and their perceived choice, competence
and relatedness in the PW context and in their normal mathematics or science lessons. Comparisons were made to establish whether there was any significant difference in terms of the students’ experiences in the different learning contexts. The result showed that students who were intrinsically motivated for doing schoolwork were ‘more likely to stay in school to achieve to evidence conceptual understanding, and to be well adjusted’ than students who were more extrinsically motivated (Deci, Vallerand, Pelletier, & Ryan, 1991, p. 332).

In another study, the autonomous collaborative environment for project based learning was developed which respects initiative of the participants in order to bring out autonomous collaboration. The workshop named "A Hundred Hour Workshop" for graduate students was carried out during summer holidays by some of the members of the real world information systems project in the 21 COE program "Information Science and Technology Strategic Core" at the Graduate School of Information Science and Technology of the University of Tokyo was also developed for supporting and analyzing autonomous collaboration process. The originality of this research is to propose a set of protocol as well as platform which shapes collaborative learning environment with practical embodiments. Number of attendees to the orientation was 50 and 13 students participated in the workshop.

There were two teams; Team A and Team B. Team A consisted of 7 members, while Team B consisted of 6 members. Members of both teams belong to either Lab X or Lab Y: research area of Lab X in the department of information and communication engineering is parallel computation; Lab Y had been working on recognition in the department of mechanic-informatics, a cross-disciplinary area of informatics and mechanical engineering. Four students of Team A belong to Lab X, three of them belong to Lab Y. Team B consisted of six members: half of them are of Lab X and
rests of them were of Lab Y. The grade of the students was as follows: one was bachelor course fourth year, six were in master course, and four were in doctor course. Both teams tried to speed up motion recognition software based on Cubic Higher-order Local Auto-Correlation (CHLAC) feature extraction algorithm through parallel computation on GRID computing environment. The goal of Team A is to speed up recognition software so as to operate in real time. The goal of Team B was to improve accuracy of the recognition which took unrealistic period of time without parallel commutating. Human motion recognition system, which can discriminate strong and weak punching and kicking motions was developed by Team A, while human gait recognition system, which could identify both Person and motion by time series of image data by Team B. The development was a big success. They express: In this study, autonomous collaborative environment which supports project based learning was developed. The environment promoted cross-disciplinary study among graduate students of different departments. This doesn’t happen without it. The goal was to realize the next generation of the information system through integrating different domains in information science and technology via collaboration. The environment comprised the workshop protocol and the community site. The workshop was proposal based, and the teams consisting of different lab members were recommended for participation. The site was built on one of the typical contents managing system. (Thomas, 2000)

Another study was conducted in Bogazici University in summer 1998 and in fall 1999 on project based learning launched in their cases, "project based learning" was implemented as educational method and teachers/students were requested to prepare unique presentations. Although some participants showed some resistance during the first weeks, group dynamics helped in securing full participation of
everybody. Projects prepared ranged from topics in literature, mathematics, life sciences, history, arts, geography, and language. Microsoft PowerPoint program was used to compile information gathered mainly from Internet and library of the university. Participants had access to the work-in-progress of their peers via the local network and oral presentations were scheduled at the end of the training programs. Some of the projects were made public on the Internet classified by author and subject.

➢ A three-year 1997 study of two British secondary schools one that used open-ended projects and one that used more traditional, direct instruction found striking differences in understanding and standardized achievement data in mathematics. The study by Jo Boaler, found that students at the project-based school did better than those at the more traditional school both on math problems requiring analytical or conceptual thought and on those considered rote, that is, those requiring memory of a rule or formula. Three times as many students at the project-based school received the top grade achievable on the national examination in math (Thomas 2000).

➢ Thomas and Mergendoller (2000) conducted a survey of PBL teachers designed to elicit or construct principles (conditions and strategies) associated with successful implementation of project work. Twelve middle- and high school teachers were selected for their status as expert practitioners in the eyes of their peers.

➢ A semi-structured telephone interview schedule was developed in order to elicit considerations and strategies associated with these teachers' planning and enactment activities. The interview consisted of 43 questions relating to such topics as record keeping, use of technology, classroom management, and grading. Teachers' responses were then categorized into recurring, qualitatively distinct themes. In the end teachers' responses were organized into 10 themes. Themes were constructed to
reflect the larger issues that seemed to recur across teachers' answers to the interview questions. Principles were summaries of teachers' strategic responses to the issues raised in the themes. An example of a theme was "creating a positive learning environment." Principles associated with this theme were: (1) establish a culture that stresses student self-management and self-direction; (2) Use models or exemplars of excellent work; and (3) Create a physical environment that will facilitate project work (Thomas 2000).

➢ In a five-year study by Penuel and Means (2000) found that technology-using students in Multimedia Project classrooms outperformed non-technology-using students in communication skills, teamwork, and problem solving. The Center for Learning in Technology researches, led by Bill Penuel, found increased student engagement, greater responsibility for learning, increased peer collaboration skills, and greater achievement gains by students who had been labeled low achievers. The project conducted a performance assessment designed to measure students' skills in constructing a presentation aimed at a particular audience. Students from Multimedia Project classrooms outperformed comparison classrooms in all three areas scored by researchers and teachers: student content, attention to audience, and design. The Multimedia Project involves completing one to four interdisciplinary multimedia projects a year that integrates real-world issues and practices (Thomas 2000).

➢ A 1992 study of 700 students from eleven school districts in Tennessee found that students doing projects using videotaped problems over a three-week period performed better in a number of academic areas later in the school year. The study, by the Cognition and Technology Group at Vanderbilt University, examined student competence in basic math, word problems, planning capabilities, attitudes, and teacher feedback. Students who had experience in the project work performed better
in all categories. The study appeared in *Educational Psychologist*, (Thomas 2000).

➢ A study by the Center for Research in Educational Policy at the University of Memphis and University of Tennessee at Knoxville (1999) found that students using the Co-nect program, which emphasized project-based learning and technology improved test scores in all subject areas over a two-year period on the Tennessee Value-Added Assessment System. The Co-nect schools outperformed control schools by 26 percent (Thomas 2000).

➢ A five-year study by University of Wisconsin-Madison researchers found that structural school reform works only under certain conditions:

1. **Students must be engaged in activities that build on prior knowledge and allow them to apply that knowledge to new situations.**

2. **Students must use disciplined inquiry.**

3. **School activities must have value beyond school.** In their report, "Successful School Restructuring," the researchers at Wisconsin's Center on Organization and Restructuring of Schools found that even innovative school improvements, such as portfolio assessment and shared decision making, are less effective without accompanying meaningful student assignments based on deep inquiry. Researchers analyzed data from more than 1,500 elementary, middle, and high schools and conducted field studies in forty-four schools in sixteen states between 1990 and 1995. (Thomas 2000).

➢ In a study by H.G. Shepherd (1998), fourth and fifth graders completed a nine-week project to define and found solutions related to housing shortages in several countries. In comparison to the control group, the project-learning students scored significantly higher on a critical-thinking test and demonstrated increased confidence in their learning (Thomas 2000).
A more ambitious, longitudinal comparative study by Jo Boaler and colleagues in England in 1997 and 1998 followed students over three years in two schools similar in student achievement and income levels. The traditional school featured teacher-directed whole-class instruction organized around texts, workbooks, and frequent tests in tracked classrooms. Instruction in the other school used open-ended projects in heterogeneous classrooms.

The study found that although students had comparable learning gains on basic mathematics procedures, significantly more project-learning students passed the National Exam in year three than those in the traditional school. Although students in the traditional school "thought that mathematical success rested on being able to remember and use rules," according to the study, the project-learning students developed more flexible and useful mathematical knowledge (Thomas 2000).

Tretten and Zachariou (1995) conducted an assessment of Project-Based Learning in four elementary schools using teacher questionnaires, teacher interviews, and a survey of parents. Of interest in this study was the fact that the schools involved had only recently began to experiment with Project-Based Learning and that all teachers, a total of 64 across the four schools, were surveyed. The average percentage of instructional time devoted to Project-Based Learning across all schools and teachers was 37%. According to teachers' self-reports, experience with Project-Based Learning activities had a variety of positive benefits for students including attitudes towards learning, work habits, problem-solving capabilities, and self esteem. In conclusion the authors stated that: Students working both individually and cooperatively felt empowered when they used effective work habits and applied critical thinking to solve problems by finding or creating solutions in relevant projects. In this productive work, students learn and/or strengthen their work habits, their critical
thinking skills, and their productivity. Throughout this process, students are learning new knowledge, skills and positive attitudes (Tomas 2000).

Another study conducted by Tretten and Zachariou (1997) expanded the survey to include fourteen schools, some of which had been involved with Project-Based Learning for three years. In this study, an attempt was made to validate teachers’ self-report ratings from the previous study by observing students working on projects. Unfortunately, the observation framework and scoring system was found to be unwieldy and was abandoned. The teacher surveys, however, did reveal at least one interesting finding. Teachers were asked to indicate the relative frequency with which student’s exhibit different kinds of learning while working on projects. The scale used was a four-point scale ranging from a 1 for "none of the time", 2 for "some of the time", 3 for "most of the time", and 4 for "almost all the time". As expected for this kind of abbreviated scale, the average ratings for different kinds of learning outcomes (e.g."problem-solving skills," "knowledge/content," "responsibility") showed little variance and were relatively high (all averages were between a 3 and a 4, that is, between "most of the time" and "almost all of the time"). Yet, the order of importance of each type of learning was interesting. Highest ratings were given to "problem-solving skills" (3.47) and "aspects of cooperation" (3.47), with all other learning outcomes ranging between 3.32 ("critical thinking skills") and 3.43 ("aspects of responsibility") except one: Teachers gave their lowest rating overall (3.07) to the statement "I believe they learn important knowledge/content." These teachers seem to believe that learning subject matter content is not one of the principal benefits of Project-Based Learning (Thomas 2000).
Patrick Foss, Nathaniel Carney, Kurtis McDonald, and Matthew Rooks teach at the School of Science and Technology at Kwansei Gakuin University in Sanda, Japan. Their research interests include fluency development (Foss), computer-mediated intercultural learning (Carney), meaningful language learning (McDonald), and comprehensible input (Rooks).

The effectiveness of the project-based teaching approach in a short-term intensive English program for Japanese university EFL students. Four distinct projects are described and evaluated, and the benefits and limitations of the four projects are given. The paper shows that project-based instruction is a viable and flexible alternative to traditional intensive English coursework (Thomas 2000).

Another study, in Baskent University, Turkey by Yasemin Gülbaşar and Hasan Tinmaz (2005), aimed at implement project-based learning by utilizing e-portfolio assessment in a small-scale classroom (N = 8). The compulsory Design, Development, and Evaluation of Educational Software course in the curriculum of the Department of Computer Education and Instructional Technology was selected due to its strong relationship with real Life while lending itself to addressing the major concern of project-based learning. Despite Insufficient classroom size and students' challenges on animation software, it was found that Project-based learning was an appropriate choice for conducting such a course. Moreover-portfolio assessment proved to be valuable in project-based learning. In the rest of the paper, findings from other research studies evaluating project-based learning are discussed and recommendations are presented. (Gülbaşar & Tinmaz, 2005).

A study by Askin Asan and Zeynep Haliloglu (2002-2003), presented a design of effective computer class that implements the well-known and highly accepted project-based learning paradigm. A pre-test/post-test control group design investigation was...
undertaken with 98 students from 6th grade students (male and female) enrolled in computer class at the elementary school in Koprubasi, Trabzon, Turkey in the 2002-2003 academic years. Students were randomly divided into two treatment groups. One group (50 students) formed the control group. Other 48 students received the project based learning treatment. The effect of the project based learning on students' computer skill achievement level was assessed using the Rubric, an instrument that was developed during the study. Group and Self evaluation forms were used to measure the learning outcomes related to the teamwork, communication and social skills. The results have been found to be positive and are discussed. (Asan&haliloglu, 2002-2003).

➢ S.H. Pee and Helene Leong (2003) After research about the CDIO concepts and realizing the potential of cultivating students with the desired skills, a pilot programmed incorporating CDIO concepts into project-based learning was implemented in the Singapore Polytechnic in 2003. The projects were developed using CDIO theories where students worked through conceive, design, implement and operate stages. In these projects, students in a class of 20 are required to build an artifact that comprises sensors and control algorithms. So far, three cohorts of students have completed their projects. As the projects developed were highly innovative and creative, the local news program had featured some of the students' innovations. Besides completing the projects, students also developed other attributes such as creative and critical thinking, resourcefulness and learning to learn traits. (Pee & leong,2003)

➢ A study by Hashim and Azizi Mohammed Din (2009), the researchers evaluated the implementation of a Project Based Learning (Project BL) incorporating the development of students' soft skills as well as technical or professional competences.
The research question addressed here is the suitability of PBL in achieving the desired learning outcomes i.e. Practical knowledge of engineering surveying, basic knowledge on engineering design, and soft skills or personal competences. The objectives are two-fold; to evaluate the effectiveness, and to identify potential improvement. The course, the Engineering Surveying Camp offered at Year-I of a four-year civil engineering degree programme, is a two-week field course. During the course, the students carried out an actual surveying and design project in groups of 6-7 students supervised by the academics. Assessment of technical aspects was based on daily output and final products while for soft skills on performance during the various sessions.

Evaluation was carried out based on the outputs and student performance during the various sessions. It was found that the technical aspects were achievable though with lesser degree for the engineering design. On soft skills, students demonstrated an overall improvement of competency but it was difficult to ascertain the levels for the average students while the best and poor performers were easily observed. (Hashim & Azizi Mohammed Din, 2009).

Firas Abdullah, Claudine Toffolon (2007), Technology Enhanced Learning Systems (TELS), these systems do not consider pedagogical and computer science aspects be unrelated. One of the teachers' major objectives is to define the way of designing, adapting or choosing the accurate platform to support the pedagogy they need to implement. Therefore our work aims to propose an approach to help the teachers to choose a platform of e-learning and deploy their lessons according to the objectives of a Project-Based Collaborative Learning (PBCL) framework. We focused on the choice and adaptation strategy rather than on the design development aspects. In this publication, we define an MDA based approach in order to establish a methodological
framework of our research project and therefore meet with our objectives. We will also report on our research progress and propose a state of our work in PBCL modeling (Abdallah, Toffolon and Warin, 2007).

At another research, Yam & Rossini (2010), discussed how PBL was implemented in an introductory property course running in semester one, year one, which is offered in multiple modes of study. This course also serves as an introduction to University study and the property profession. Two qualitative student surveys were conducted during the study period to explore students' feedback on their learning experience. Feedback from students suggested that PBL provides good insights to the valuation process and the field work involved and that group exercises help to motivate students and make the subject matter more interesting. As well, we have identified challenges in implementing PBL; these include workload issues, teachers' content knowledge, lack of experience from both teachers and students and the need to develop specialized material for off-campus study. For the initial qualitative study two groups of students were involved: Group One consisting of 36 internal students and Group 2 consists of 12 students who studied online (external). In each instance an open-ended questionnaire survey was carried out in week 6. (Yam & Rossini, 2010)

In another study, Lam et al (2008), examined the relationship between teacher and student intrinsic motivation in project-based learning. The participants were 126 Hong Kong secondary school teachers and their 631 students who completed evaluation questionnaires after a semester-long project-based learning program. Both teachers and students were asked to indicate their motivation in the program, and students were also asked to report the instructional support they received from their teachers. The results of hierarchical linear modeling analyses showed that teacher intrinsic motivation predicted student intrinsic motivation directly as well as indirectly through
the mediation of instructional support. When teachers reported higher intrinsic
motivation in the program, their students tended to perceive receiving more
support from them and to report higher intrinsic motivation in the learning
experience. (Lam et al., 2008).

Kurzel and Rath, (2007), described the characteristics of Project Based Learning, a
derivative of problem based learning and report on a multimedia course where this
methodology was pursued. The instructional materials were reported on and the
artifacts/documentation developed by students discussed. A factor analysis was
performed on questionnaire data that was collected at the end of the semester to
evaluate the methodology pursued and the instructional artifacts developed. The
results of this analysis are discussed along with the implications of this analysis on the
use of online learning environments. A model to provide alternate instruction in an
online environment is further discussed. A factor analysis was applied to the 27 item
scale that came from the questionnaire. It was apparent that a 3 factor resolution,
accounting for 45% of the overall variance was appropriate. The eigenvalue was set at
2.5 to create the three factors. A principal components analysis was the followed up
with a factor analysis using an oblimin rotation. (Kurzel and Rath, 2007).

At another study, Ravitz et al (2010-2011), determined the effect of project based
learning (PBL) professional development and implementation on teachers’
perceived ability to teach and assess 21st century skills. At the end of the 2010-
2011 school year, data on teaching practices and perceptions were systematically
gathered and compared from two groups of teachers matched by demographics,
grade and subject: teachers expected to have utilized PBL after extended professional
development and teachers who had not received the professional development or not
expected to have used PBL. Teachers who used PBL and received extensive
professional development reported more teaching and assessment of 21st century skills overall, with similar patterns seen within subjects and for nearly all of the measured skills. (Ravitz et al, 2010-2011).

In the present study the researcher has emphasized on the role of thinking skills especially critical thinking in education. On the basis of the result of research all courses whether in primary secondary or tertiary education, need to be taught in such a way as to encourage critical thinking in science subjects. Indeed, this opinion is so common in such areas as the social sciences as to be fairly uncontroversial. What the researcher would add, however, is that critical thinking should be added to the curriculum as an independent course. Without an independent course that teaches the generic aspects of critical thinking, it will be difficult for the teachers in the particular disciplines to convey to their students why critical thinking is important.

The present study has tried to infusion of critical thinking into the curriculum carries with it the promise of the academic empowerment of the students. Once this is recognized, it will be necessary to come to grips with the question of the best way to bring about such infusion.

According to Cropley (2001) creative teaching may be defined in two ways: firstly, teaching creatively and secondly, teaching for creativity.

In the present study, the researcher has tried to teach creatively that is described as using imaginative approaches to make learning more interesting, engaging, exciting and effective. Teaching for creativity might best be described as using forms of teaching that are intended to develop students own creative thinking and behavior. However it would be fair to say that teaching for creativity must involve creative
After collecting the related literature for Project Based Learning (PBL) from websites, journals and encyclopedia, the researcher has now come to a valid conclusion that PBL is a new method of learning. The roots of PBL lie in “Doing projects”. Project Based Learning (PBL) is a model that organizes learning around projects. Project-based learning provides an authentic environment in which teachers can facilitate students increasing their skills in cooperative way. Project-Based Learning is often applied in the case of complex learning i.e. which aims to make students acquire various linked skills or develop their behavior.

According to Krajcik et al. (1999) PBL approach engages learners in exploring important and meaningful questions through a process of investigation and collaboration. Students ask questions, make predictions, design investigations, collect and analyze data, use technology, make products and share ideas.

PBL is also helpful for developing long-term learning skills. Krajcik et al. (1999) suggested four benefits for the students. Firstly, learners develop deep, integrated understanding of content and process. Secondly, students learn to work together to solve problems. Collaboration involves sharing ideas to find answers to questions. In order to succeed in the real world, students need to know how to work with people from different backgrounds. Thirdly, this approach promotes responsibility and independent learning. As a final benefit, this approach actively engages students in various types of tasks; thereby meeting the learning needs of many different students.

Four variables have been included in PBL in the present study which plays a very important role in active, lifelong and permanent learning. They are thinking skill, creativity, team collaboration, and problem solving.

Studies related to PBL especially on Primary students are scanty. PBL is very important for primary students. Jo Boaler (1994) found that students at the project-based school did better
those at the more traditional school. The ability to think critically that comes with having tools for higher order thinking can help students for into their future not only grasp new information and material but also figure out how to change and adapt to new situations. Williams, 2003, p3) Recent reviews of thinking distinguish between a general definition of thinking that includes all intelligent cognitive activities and a more specific definition that includes only the most complex form of cognitive activities, such as reasoning, decision making, and problem solving (Sternberg, 1994, p35). The mind shapes higher order skills only when higher order performance is demanded. According to Rainbolt and Dwyer, 2012, critical thinking is the skill of making decisions based on good reasons. Learning to think critically is one of the most valuable skills that can acquire because it is reflective, analytical, and evaluative aspects can be brought to bear on any problem or issue. Critical thinking (higher order of thinking skill) has its roots in the Socratic Method. Plato described Socrates as someone who encouraged his students to reflectively question common beliefs, analyze basic concepts and to carefully distinguish beliefs that are reasonable and logical from beliefs that lack rational foundation (Paul, Elder, & Bartell, 1997). Critical Thinking is important and inseparable part of PBL and its importance cannot be ignored in educational setting. That’s why CT has been included in PBL. Primary students should be motivated to think critically and they will start thinking differently and in new way.

According to Croply creativity involves departing from the facts, finding new ways, making unusual associations or seeing unexpected solutions.

Creativity can be regarded as not only a quality found in exceptional individuals, but also as an essential life skill through which people can develop their potential to use their imagination to express themselves, and make original and valued choices in their lives. Creativity makes learning interesting and curriculum of primary schools should be based on it. Craft 1999 supported this notion that creativity is an essential life skill, which needs to be fostered by the
education system(s) from the early years onward. Such a statement emphasizes the importance of playfulness, imagination and creativity in learning for children, young people and adults and the role that schools might play in promoting these qualities in learning experiences (Anning 1994; Shagoury-Hubbard 1996; Whitaker 1997). According to Scandura (1977) problem solving as the generate on and selection of discretionary actions to bring about a goal state, it becomes apparent that creative thought represents a form of problem solving. Learning activities designed to foster creativity cast students in the roles of problem solvers and communicators rather than passive acquirers of information. Project-based learning provides an authentic environment in which teachers can facilitate students increasing their skills in cooperative learning and collaborative problem solving.

Problem solving is related to creativity. If students are to solve real problems, teachers have the responsibility not only to teach them the necessary knowledge and skills, but also to set problems for which the teachers have no answers and to work together with students to find the solutions together, usually in small groups, on a shared activity and with a common goal. Team-working promotes the distribution of students and roles within the team, which led to self-commitment in tasks according to each student’s personality and capabilities. Work in Team leads to solve problem, they are goal oriented and their aim is common and they work together in reaching the goal. Working in team develops among students responsibility, discipline and the most important is to make learning interesting.

Keeping in mind the importance of all these variables in PBL, the researcher has made a modest attempt to create a congenial atmosphere for learning of primary school students (undergraduate students in Iran). The researcher has adapted experimental method (use of experimental and control group) to found out the efficacy of project-based learning including Thinking Skills, Creativity, Problem Solving and Team- Collaboration on learning among undergraduate school students.
CHAPTER 3
RESEARCH DESIGN AND METHODOLOGY

The research design is the detailed plan of the investigation. In fact, it is the "blue print" of the detailed procedure of testing the hypothesis and analyzing the obtained data. The research design may be defined as the sequence of those steps taken ahead of time to ensure that the relevant data will be collected in a way that permits objective analysis of the different hypotheses formulated with respect to the research problems. Thus, the research design helps the researcher in testing the hypothesis by reaching valid and objective conclusion regarding the relationship between independent and dependent variables.

In this chapter a description of the sample, its size research tools, administration and collection of data and statistical techniques used by the researcher for analyzing data, has been prepared.

SAMPLING, POPULATION AND SAMPLE OF THE PRESENT STUDY

Sampling is the process by which a relatively small number of individuals or measures of individuals, objects or events is selected and studied in order to draw some inferences about the entire population from which it was drawn. It helps to reduce expenditure, save time and energy permit measurement of greater scope, or produce precision and accuracy. Sampling procedures provide generalizations on the basis of a relatively small portion of population.

A population refers to a group of individuals with at least one common characteristic which distinguishes that group from other individuals. A study of the entire population is impossible due to its size, lack of time and resources. Moreover; in most of cases it is not required. To avoid these problems a smaller portion of the population is selected as a sample which is studied in detail and conclusions are drawn for the whole population.

In the present study, the target population was consisted of students enrolled in class fifth from school of city of Qom in Iran. Qom is situated on the bank of river's Qom and is 156 kilometers southwest of Tehran. Qom consists of four educational districts. Districts 1 & 2 are non-prosperity districts having 115 schools in city. Districts 3 & 4 are prosperity districts having 169 city schools. Thus there are two clusters in our statistical population, cluster 1 and
Table 3.1 information regarding the school and the distribution in the experimental and control groups

<table>
<thead>
<tr>
<th>Name of Schools</th>
<th>Classes (6)</th>
<th>Number of Childrens enrolled in the classroom</th>
<th>Number of Children taken for research</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boy</td>
<td>Girl</td>
<td>Fifth class</td>
</tr>
<tr>
<td>Shahid mofatteh (A)</td>
<td>■</td>
<td></td>
<td>33</td>
</tr>
<tr>
<td>Kosar</td>
<td>■</td>
<td></td>
<td>29</td>
</tr>
<tr>
<td>Shahid mofatteh (B)</td>
<td>■</td>
<td></td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td>84</td>
</tr>
</tbody>
</table>

Table 3.1 number of children and clusters information regarding the school

Cluster 2 is non-prospersity districts and cluster 2 is the prosperity districts. Due to paucity of time, the researcher could collect data only from few schools. Originally four schools were randomly selected for this study. Two schools namely Shahid Mofatteh A (for boys) and a different shahid mofatteh B (for girls) were selected under cluster 1, two schools namely Mirza Shirazi (for boys) and Kosar (for girls) were selected under cluster 2, but unfortunately, Mirza Shirazi school for boys did not cooperate with the researcher, therefore in effect, the children of only three schools could be studied. In each school there were two separate fifth classes. All the students enrolled in a class served as subjects of the present study. As the table 3.1 shows there were 66 boys in cluster 1 school, 33 boys in each class, and 51 girls, 22 in one class and 29 in another. In cluster two, Kosar school again there were 51 girls, 22 girls in one class and 29 in another.
The experimental group consisted of students engaged in project-based learning, the control group learned through regular method. The experimental group consists of students who received training on project-based learning. During the 6 sessions of the classes, students were engaged in project-based learning. Before the Project Based Learning was introduced, the students were given pre-test, and after the completion of PBL post-test was given.

INSTRUMENT/TOOLS USED:

For collecting relevant information for the present study, four researcher-made questionnaires were used to measure the variables.

PROJECT-BASED LEARNING QUESTIONNAIRE:

The PBL questionnaire has been developed by Barbara A. Soloman and Richard M. Felder (2000) in North Carolina State University on the secondary school. The inventory contains 20 items. It provides 4 separate indicator and dimensions of PBL. It also gives a total PBL score. The test was modified by the researcher to suit visually challenged students.

CONCEPTUAL AND OPERATIONAL DEFINITION

In order to move from general principals of theoretical framework to specific realms of the facts in this research, it becomes necessary to define the variables operationally and check their validity and reliability in a systematic way. Herein, after conceptual definition of the variables, the operational definition will be presented. A conceptual definition tells meaning of the concept, while operational definitions tell us how to measure it.

Experimental research as applied to education is defined as the application of systematic methods and techniques that help researcher and practitioners understand and enhance the teaching and learning process. (Lodico et al, 2010).

Project-Based Learning:

Conceptual definition: PBL is an approach where the teacher becomes a guide or a facilitator, while student learning has a central role. A complex task in a real-world context is presented to the students at the beginning of the project, without preliminary teaching having taken place. Through collaborative group work, students must question, discover, learn and organize the different parts of the project at hand. The ultimate goal in PBL is to
create and build a final product while gaining deeper knowledge about the content area (Moncton, 2009).

**Operational definition:** In this research PBL means style of teaching and learning that the researcher used in order to measure the influence of four variables (thinking skills, creativity, problem solving and team-collaboration) in the development of higher order thinking.

**Thinking Skills:**

**Conceptual definition:** “Thinking skills are sequences of choices, across various mental processes. The repertoire of thinking skills comprises your strengths and weaknesses in each skills area.” (Nelson, 2004, p 11)

**Operational definition:** Thinking skills in this study means, active engagement and sustained cognitive effort directed at solving a complex problem and use of prior knowledge in addressing the problem.

**Scoring:** To measure this indicator, 5 questions open-answered based upon curriculum (science book) were prepared and questioned from students that, in order to give marks, the answers are scored on the basis of 5 point Likert type scale.

**Reliability:** Reliability analysis result shows that the Cronbach’s Alpha scale value is (0.91) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the thinking skills’ variable.

**Face validity:** In order to move from general principals of theoretical framework to specific realms of the facts in this research, it becomes necessary to determine and check their validity in a systematic way. In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and two to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs, “Thinking Skills”. In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low) .The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.
Creativity:

**Conceptual definition:** "Creativity involves abilities, knowledge, skills, motives, attitudes and values as well as personal properties such as openness, flexibility or courage." (Cropley, p, 6, 2001).

**Operational definition:** In this research, creativity means pupils keep their minds open and modify their ideas to achieve creative result and look at things from different viewpoints.

**Scoring:** To measure this indicator, 5 questions open-answered based upon curriculum (science book) are prepared and questioned from students, the responses of the students were scared on five point Likert type scale.

**Reliability:** Reliability analysis result shows that the Cronbach’s Alpha scale value is (0.88) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the variable of creativity.

**Face validity:** In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and one to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs “Creativity”, In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low). The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.

Problem Solving:

**Conceptual definition:** “Problem solving is a practical skill that is fairly general, that could be learned, and that consists of four phases or principles: (a) understand the problem (the goal, what is known, what is not known), (b) devise a plan or solution approach, (c) implement the plan and confirm correctness of the implementation, and (d) examine the solution, confirm the result, and consider whether alternate solutions are possible.” (Polya, 945)
Operational definition: problem solving in this study means responses to challenges of pupils to problems in their real life and helps the students to solve them.

Scoring: To measure this indicator, 5 questions close-answered based upon curriculum (science book) are prepared and questioned from students. Scoring is again based on five point Likert type scale.

Reliability: reliability analysis result shows that the Cronbach's Alpha scale value is (0.91) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the variable of problem solving.

Face validity: In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and one to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs “Problem Solving”, In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low). The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.

Team-Collaboration:

Conceptual definition: “When a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain is called team- collaboration.” (Kateen et al, 2011).

Operational definition: In this research team-collaborating means some of students as a team engage and work together and each of the members cooperate with the teammate, in order to explore ideas and to reach themes of the project.

Scoring: To measure this indicator, 5 questions close-answered based upon curriculum (science book) are prepared and questioned from students. Scoring based on five points the Likert type.

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**Reliability:** Reliability analysis result shows that the Cronbach’s Alpha scale value is (0.95) for 5 questions, that is, there is reasonable internal consistency and cohesion in order to measure the team-collaboration variable.

**Face validity:** In order to check the face validity of the instrument in terms of item coverage, item relevance and clarity of the items, an expert panel consists one expert in Research Methodologist, one belonging to Sociology department and one to Education department who were specialized in the field of Educational Psychology judged the validity of items, whether items are appropriate to the constructs “Team-Collaboration”, In order to determine and measure the validity of questionnaire were taken the views of teachers and experts in Educational Planners and Curriculum Programmer. The appropriateness of the item was sorted out on a 5 point scale ranging from very much to very low. (Very much, much, moderate, low, very low). The items of the test were judged by the experts mostly ranged from very appropriate to appropriate.

**Under-graduate students:**

Operational definition: in this study, Under-graduate students consists students of last grade in primary school in IRAN.

**3.6. PROCEDURE:**

In each class, the first session was confirmed of familiarizing and introducing researcher and student with each other and the teachers, and then students responded to a pre-test questionnaire which included 20 questions (5 question covered thinking skills, 5 question creativity, 5 question problem solving & the last 5 question team-collaborating). In the questionnaire each question is made assessment of a criterion skill. It’s necessary to mention that material was changed in the second’s lesson in science book. In the first lesson, students learnt about materials, molecules, and how to set molecules, and familiarity with scientific methods included: observation, classification, combination, analysis and conclusion.

The students that participated in this research belonged to fifth grade in science course. Because the study of science is based on exploration and investigation, many opportunities exist in the science classroom for project-based learning. Students work together to come up with experiments to answer simple or complex scientific questions, or they may explore alternative solutions to everyday problems.
In order to implement PBL to the experimental group, the researcher started with creating challenge in the minds of pupils. For example what are problems that you face with them daily? Have you ever thought to solve the problems? Some of children responded with bigger problems for instance air pollution, traffic jam etc. Small issues for example the frozen streets after snowing, lack of the bridge overpass and so on. The purpose was to explore what pupils can think about problems & issues with their teammates and note them. We encourage pupils to brain storming and to think about surrounding and pay attention to issues that exists in environment of their real life, in continuing, students have been teaming into 4 or 5 people in each team. Some of pupils had some questions about the method that is responded them. The researcher explained for student, what’s purpose of this instruction method (PBL) and how does it work. In all of time (6 sessions) students were working with each other in the laboratory or free space (park is named ALAVI’s BOOSTAN). Over there was a suitable space for student to can experience material changes, each team should 5 cases make change in material and noted their observations & experiences and classify into two ranges (physical change & chemical change).

In the next session the researcher tried to guide the attention of students to the main course (material changes) therefore some questions about it. Now every team engaged, consulted and discussed together. The researcher joined with them, in order to lead pupils to be situated on the itinerary of project, patterned questions such as: how do you solve the problems? For example one of pupils responded I can to solve a problem when the streets frozen I would sprinkle salt and sand on them, it help to melt snows as soon as possible. Why was the snow melt? They responded different and to my scattering question. What happen when you scatter salt and sand on the snow? Students were motivated to think about more examples in their real life and search about it, note results of their finding for the next session.

In the third session, the class was formed in free space (ALAVI Park). Over there was a space very appropriate and interesting for students to experience material change. In the beginning class, students organized their teams and got ready for collaboration. Each team sitting placed at long distance. Each team should 5 cases make change in material, and noted their observations and experiences, then to classify into two ranges (physical & chemical changes). The students argued, reasoned as to why the bread after sometimes to changed mould (fusty), and or why the fruits and vegetables after long time become wrinkled? Every team engaged and discussed the problem that was defined as a project, for example a team made a fire and
burned some woods that were turning into coal. The teammate were discussing with each other what’s happened to the wood?

Other projects that the students designed and were thinking about consisted of: clay molded into a new shape. Is it physical or chemical change? Why? What happen to your body after eating the food? Why does water evaporate from the surface of the oceans? Where does the weight go when we lose weight? What happens when iron rusts? Why do the leaves of trees in autumn (fall) turn yellow? How to make dough for making bread?

In the next session, the teams extended quality and quantity discussions. Now, they know how to engage with each other and plan the problem and solve it. How can to collaborate as a teammate. The researcher went from team to another team during their collaborative time, she posed questions to designing an experimental procedure, and all teams were able to create their own procedure, to examine the effects of material change on their life, although the procedure varied in quality and details. Some of children didn’t discover what are the reasons which lead to chemical and physical changes? Of course most of them know in physical change the shape and size of the object has changed. It wasn’t a change in the state of matter, but something changed, and they can cause physical changes with forces like motion, temperature, and pressure, and chemical changes happen between molecules and are unseen.

When iron rusts we can see it happen over a long period of time. The actual molecules have changed their structure (the iron oxidized). and or melting a sugar cube is physical change, because the substance is still sugar. Burning a sugar cube is a chemical change. The energy of the fire has broken down the chemical bonds. Actually, the role of variables to create changes is vital, and pupils took it as a challenge and this was a great event to continue on PBL. To test the effects of different variables on the material was the next target for students. They had to record each variable such as temperature, humid and so on, to test in their experiments. The researcher explained a variable is anything that is different from the original, unaltered control sample, such as a change in heat. A variable could also be the addition of a foreign substance to your experiment.

During this study the students were working on material changes unit that was incorporated in project-based science. The goal of the project was for student to understand, integrate, engage, think, and solve their problem, to be creative and to work as a team member. In the last session, the researcher teaches power point software to students, to use in presenting in their final report. Finally students responded on same questionnaire pre-test. The researcher
requested the students to state the points of view about the instruction based on project. Three snapshot of the project’s plan can be seen under prefect overview.

**Administration: (pre-test and post-test)**

The experimental group consists of students who were selected in order to receive training on Project Based Learning. During the six sessions the classes, students had been engaged in Project-Based Learning. Before the PBL was introduced to the students (experimental and control groups) will be given pre-test(American based test) was given which consist of 4 questionnaires (thinking skills, creativity, problem solving and team-collaboration) in order to measure their initial abilities and after the completion of PBL post-test was found that their result was progressive. The analysis of data was done through by systematic random sampling technique.

It is an experimental research. This study aims to explore the effect of instruction method based on project based learning on the development of student's thinking skills.

**3.7. Statistical Techniques**

All the calculations were done on the computer with the help of a software package named as Statistical Package for Social sciences (SPSS) (version 18.0).

The analysis was done in two steps:

1. t-test.
2. Mann-Whitney U test

**t-test:**

A Mean is probably the most satisfactory measure for characterizing a group, it is important to determine whether the difference between Means of samples is significant.

The test of the significance of the difference between two Means is known as a t test. It is used to compare two Means.

Before applying this test the investigator made sure that the data were normally distributed. The basic statistics like Mean and Standard deviation were computed for each variable.

**Mann-Whitney U:**

A Mean is probably the most satisfactory measure for characterizing a group, it is important to determine whether the difference between Means of samples is significant.
The test of the significance of the difference between two Means is known as a t test. It is used to compare two Means.

Before applying this test the investigator made sure that the data were non-normally distributed.

DELIMITATIONS

One vital point observed by the researcher was the student’s inability to create scenarios for the PBS (project-based science). This may be due to the lack of course content emphasizing thinking skills such as creativity and problem solving. Additionally, the teachers don’t know how to write instructional scenario. Therefore, the curriculum should be evaluated and enhanced with courses emphasizing creativity and problem solving. This curriculum analysis will yield better results for PBS.

The limitations of this research are in its scope. We studied a small number of students working on within one project. We are limited in our ability to generalize about the patterns of challenges seekers and about how PBL in mathematics’ or other topics, might present academic challenges.
CHAPTER 4
In this chapter, the results of the study are presented in details. The descriptive results are discussed in the first section. Inferential results are presented in second section of this chapter. The descriptive section of the study demonstrates the statistical results through tables and clustered bar charts which are constructed by SPSS 18.

4.1. DESCRIPTIVE RESULT

In this section every variable is presented through a table and a clustered bar chart. Charts are visualizing the distribution of the variables and at the same time tables are indicating the percentage of the distribution of the relevant variables.
Table 4.1: Frequency distribution of population based on gender and groups

<table>
<thead>
<tr>
<th>GROUPS</th>
<th>Sex</th>
<th>Boy</th>
<th>PERCENT</th>
<th>Girl</th>
<th>PERCENT</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>EXPERIMENTAL</td>
<td>Boy</td>
<td>33</td>
<td>39%</td>
<td>51</td>
<td>61%</td>
<td>84</td>
</tr>
<tr>
<td>CONTROL</td>
<td></td>
<td>33</td>
<td>39%</td>
<td>51</td>
<td>61%</td>
<td>84</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>66</td>
<td></td>
<td>102</td>
<td></td>
<td>168</td>
</tr>
</tbody>
</table>

Figure 4.1: Frequency distribution of population chart based on gender and groups

Table and figure 4.1 indicates that the total of 168 student sample was divided into the experimental and the control group. Fifty percent (50%) of the sample was 84 students of the experimental group and 84 students of the control group. The above table and figure also indicates that 33% of the respondents were boys in both the groups and 51% were girls in both the groups.
Table 4.2: Frequency distribution of scores (pre-test) based on range of scores and groups

<table>
<thead>
<tr>
<th>RANGE OF SCORES</th>
<th>EXPERIMENTAL GROUP (PRE-THINKING SKILLS)</th>
<th>CONTROL GROUP (PRE-THINKING SKILLS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very low</td>
<td>61</td>
<td>72.6</td>
</tr>
<tr>
<td>Low</td>
<td>16</td>
<td>19.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>5</td>
<td>6.0</td>
</tr>
<tr>
<td>High</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>Very High</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 4.2: Frequency distribution of scores (pre-test) based on range of scores and groups

As seen the above table, that 61 pupils (73%) were very low, 16 pupils (19%) were in range of low and 5 pupils (6%) were in range of moderate, as against the control group, where 52 pupils (62%) were in very low, 26 pupils low (31%) and 4 pupils were moderate. So table and figure 4.2 indicates that pre-test thinking skills were to be found in both the groups (experimental & control) before implementing PBL method.
Table 4.3: Frequency distribution of scores post-test (thinking skills) based on range of scores and groups

<table>
<thead>
<tr>
<th>RANGE OF SCORES</th>
<th>EXPERIMENTAL GROUP (POST-TEST THINKING SKILLS)</th>
<th>CONTROL GROUP (POST-TEST THINKING SKILLS)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very low</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Low</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>Moderate</td>
<td>7</td>
<td>8.3</td>
</tr>
<tr>
<td>High</td>
<td>36</td>
<td>42.9</td>
</tr>
<tr>
<td>Very High</td>
<td>37</td>
<td>44.0</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 4.3: Frequency distribution of scores post-test (thinking skills) based on range of scores and groups

As seen in the table that 4.3 the most of students in the experimental group were in high (43%) and very high (44%) range of scores. Frequency distribution in control group shows that the most of students were in very low (25%) and low (61%) range of scores. Table and figure 4.3 shows that students of the experimental group in comparison with the control group developed thinking skills as revealed in the post-test.
Table 4.4: Frequency distribution of scores pre-test (creativity) based on range of scores and groups

<table>
<thead>
<tr>
<th>RANGE OF SCORES</th>
<th>EXPERIMENTAL GROUP (PRE-TEST CREATIVITY)</th>
<th>CONTROL GROUP (PRE-TEST CREATIVITY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very low</td>
<td>43</td>
<td>61.2</td>
</tr>
<tr>
<td>Low</td>
<td>16</td>
<td>19.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>13</td>
<td>15.5</td>
</tr>
<tr>
<td>High</td>
<td>8</td>
<td>9.5</td>
</tr>
<tr>
<td>Very High</td>
<td>4</td>
<td>4.8</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 4.4: Frequency distribution of scores pre-test (creativity) based on range of scores and groups

According to the table and figure 4.4 the pre-test scores of the students on creativity in experimental group was low in (70%) students and very low in (51%) and in control group scores scattered in range from very low to high.
Table 4.5: Frequency distribution of scores post-test (creativity) based on range of scores and groups

<table>
<thead>
<tr>
<th>RANGE OF SCORES</th>
<th>EXPERIMENTAL GROUP (POST-TEST CREATIVITY)</th>
<th>CONTROL GROUP (POST-TEST CREATIVITY)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very low</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Low</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Moderate</td>
<td>30</td>
<td>36</td>
</tr>
<tr>
<td>High</td>
<td>43</td>
<td>51</td>
</tr>
<tr>
<td>Very High</td>
<td>8</td>
<td>9.0</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 4.5: Frequency distribution of scores post-test (creativity) based on range of scores and groups

As it can be seen in the above table 4.5 that frequency distribution of scores in the experimental group developed toward moderate (36%) and high (51%) range. While the control group show low (49%) and moderate (37%) range in the post-test creativity scores.
Table 4.6: Frequency distribution of scores pre-test (problem solving) based on range of scores and groups

<table>
<thead>
<tr>
<th>GROUPS</th>
<th>EXPERIMENTAL GROUP (PRE-TEST PROBLEM SOLVING)</th>
<th>CONTROL GROUP (PRE-TEST PROBLEM SOLVING)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very Low</td>
<td>7</td>
<td>8.3</td>
</tr>
<tr>
<td>Low</td>
<td>16</td>
<td>19.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>39</td>
<td>46.4</td>
</tr>
<tr>
<td>High</td>
<td>19</td>
<td>22.6</td>
</tr>
<tr>
<td>Very High</td>
<td>3</td>
<td>3.6</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 4.6: Frequency distribution of scores pre-test (problem solving) based on range of scores and groups

According to the table 4.6 pupil's pre-test problem solving scores in experimental group was mostly moderate (46%) and high (23%) and against the scores in control group most students fluctuated between very low (26%) to high (4%).
Table 4.7: Frequency distribution of scores post-test (problem solving) based on range of scores and groups

<table>
<thead>
<tr>
<th>RANGE OF SCORES</th>
<th>EXPERIMENTAL GROUP (POST-TEST PROBLEM SOLVING)</th>
<th>CONTROL GROUP (POST-TEST PROBLEM SOLVING)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very low</td>
<td>1</td>
<td>1.2%</td>
</tr>
<tr>
<td>Low</td>
<td>1</td>
<td>1.2%</td>
</tr>
<tr>
<td>Moderate</td>
<td>18</td>
<td>21.4%</td>
</tr>
<tr>
<td>High</td>
<td>36</td>
<td>42.9%</td>
</tr>
<tr>
<td>Very High</td>
<td>28</td>
<td>33.3%</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

Figure 4.7: Frequency distribution of scores post-test (problem solving) based on range of scores and groups

As seen in the above table 4.7 students in the experimental group (post-test) had been settled in moderate (21%), high (43%), and very high (33%) and scores of the control group students were in very low (24%), low (56%) and moderate (19%) range which in comparison to the pre-test table indicates that pupils developed problem solving skill in the experimental group.

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Table 4.8: Frequency distribution of scores pre-test (collaborating) based on range of scores and groups

<table>
<thead>
<tr>
<th>RANGE OF SCORES</th>
<th>EXPERIMENTAL GROUP (PRE-COLLABORATING)</th>
<th>CONTROL GROUP (PRE-COLLABORATING)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very low</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Low</td>
<td>2</td>
<td>2.4</td>
</tr>
<tr>
<td>Moderate</td>
<td>11</td>
<td>13.1</td>
</tr>
<tr>
<td>High</td>
<td>31</td>
<td>36.9</td>
</tr>
<tr>
<td>Very High</td>
<td>40</td>
<td>47.6</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Figure 4.8: Frequency distribution of scores pre-test (collaborating) based on range of scores and groups

According to the table 4.8, in experimental group 38% students had been settled in the range of high and 47% in the range of very high, as against the control group in which 40% were in low and 44% were in moderate range. So the experimental group had developed in team-collaboration after implementing PBL method in comparison with the control group.
Table 4.9: Frequency distribution of scores post-test (collaborating) based on range of scores and groups

<table>
<thead>
<tr>
<th>RANGE OF SCORES</th>
<th>EXPERIMENTAL GROUP (POST-COLLABORATING)</th>
<th>CONTROL GROUP (POST-COLLABORATING)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>FREQUENCY</td>
<td>PERCENT</td>
</tr>
<tr>
<td>Very low</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Low</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Moderate</td>
<td>1</td>
<td>1.2</td>
</tr>
<tr>
<td>High</td>
<td>5</td>
<td>6.0</td>
</tr>
<tr>
<td>Very High</td>
<td>78</td>
<td>92.0</td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>100.0</td>
</tr>
</tbody>
</table>

As seen in table and figure 4.9, 78 students in experimental group are very high in the scale (92%), and in control group, pupil's score fluctuated between very low to high. This indicates that post-test scores on collaboration are more in experimental group.
4.2. INFERENTIAL RESULT

In the first step of this section t-test analysis describes the difference between variables, assessing the significance level of the between two variables. These features will help us to test our hypotheses. There are numbers of different statistics available from SPSS in order to test the hypotheses. Herein, the first thing to be considered is assessing the significance level to test the hypothesis. If the p value (significance level) is less than 0.05, then with 95% confidence we can say that there is the two groups differ and consequently the Null hypothesis is rejected and the alternative hypothesis is accepted. If the p value (significance level) is less than 0.01, then with 99% confidence we can say that two groups differ and again Null hypothesis is rejected.

TESTING THE HYPOTHESES BASED ON EXPERIMENTAL AND CONTROL GROUPS DATA

1. **Hypothesis:** There is no significant difference between experimental and control group in the development of student's thinking skills.

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's thinking skills with consideration of groups is mentioned in the following table:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking</td>
<td>Experimental</td>
<td>84</td>
<td>9.74</td>
<td>2.370</td>
<td>0.259</td>
</tr>
<tr>
<td>Skills</td>
<td>Control</td>
<td>84</td>
<td>2.36</td>
<td>1.147</td>
<td>0.125</td>
</tr>
</tbody>
</table>

For responding to the question "Is there no significant difference between experimental and control group in the development of student's thinking skills?" t-test should be run. One of
the assumptions of t-test that should be tested is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov is run as follow:

Table 4.11: Normality Test for development of thinking skills with consideration of groups

<table>
<thead>
<tr>
<th>Groups</th>
<th>Thinking Skills</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>0.986</td>
<td>0.286</td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>1.775</td>
<td>0.004</td>
<td>Non-normal</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>2.456</td>
<td>0.000</td>
<td>Non-normal</td>
<td></td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of development of thinking skills violate the criterion of normal distribution, therefore Mann-Whitney U test is run as follows:

Table 4.12: Mann-Whitney U test in development of thinking skills with consideration of groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Sum of ranks</th>
<th>(M-W) U</th>
<th>Z</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking Skills</td>
<td>Experimental</td>
<td>84</td>
<td>126.24</td>
<td>10604.00</td>
<td>22.000</td>
<td>-11.183</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>84</td>
<td>42.76</td>
<td>3592.00</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Experimental group shows higher mean score in comparison with Control group in development of thinking skills scale (p=0.000<0.01) which was more than 99 percent confidence level, then significant level (sig= 0.000) for both groups was acceptable, and result could be generalized to the whole statistical universe. **Thus, the null hypothesis is rejected.**

2. **Hypothesis:** There is no significant difference between experimental and control group in the development of student's creativity.
The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's creativity with consideration of groups is mentioned in the following table:

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity</td>
<td>Experimental</td>
<td>84</td>
<td>10.04</td>
<td>2.847</td>
<td>0.311</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>84</td>
<td>2.90</td>
<td>1.854</td>
<td>0.202</td>
</tr>
</tbody>
</table>

For responding to the question "Is there any significant difference between experimental and control group in the development of student's creativity?" t-test should be run. One of the assumptions of t-test that should be tested is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov is run as follow:

<table>
<thead>
<tr>
<th>Groups</th>
<th>Creativity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(K-S)Z</td>
</tr>
<tr>
<td>Experimental</td>
<td>0.974</td>
</tr>
<tr>
<td>Control</td>
<td>1.061</td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of creativity were satisfied the criterion of normal distribution, then t-test is run as follow:
Table 4.15: t-test (Creativity) with consideration of group

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leven's F</th>
<th>Sig</th>
<th>t</th>
<th>D.F</th>
<th>Sig</th>
<th>Mean Dif.</th>
<th>Std. E. Dif</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity</td>
<td>13.994</td>
<td>0.000</td>
<td>19.236</td>
<td>142.649</td>
<td>0.000</td>
<td>7.131</td>
<td>0.371</td>
</tr>
</tbody>
</table>

The second row Equal variances were not assumed as the level of significant in Leven'F was less than 0.05. Because of \( P=0.000<0.05 \) there is significant difference between Experimental and Control groups in the scores of Creativity. Scores of the experimental group were higher than the scores of control group in the development of the student's creativity. Thus, the null hypothesis is rejected.

3. **Hypothesis:** There is no significant difference between experimental and control group in the development of student's problem solving.

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's problem solving with consideration of groups is mentioned in the following table:

Table 4.16: Descriptive statistics of development of student's problem solving

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving</td>
<td>Experimental</td>
<td>84</td>
<td>8.00</td>
<td>2.962</td>
<td>0.323</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>84</td>
<td>3.08</td>
<td>1.630</td>
<td>0.178</td>
</tr>
</tbody>
</table>

responding to the question "Is there any significant difference between experimental and control group in the development of student’s problem solving?" t-test should be run. One of
the assumptions of t-test is that it should be tested for the normal distribution of variable in both the groups. For testing of this assumption kolmogrov-smirnov is run as follow:

**Table 4.17: Normality Test for development of problem solving with consideration of groups**

<table>
<thead>
<tr>
<th>Groups</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental</td>
<td>0.982</td>
<td>0.290</td>
<td>Normal</td>
</tr>
<tr>
<td>Control</td>
<td>1.496</td>
<td>0.023</td>
<td>Non-normal</td>
</tr>
<tr>
<td>Total</td>
<td>1.940</td>
<td>0.001</td>
<td>Non-normal</td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of the development of problem solving don’t fulfil the criterion of normal distribution, therefore Mann –Whitney U test is run as follows:

**Table 4.18: Mann-Whitney U test in development of problem solving with consideration of groups**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>Sum of ranks</th>
<th>(M-W) U</th>
<th>Z</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problem Solving</td>
<td>Experimental</td>
<td>84</td>
<td>119.86</td>
<td>10068.50</td>
<td>557500</td>
<td>-9.468</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>84</td>
<td>49.14</td>
<td>4127.50</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The experimental group shows higher mean score in comparison with Control group in development of problem solving skill \((p=0.000<0.01)\) which is at 99 percent confidence level. **Thus, the null hypothesis is rejected.**

4. **Hypothesis:** There is no significant difference between experimental and control group in the development of student's Team- Collaboration.

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's Team- Collaboration with consideration of groups is mentioned in the following table:

**Table 4.19: Descriptive statistics of development of student's Team- Collaboration**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team- Collaboration</td>
<td>Experimental</td>
<td>84</td>
<td>4.08</td>
<td>3.167</td>
<td>0.346</td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>84</td>
<td>2.81</td>
<td>2.056</td>
<td>0.224</td>
</tr>
</tbody>
</table>

For responding to the question "Is there any significant difference between experimental and control group in the development of student's Team- Collaboration?" t-test should be run. One of the assumptions of t-test that should be tested is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov is run as follow:

**Table 4.20: Normality Test for development of Team- Collaboration with consideration of groups**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Team- Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(K-S)Z</td>
</tr>
<tr>
<td>Experimental</td>
<td>1.248</td>
</tr>
<tr>
<td>Control</td>
<td>0.888</td>
</tr>
</tbody>
</table>
As seen in the before page table that the result of the criterion of normal distribution of Team- Collaboration was found to be satisfied, and then t-test is run as follow:

Table 4.21: T- test in development of Team- Collaboration with consideration of groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leven's F</th>
<th>Sig</th>
<th>t</th>
<th>D.F</th>
<th>Sig</th>
<th>Mean Diff.</th>
<th>Std. E. Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team- Collaboration</td>
<td>11.733</td>
<td>0.001</td>
<td>3.092</td>
<td>142.427</td>
<td>0.002</td>
<td>1.274</td>
<td>0.412</td>
</tr>
</tbody>
</table>

The experimental group shows higher mean score (4.08) in comparison with Control group (2.81) in development of Team- Collaboration scale (p=0.000<0.01) which is 99 percent confidence. According to obtained results of experimental and control data, tables 4.23, 4.24 and 4.25 shows a significant difference between Experimental and Control groups in the scores of Team- Collaboration. The experimental group’s score is higher than control group’s score in the development of student’s Team- Collaboration. Thus, the null hypothesis is rejected.

5. **Hypothesis:** There is no significant difference in the development of thinking skills among girl & boy student for experimental group.

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's Thinking skills with consideration of groups is mentioned in the following table:

Table 4.22: Descriptive statistics of development of student’s thinking skills

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking skills</td>
<td>Boy</td>
<td>33</td>
<td>10.30</td>
<td>2.592</td>
<td>0.451</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>51</td>
<td>9.37</td>
<td>2.163</td>
<td>0.303</td>
</tr>
</tbody>
</table>
For responding to the question "Is there any significant difference between Boys and Girls in the development of student's thinking skills for experimental group?" t-test should be run. One of the assumptions of t-test is that it should be tested for normal distribution of scores in both groups. For testing this assumption kolmogrov-smirnov was run as follow:

Table 4.23: Normality Test for development of thinking skills

<table>
<thead>
<tr>
<th>Groups</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy</td>
<td>0.791</td>
<td>0.560</td>
<td>Normal</td>
</tr>
<tr>
<td>Girl</td>
<td>0.907</td>
<td>0.383</td>
<td>Normal</td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of the development of thinking skills was found to be satisfied the criterion of normal distribution, and then t-test is run as follow:

Table 4.24: T-test test in development of thinking skills with consideration of gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leven's F</th>
<th>Sig</th>
<th>t</th>
<th>D.F</th>
<th>Sig</th>
<th>Mean Dif.</th>
<th>Std. E. Dif</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thinking skills</td>
<td>1.813</td>
<td>0.182</td>
<td>1.780</td>
<td>82</td>
<td>0.079</td>
<td>0.930</td>
<td>0.523</td>
</tr>
</tbody>
</table>

As the level of significant in Leven'F is more than 0.05, we should consider the first row Equal variances were assumed. Because of (P=0.000>0.05) there isn't any significant difference between boy and girl in the experimental groups in the scores of thinking skills. So the null hypothesis is accepted.

6. **Hypothesis:** There is no significant difference in the development of creativity among girl & boy student for the experimental group.
The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's creativity with consideration of groups is mentioned in the following table:

**Table 4.25: Descriptive statistics for the development of student’s creativity**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>creativity</td>
<td>Boy</td>
<td>33</td>
<td>10.73</td>
<td>3.253</td>
<td>0.566</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>51</td>
<td>9.59</td>
<td>2.483</td>
<td>0.348</td>
</tr>
</tbody>
</table>

For responding to the question “Is there any significant difference between Boy and Girl in the development of student’s creativity for experimental group?” t-test should be run. One of the assumptions of t-test that we should test is scores are normally distributed in both groups. For testing of this assumption kolmogrov-smirnov was run as follow:

**Table 4.26: Normality Test for development of creativity**

<table>
<thead>
<tr>
<th>Groups</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy</td>
<td>0.555</td>
<td>0.918</td>
<td>Non-normal</td>
</tr>
<tr>
<td>Girl</td>
<td>0.879</td>
<td>0.423</td>
<td>Non-normal</td>
</tr>
</tbody>
</table>

As seen in above table, the scores of creativity satisfied the criterion of normal distribution, and then t-test is run as follow:
Table 4.27: T-test in development of creativity with consideration of gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leven’s F</th>
<th>Sig</th>
<th>t</th>
<th>D.F</th>
<th>Sig</th>
<th>Mean Dif.</th>
<th>Std. E. Dif</th>
</tr>
</thead>
<tbody>
<tr>
<td>Creativity</td>
<td>2.302</td>
<td>0.133</td>
<td>1.815</td>
<td>82</td>
<td>0.073</td>
<td>1.139</td>
<td>0.627</td>
</tr>
</tbody>
</table>

As the level of significant in Leven’F is more than 0.05, we should consider the first row Equal variances assumed. Because of (P=0.000>0.05) there isn’t any significant difference between boy and girl in the experimental groups in the scores of Creativity. Thus, the null hypothesis is rejected.

7. Hypothesis: There is no significant difference in the development of problem solving among girl & boy student for experimental group.

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student’s problem solving with consideration of groups is mentioned in the following table:

Table 4.28: Descriptive statistics of development of student’s problem solving

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>problem solving</td>
<td>Boy</td>
<td>33</td>
<td>7.85</td>
<td>2.863</td>
<td>0.498</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>51</td>
<td>8.10</td>
<td>3.048</td>
<td>0.427</td>
</tr>
</tbody>
</table>

For responding to the question “Is there any significant difference between Boy and Girl the development of student’s problem solving for experimental group?” t-test should be run. One
of the assumptions of t-test that should be tested is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov was run as follow:

Table 4.29: Normality Test for development of problem solving

<table>
<thead>
<tr>
<th>Groups</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boy</td>
<td>0.636</td>
<td>0.813</td>
<td>Non-normal</td>
</tr>
<tr>
<td>Girl</td>
<td>0.914</td>
<td>0.374</td>
<td>Non-normal</td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of the development of problem solving satisfied the criterion of normal distribution, and then independent t-test is run as follow:

Table 4.30: T-test in development of problem solving with consideration of groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leven’s F</th>
<th>Sig</th>
<th>t</th>
<th>D.F</th>
<th>Sig</th>
<th>Mean Dif.</th>
<th>Std. E. Dif</th>
</tr>
</thead>
<tbody>
<tr>
<td>problem solving</td>
<td>0.007</td>
<td>0.934</td>
<td>-0.375</td>
<td>82</td>
<td>0.708</td>
<td>-0.250</td>
<td>0.665</td>
</tr>
</tbody>
</table>

As the level of significant in Leven’F was more than 0.05, the first row Equal variances were assumed. Because of (P=0.000>0.05) no significant difference was found in the scores of problem solving between boys and girls in the experimental group. That is there isn’t any significant difference between boy and girl (in experimental group) in scores of Problem Solving.

**Thus, the null hypothesis is rejected.**

8. **Hypothesis:** There is no significant difference in the development of team-collaboration among girl & boy student for experimental group.
The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's Team-Collaboration with consideration of groups is mentioned in the following table:

**Table 4.31: Descriptive statistics of development of student's team-collaboration**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Groups</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>team-collaboration</td>
<td>Boy</td>
<td>33</td>
<td>2.67</td>
<td>2.423</td>
<td>0.423</td>
</tr>
<tr>
<td></td>
<td>Girl</td>
<td>51</td>
<td>5.00</td>
<td>3.268</td>
<td>0.458</td>
</tr>
</tbody>
</table>

For responding to the question “Is there any significant difference between Boy and Girl in the development of student's team-collaboration for experimental group?” t-test should be run. One of the assumptions of independent t-test that should be tested is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov was run as follow:

**Table 4.32: Normality Test for development of team-collaboration**

<table>
<thead>
<tr>
<th>Groups</th>
<th>Team-Collaboration</th>
</tr>
</thead>
<tbody>
<tr>
<td>(K-S)Z</td>
<td>Sig</td>
</tr>
<tr>
<td>Boy</td>
<td>1.056</td>
</tr>
<tr>
<td>Girl</td>
<td>0.910</td>
</tr>
</tbody>
</table>

As seen in above table, the scores of team-collaboration satisfied the criterion of normal distribution, t-test is run as follow:
Table 4.33: t-test in development of team-collaboration with consideration of gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>Leven’s F</th>
<th>Sig</th>
<th>t</th>
<th>D.F</th>
<th>Sig</th>
<th>Mean Dif.</th>
<th>Std. E. Dif</th>
</tr>
</thead>
<tbody>
<tr>
<td>team-collaboration</td>
<td>2.419</td>
<td>0.124</td>
<td>-3.514</td>
<td>82</td>
<td>0.001</td>
<td>-2.333</td>
<td>0.664</td>
</tr>
</tbody>
</table>

As the level of significant in Leven’F is more than 0.05, we should consider the first row Equal variances assumed. Because of (P=0.000<0.05) there is significant difference between boy and girl in the experimental groups in the scores of team-collaboration. That is, girl students have higher mean score (5.00) in comparison with boy students (2.67) in development of Team-Collaboration scale (p=0.000<0.01) which is 99 percent confidence. Again, the null hypothesis is rejected.

9. Hypothesis: There is no significant difference between girls and boys groups in the development of student’s thinking skills before and after administration of project-based learning.

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student’s thinking skills with consideration of groups is mentioned in the following table:

Table 4.34: Descriptive statistics of development of student’s thinking skills

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Variable</th>
<th>Girl</th>
<th>Boy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>S.D</td>
</tr>
<tr>
<td></td>
<td>Rank</td>
<td>Mean</td>
<td></td>
</tr>
<tr>
<td>Pre-Test</td>
<td>51</td>
<td>5.59</td>
<td>1.062</td>
</tr>
<tr>
<td>Post-Test (thinking skills)</td>
<td>51</td>
<td>14.96</td>
<td>2.306</td>
</tr>
</tbody>
</table>
For responding to the question “Is there any significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student’s thinking skills?” t-test should be run. One of the assumptions of t-test is that it should be tested for is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov is run as follow:

**Table 4.35: Normality Test for development of thinking skills with consideration of groups**

<table>
<thead>
<tr>
<th>variables (thinking skills)</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>2.911</td>
<td>0.000</td>
<td>Normal</td>
</tr>
<tr>
<td>Post-Test</td>
<td>1.343</td>
<td>0.054</td>
<td>Non-normal</td>
</tr>
<tr>
<td>Total</td>
<td>2.563</td>
<td>0.000</td>
<td>Non-normal</td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of development of thinking skills don’t fulfill the criterion of normal distribution, therefore Mann–Whitney U test is run as follows:

**Table 4.36: Mann-Whitney U test in development of thinking skills with consideration of groups**

<table>
<thead>
<tr>
<th>Experimental Groups</th>
<th>Girl</th>
<th>Boy</th>
<th>Result (M-W) U test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables (thinking skills)</td>
<td>N</td>
<td>mean</td>
<td>N</td>
</tr>
<tr>
<td>pre-test</td>
<td>51</td>
<td>5.59</td>
<td>33</td>
</tr>
<tr>
<td>post-test</td>
<td>51</td>
<td>14.96</td>
<td>33</td>
</tr>
</tbody>
</table>
In the experimental group, boys show higher mean score in comparison with girls in the development of thinking skill (p=0.000<0.01) which were at 99 percent confidence level.

*Again the null hypothesis is rejected.*

10. **Hypothesis:** *There is no significant difference between girls and boys groups in the development of student's Creativity before and after administration of project-based learning.*

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's Creativity with consideration of groups is mentioned in the following table:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Experimental Group</th>
<th>Girl</th>
<th>Boy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>Mean</td>
<td>S.D</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>51</td>
<td>7.29</td>
<td>2.508</td>
</tr>
<tr>
<td>Post-Test</td>
<td>51</td>
<td>16.88</td>
<td>2.438</td>
</tr>
</tbody>
</table>

(Creativity)

For responding to the question “Is there any significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student’s Creativity?” t-test should be run. One of the assumptions of t-test is that it should be tested for is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov is run as follow:
Table 4.38: Normality Test for development of Creativity with consideration of groups

<table>
<thead>
<tr>
<th>variables (creativity)</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>1.866</td>
<td>0.002</td>
<td>Normal</td>
</tr>
<tr>
<td>Post-Test</td>
<td>1.034</td>
<td>0.235</td>
<td>Non-normal</td>
</tr>
<tr>
<td>Total</td>
<td>2.018</td>
<td>0.001</td>
<td>Non-normal</td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of the development of Creativity don’t fulfil the criterion of normal distribution, therefore Mann–Whitney U test is run as follows:

Table 4.39: Mann-Whitney U test in development of Creativity with consideration of groups

<table>
<thead>
<tr>
<th>Experimental Groups</th>
<th>Girl</th>
<th>Boy</th>
<th>Result (M-W) U test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>M-W U z sig</td>
</tr>
<tr>
<td>Variables (creativity)</td>
<td>mean</td>
<td>mean</td>
<td></td>
</tr>
<tr>
<td>pre-test</td>
<td>51</td>
<td>33</td>
<td>813.000 -0.268 0.789</td>
</tr>
<tr>
<td>post-test</td>
<td>51</td>
<td>33</td>
<td>630.500 -1.955 0.051</td>
</tr>
</tbody>
</table>

In the experimental group (in post test administration), boys has higher mean score in comparison with girls in development of Creativity \((p=0.000<0.01)\) which is at 99 percent confidence level. Thus, the null hypothesis is rejected.

11. **Hypothesis**: There is no significant difference between girls and boys groups in the development of student’s problem solving before and after administration of project-based learning.
The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's problem solving with consideration of groups is mentioned in the following table:

Table 4.40: Descriptive statistics of development of student's problem solving

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Variable (problem solving)</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
<th>N</th>
<th>Mean</th>
<th>S.D</th>
<th>Std. error mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Girl</td>
<td>Pre-Test</td>
<td>51</td>
<td>12.10</td>
<td>3.282</td>
<td>0.460</td>
<td>33</td>
<td>12.79</td>
<td>3.629</td>
<td>0.632</td>
</tr>
<tr>
<td>Girl</td>
<td>Post-Test</td>
<td>51</td>
<td>20.20</td>
<td>3.600</td>
<td>0.504</td>
<td>33</td>
<td>20.64</td>
<td>2.572</td>
<td>0.448</td>
</tr>
<tr>
<td>Boy</td>
<td>Pre-Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boy</td>
<td>Post-Test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For responding to the question "Is there any significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's problem solving?" t-test should be run. One of the assumptions of t-test is that it should be tested for is normal distribution of variable in both groups. For testing of this assumption kolmogrov-smirnov is run as follow:
Table 4.41: Normality Test for development of problem solving with consideration of groups

<table>
<thead>
<tr>
<th>Variables (problem solving)</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>1.099</td>
<td>0.178</td>
<td>Normal</td>
</tr>
<tr>
<td>Post-Test</td>
<td>1.155</td>
<td>0.139</td>
<td>Normal</td>
</tr>
<tr>
<td>Total</td>
<td>1.273</td>
<td>0.078</td>
<td>Normal</td>
</tr>
</tbody>
</table>

As seen in above table, the scores of problem solving were satisfied the criterion of normal distribution then independent samples t-test is run as follow:

Table 4.42: independent- samples t- test in development of problem solving with consideration of groups

<table>
<thead>
<tr>
<th>Variable (problem solving)</th>
<th>Leven's F</th>
<th>Sig</th>
<th>t</th>
<th>D.F</th>
<th>Sig</th>
<th>Mean Dif</th>
<th>Std. E. Dif</th>
</tr>
</thead>
<tbody>
<tr>
<td>pre-test</td>
<td>0.458</td>
<td>0.500</td>
<td>0.902</td>
<td>82</td>
<td>0.369</td>
<td>0.690</td>
<td>0.764</td>
</tr>
<tr>
<td>post-test</td>
<td>5.453</td>
<td>0.022</td>
<td>0.653</td>
<td>81.125</td>
<td>0.516</td>
<td>0.440</td>
<td>0.674</td>
</tr>
</tbody>
</table>

Because of (sig = 0.369 > 0.05 for pre-test and sig = 0.516 > 0.05 post test of problem solving no significant difference was found in the scores of Problem Solving between girls and boys of the experimental group. Thus, the null hypothesis is accepted.
12. **Hypothesis:** There is no significant difference between girls and boys groups in the development of student's team-collaboration before and after administration of project-based learning.

The descriptive statistic (number, mean, standard deviation and standard error mean) of the development of student's team-collaboration with consideration of groups is mentioned in the following table:

**Table 4.43: Descriptive statistics of development of student's team-collaboration**

<table>
<thead>
<tr>
<th>Experimental Group</th>
<th>Girl</th>
<th></th>
<th></th>
<th>Boy</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Variable</td>
<td>N</td>
<td>Mean</td>
<td>S.D</td>
<td>N</td>
<td>Mean</td>
<td>S.D</td>
</tr>
<tr>
<td>Pre-Test</td>
<td>51</td>
<td>18.98</td>
<td>3.438</td>
<td>33</td>
<td>22.21</td>
<td>2.522</td>
</tr>
<tr>
<td>Team-Collaboration</td>
<td>51</td>
<td>23.98</td>
<td>1.631</td>
<td>33</td>
<td>24.88</td>
<td>0.331</td>
</tr>
</tbody>
</table>

For responding to the question "Is there any significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student’s team-collaboration?” t-test should be run. One of the assumptions of t-test is that it should be tested for is normal distribution of variable in both groups. For testing of this assumption Kolmogrov-Smirnov is run as follow:
Table 4.44: Normality Test for development of team-collaboration with consideration of groups

<table>
<thead>
<tr>
<th>variables (team-collaboration)</th>
<th>(K-S)Z</th>
<th>Sig</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Test</td>
<td>1.265</td>
<td>0.082</td>
<td>Normal</td>
</tr>
<tr>
<td>Post-Test</td>
<td>3.473</td>
<td>0.000</td>
<td>Non-Normal</td>
</tr>
<tr>
<td>Total</td>
<td>2.846</td>
<td>0.000</td>
<td>Non-Normal</td>
</tr>
</tbody>
</table>

As seen in the above table, the scores of the development of Team-Collaboration don’t fulfil the criterion of normal distribution, therefore Mann–Whitney U test is run as follows:

Table 4.45: Mann-Whitney U test in development of team-collaboration with consideration of groups

<table>
<thead>
<tr>
<th>Experimental Groups</th>
<th>Girl</th>
<th>Boy</th>
<th>Result (M-W) U test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>N</td>
<td>M-W U</td>
</tr>
<tr>
<td>pre-test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Variables (Team-Collaboration)</td>
<td>N</td>
<td>mean</td>
<td>mean</td>
</tr>
<tr>
<td>post-test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>18.98</td>
<td>22.21</td>
</tr>
<tr>
<td></td>
<td>51</td>
<td>23.98</td>
<td>24.88</td>
</tr>
</tbody>
</table>

Because of (Sig=0.000>0.05 for pre test and Sig=0.001>0.05 for post test) for variable of Team-collaboration, no significance difference was exist between boys and girls students. In the experimental group, boys show higher mean score in comparison to the girls in the development of Team-Collaboration both in the pre-test and post test which was found at 99 percent confidence level. Again, the null hypothesis is rejected.
The results of the study were presented in detail. The descriptive results were discussed in the first section. The inferential results section entails bivariate tests results; t-test and Munn-Whitney U results helped to test the hypotheses and theoretical model to obtain empirical models of the study for both the boys and girls in the second section of this chapter. The data was used for both descriptive and inferential parts of this study and was collected through a survey conducted in IRAN (n=168). The descriptive section of the study demonstrated the statistical results through tables and clustered pie charts which were constructed by SPSS.(18) The graphs in the first section help us to visualize the distribution of our variables, and the tables depict the magnitudes, which both meet the last objective of the study.
CHAPTER 5
OVERVIEW OF THE STUDY

As a field, PBL is still in the developmental stage. There is not sufficient research or empirical data to state that PBL is a proven alternative to other forms of instruction. Based on evidence gathered over the past ten years, PBL appears to be an equivalent or slightly better model for producing gains in academic achievement, although results vary with the quality of the project and the level of student engagement. Also, PBL is not appropriate as a method for teaching certain basic skills such as reading or computation; however, it does provide an environment for the application of those skills. More important, evidence shows that PBL enhances the quality of learning and leads to higher-level cognitive and metacognitive development through students’ engagement with complex, novel problems. It is also clear that PBL teaches students complex processes and procedures such as planning and communicating. Accomplishing PBL can help teachers create a high-performing classroom in which they and their students form a powerful learning community focused on achievement, self-mastery, and contribution to the community. The researcher has tried to analyze relation between teaching and learning based on PBL method and development thinking skills, creativity, problem solving and team-collaboration and the difference between genders. The research focuses on science subjects; PBS (project-based science) is the appropriate method to be studied through a comparison between experimental and control group.

DISCUSSION

In this study the effect of PBS (project based science) on student’s thinking skills achievement level and team collaboration skill were investigated. For PBS to be effective, the school must give students change to involve team projects frequently. Placing students in a team and assigning them a task does not guarantee that the students will engage in
effective collaborative learning behavior. When put a group as people that have never worked together, personalities might lead to arguments. The traditional lecture-oriented classrooms do not teach students the social skills they need to interact effectively in a team. Teaches should give students the skills they need to succeed in teams.

Chapter four gives the conclusions of this research, provides testing of theoretical concepts by concrete data. This chapter helps to discuss the findings and compare them with empirical documents which have been presented in other research.

The following null hypotheses were formulated:

1. There is no significant difference between experimental and a control group in the development of students’ thinking skills.

2. There is no significant difference between experimental and control groups in the development of students’ creativity.

3. There is no significant difference between experimental and control groups in the development of students’ problem solving.

4. There is no significant difference between experimental and control groups in the development of students’ team-collaborating.

5. There is no significant difference in the development of thinking skills among girl & boy students.

6. There is no significant difference in the development of creativity among girl & boy students.

7. There is no significant difference in the development of problem solving among girl & boy students.

8. There is no significant difference in the development of team-collaboration among girl & boy students.
9. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's thinking skills.

10. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's Creativity.

11. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's problem solving.

12. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's team-collaboration.

1. First hypothesis considers the difference between experimental and control groups in thinking skills. In recent two decades many researchers have been done on the relation between project-based learning method and development of thinking skills. (Tretten et al 1995, Horan et al 1996, Shepherd et al 1998, Pee and Leong 2003, Ravitz et al 2011). The findings of the present study are in agreement with previous studies.

A few studies about thinking skills have been done which focus on critical thinking (Tretten et al 1995). In particular, one study of PBL showed a positive effect on low-ability students, who increased their use of critical-thinking skills including synthesizing, evaluating, predicting, and reflecting by 446% while high-ability students improved by 76% (Horan, et al., 1996). Some of researches have considered other dimensions of thinking skills such as creative thinking (Doppelt 2009). Students who participated benefitted PBL, showing from improved critical thinking (Mergendoller, et al., 2006; Shepherd, 1998; Tretten & Zachariou, 1995). Beringer's (2007) findings indicated that although there were high levels of
engagement with the content, the lack of structure caused some students to focus on technical skills rather than higher level thinking.

These studies along with the finding of present study reveal that implementing the project-based learning method will develop the higher order thinking.

2. Second hypothesis is related to the difference project-based learning method between experimental and control groups in creativity. The results of the present study show that experimental group where the PBL was applied showed for more creativity than control group. Muhammad Yasin et al (2006) pointed out PBL not only focuses on getting solution to interested social issues but also to promote students’ creativity. It is more student-centered approach which does not require students to memories theory or formula; instead they are required to be more analytical and creative in thinking by analyzing information gathered to solve the problem. Pee and Leong (2005) show that besides completing the projects, students also developed other attributes such as creativity. Also Gulbahar and Tinmaz (2006) believe that the curriculum should be evaluated and enhanced with courses emphasizing creativity. Lipson et al (2007) report that slightly over 70 percent student showed improvement after PBL in their creativity. Holubova (2008) in his research on physic topic perceive that Students apply core academic skills and creativity to solve authentic problems in real world situations. To promote creativity of the students, creative teachers are needed as well.

The third hypothesis is regarding the difference between experimental and control groups in problem solving skill. The results of this study again show a marked superiority of experimental group over control group in problem solving skills. Garcia et al (2006-2007) reported that, teachers have found in students a higher interest for completing the practical tasks and more effort to solve an open problem. It can be seen
as a better attitude in internal discussions inside student groups in order to solve the
Zachariou, (1995) pointed out that those Students who participated in PBL also benefitted
from improved critical thinking and Problem-solving skills. Although one study found
that students had difficulty adapting to the PBL structure, which negatively affected their
learning of problem-solving skills (Beringer, 2007). Additionally, research on contextual
factors has led to the recommendation that, to the extent that it is important for students to
be able to apply what they learn to solve problems and make decisions, instruction be
carried out in a problem-solving context. Learning that occurs in the context of problem
solving is more likely to be retained and applied. Such learning is also seen as being
more flexible than the inert knowledge that is acquired as a result of more traditional
didactic teaching methods (Boaler, 1998b; Bransford, Sherwood, Hasselbring, Kinzer, &
Williams, 1990). Results from the attitude surveys were similar to those reported by
Learning activities had a variety of positive benefits for students including attitudes
towards learning, problem-solving capabilities.

According to the present research, it was found that Project-Based Learning experience
had a significant impact on students' problem-solving skills. The researcher believes not
only were students at the traditional school unable to use their knowledge to solve
problems, but "Students taught with a more traditional, formal, didactic model developed
an inert knowledge that they claimed was of no use to them in the real world. In contrast,
"Students taught with a more progressive, open, project-based model developed more
flexible and useful forms of knowledge and were able to use this knowledge in a range
of settings such as solve of problem."
4. Fourth hypothesis is based on the difference between experimental group where PBL was used and control groups in team-collaboration. It's obvious that the most important expected result and feedback in implementing PBL method is to achieve team-collaboration skill. The results of the present research are in agreement with most of researchers. Students who participated in PBL also benefitted from improved Collaboration skills (Belland, et al., 2006; ChanLin, 2008). In particular, one study of PBL showed a positive effect on low-ability students that demonstrated initiative, and teamwork, as they worked in groups (Horan, et al., 1996). Also in a study students reported that they enjoyed PBL because it gave them opportunities to interact with their friends and make new friends through cooperative projects (Belland, et al., 2006; Lightner, et al., 2007). In addition, Yiping and MacGregor (2004) reported that between-group mentoring and review facilitated growth in collaboration skills for university students engaged in PBL. Baumgartner and Zabin (2008) also found that collaboration among students contributed to the growth of a “scientific community”.

Marx et al. (1991) believe that one of challenges grew out of difficulties teachers had in accepting the ideas that effective collaboration among students requires more than involvement, it requires exchanging ideas and negotiating meaning. Asan and Haliloghlu (2005) indicated when students work together in teams to create projects, they maximize their computer skills. They also indicated that PBL improves students’ collaboration skills. PBL accommodates and promotes collaboration among students, between students and the teacher. Harrison (1999) and Dooling’s (2000) studies support this conclusion as well. Frank et al (2003) state that in order to PBL to be an effective learning’s environment, students should be trained in teamwork either before or during the process. This preparation will help them to cope with in-team conflicts, to make team decisions, to allot tasks to team-members, and to take the necessary organizational steps. Abdallah et
al (2007) suggest a metamodel to help the teachers to choose a platform of e-learning and deploy their lessons according to the objectives of a Project-Based Collaborative Learning (PBCL) framework.

In the present study the researcher observed that most of the students respected each other's opinion in the group and they learned to share tasks and take responsibility for accomplishing them. But some responses presented a more complex situation than researcher anticipated. Approximately 20 percent of students indicated that there was a disagreement within the group members. Also some responses emerged to confirm the presence of a strong individualistic culture in the groups. Most students rated their own team work abilities highly. 90 per cent indicated that their success is entirely due to their efforts. In other words, students had confidence in their own skills to effectively complete team projects. Students also believed that their fellow students contributed to the best of their ability to satisfactorily complete the team project. From all of these responses we can conclude that the students felt very positive about their collaboration. The way they talked about arguing seems to suggest that there was a battle of wills over different people's opinions rather than a sharing of ideas. At the end of the project, they seemed to appreciate that the final outcome was a combined effort and they enjoyed working with the other team members, learned about the importance of teamwork and learned to be more patient with others and to be more open-minded.

Few students complained about group size and time management. This is because this class were not used to group work, they wasted a lot of time and worked slowly.

5. Fifth hypotheses related to differences in the development of thinking skills among girl & boy students. Munns et al (2004-2005) considered ways to motivate and engage boys in thinking critically and creatively about their own and their peers’ schooling, their worldview, their future employment and what they want to make of their lives. They
suggest that traditional curricular, pedagogical and assessment practices have failed for some - perhaps many - of these boys. Curricula that connect with boys' interests and experiences can provide rich material through which their existing knowledge is not only acknowledged, but can be extended, deepened and subjected to critical reflection.

Chadwell (2007) suggested use of project-based learning as a strategy for working with girls. Embedded units and lessons with connections to the real world, show relationship between content/skill and the lives of real people. He emphasized that teachers must recognize the energy that boys bring to the classroom as a learning opportunity instead of behavior that needs to be controlled, so offer use of problem-based learning as a strategy for working with boys, start units or lessons with an essential question involving decisions or choices. Present study shows that boy's groups score is higher than girl's groups score in the development of student's thinking skills. The researcher believes that there is no different between gender to learn thinking skills on project-based learning method and both of genders indicate great abilities meanwhile implementing of method. It may be this difference due to number of boys that less than girls, and or cause boys were from school in prosperity region. In order to present exact viewpoint about should implement vast amount research between genders.

6. Sixth hypothesis is related to difference in the development of creativity among girl & boy students. Muhammad Yasin et al (2006) point out that creativity is considered as a critical skill in lifelong learning, as well as a skill needed in scientific problem solving and entrepreneurship. One way of promoting creativity is through the approach of Problem Oriented Project Based Learning.

McGrath (2004) found no gender differences between girls and boys at any level, and the students attained significantly higher grades than the students at the more procedural school.
Mioduser and Betzer (2007) demonstrate that Students in both groups showed poor creativity knowledge of the curricular concepts in the pre-test, as expected. After the learning process both groups performed significantly better, but the gain for the experimental group was impressive with an increase of 84% compared with 52% by the control group. The mean increase for the girls of the experimental group was even higher, above 90%. Analysis of variance test considering the variables “group” (experimental, control), “testing-time” (pre, post) and gender showed significant difference for the gain in creativity in both groups, and between groups but not for gender.

7. Seventh hypothesis is related to difference in the development of problem solving among girl& boy students. Project-based learning requires students to understand a problem, with all of the fundamental science, societal, ethical and other constraints, prior to assessing and implementing a solution. Powers et al (2003) reports that there was no real difference between boys and girls in their perceptions of the types of problems science and technology can solve. Both recognized that these disciplines could fix many specific problems but had less confidence that engineers could solve social problems. Westheider and Brown (2010) indicate that the girls paid more attention to details, did more thorough testing and retesting, and did more extensive work in the planning phase.

They kept working at solving the programming and equipment problems longer than the two boys’ teams. They tried more solutions out, and collaborated more on how well each new facet of the solution worked. The researchers deducted that the boys did their programs more by trial and error, with less pre-planning than their female counterparts. The most obvious difference between the girls’ group and the other two groups of boys was the level of attention to detail shown by the girls.
8. Eighth hypotheses state difference in the development of team-collaboration among girl & boy students. Westheider and Brown (2010) indicate that the boys' groups were willing to give up sooner and to accept a robot that could not do exactly what they had in mind for it to do and against the girls urge done another to continue, and collaborated more in dividing the labor to get the robot to do the target actions. Sarvar (2002) believes it's very difficult for girls to work together in a group especially if two of them want to be 'the boss.' This problem was also voiced in the group interview. One interviewee said 'there should be rules of behavior in projects like these. A revealing reflection is given by another learner of the same group. Zastavker et al (2006) state our results indicate that:

a. On average, both men and women find in-class group work helpful in their learning.

b. Found a positive correlation between student participation in small group work (both in and outside of the classroom) and the extent to which students report that group work positively impacts their own engagement.

c. Women experience PBL with higher levels of anxiety than men and report that their coursework is very challenging and time-consuming. Powers et al (2003) believe that the girls tended to rate group work activities higher and are more confident in this area than the boys.

McGrath (2004) states the researchers looked at how girls and boys worked in teams over a10-week project. They anticipated that these mixed groups would be a problem for girls at first but that these problems would gradually go away.

Working collaboratively has also been seen as especially beneficial for girls. Reasons given are that most girls prefer collaboration to competition; girls generally have good communication skills and benefit from and enjoy discussion; small collaborative groups facilitate “connected” learning and support and encourage risk taking; and
collaboration helps to create a more egalitarian environment (Cordeau, 1995; Jacobs, 1994; Morrow & Morrow, 1996; Solar, 1995). In a comparative study of two schools, Jo Boaler (1997a, 1997b, 1997c) found that girls in a school that used an approach based on collaboration and open-ended inquiry reported increased confidence and enjoyment of mathematics. Girls in a school with a similar population that used a traditional textbook-based approach reported widespread disaffection, lack of confidence, and the feeling that they were not being given a chance to understand.

For people concerned with gender equity, another potential benefit of the collaborative approach is that boys may play a less dominant role in small-group discussions than they do in whole-class teaching. Studies of the latter have consistently found that a disproportionate number of teacher-student interactions are with boys (Howe, 1997; Koehler, 1990; Leder, 1990). Collaborative work in small groups may allow more students the opportunity to articulate their ideas than would be possible in whole-class teaching, and so may have the effect of counteracting the tendency for a few males to dominate classroom interactions.

Although many studies of gender and classroom interaction, such as those cited earlier, have looked at the context of whole-class instruction, relatively few have investigated the influence of gender on interaction in a collaborative inquiry context.

In present study, the collaboration allowed team members to share and critique ideas, of course, difference between genders is natural according to psychological studies but there was no difference in collaboration or no collaboration but difference was observed in interactions quality between them. The girls showed more patience in team working and the boys could be taking risk and manage the interactions.

The cases of learning differences between girls and boys were discussed above (hypothesizes 9-12).
CONCLUSION:

Thinking Skills, Creativity, Problem Solving and Team-Collaboration as parameters of PBL method, are considered determinant factor in higher order thinking.

In the first section of this chapter, we stated the relations of PBL parameters in experimental and control groups in comparison with related studies, and tested the hypotheses of this research.

Since in this study, research subjects are dependent on research questions, so in this section by answering the hypotheses of research we try to conclude thesis.

1. There is no significant difference between experimental and control group in the development of student's thinking skills.

This question is one of the most important effective aspects of PBL on our dependent variable. To answer the first question of our analysis, we conducted the Mann–Whitney U test. According to obtained results from data of experimental and control group, we can concretely state that which degree of our dependent variable variance is determined by independent variable. Tables 4.14, 4.15 and 4.16 show high Mean of scores between two variables in experimental and control groups, and significant level (sig=0.000) for both groups is acceptable, and result could be generalized to the whole statistical universe. Thus, the null hypothesis is rejected.

2. There is no significant difference between experimental and control groups in the development of student’s creativity.

To respond this question of our research, we conducted the t-test, for experimental and control groups. According to obtained results of experimental and control data, tables 4.17, 4.18 and 4.19 shows a significant difference between Experimental and
Control groups in the scores of Creativity. That is experimental group's score is higher than control group's score in the development of student's creativity. Thus, the null hypothesis is rejected.

3. There is no significant difference between experimental and control group in the development of student's problem solving.

To investigate this hypothesis, we conducted the Mann–Whitney U test. According to obtained results from data of experimental and control, concretely we can state as to what degree our dependent variable variance is determined by independent variable. Tables 4.20, 4.21 and 4.22 show high Mean of scores in the experimental groups which has significant level (sig= 0.000). Thus, the null hypothesis is rejected.

4. There is no significant difference between experimental and control group in the development of student's Team- Collaboration.

To respond this question of our research, we conducted the t-test, for experimental and control groups. According to obtained results of experimental and control data, tables 4.23, 4.24 and 4.25 shows a significant difference between Experimental and Control groups in the scores of Team- Collaboration. The experimental group's score is higher than control group's score in the development of student's Team- Collaboration. Thus, the null hypothesis is rejected.

5. There is no significant difference in the development of thinking skills among girl & boy student for experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy's data, tables 4.26, 4.27 and 4.28 shows a significant difference between girls and boys groups in the scores of thinking skills. So
null hypothesis is accepted, that is there isn't any significant difference between boy and girl (in experimental group) in scores of thinking skill.

6. There is no significant difference in the development of creativity among girl & boy student for the experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy’s data, tables 4.29, 4.30 and 4.31 shows a significant difference between girls and boys groups in the scores of creativity. That is boys group’s score is higher than girls group’s score in the development of student’s creativity. Thus, the null hypothesis is rejected.

7. There is no significant difference in the development of problem solving among girl & boy student for experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy’s data, tables 4.32, 4.33 and 4.34 shows a significant difference between girls and boys groups in the scores of problem solving. That is girls group’s score is higher than boys group’s score in the development of student’s problem solving. Thus, the null hypothesis is rejected.

8. There is no significant difference in the development of team-collaboration among girl & boy student for experimental group.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy’s data, tables 4.35, 4.36 and 4.37 shows a significant difference between girls and boys groups in the scores of team-collaboration. That is girls group’s score is higher than boys group’s score in the development of student’s team-collaboration. Again, the null hypothesis is rejected.
9. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's thinking skills.

To investigate this hypothesis, we conducted the Mann–Whitney U test, for girls and boys groups. According to obtained results of girls and boy's data, tables 4.38, 4.39 and 4.40 shows a significant difference between girls and boys groups in the scores of thinking skills. Both of groups have progressive in post test scores but boys group's score in post PBL administration is higher than girls group's score in the development of student's thinking skills. Again the null hypothesis is rejected.

10. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's Creativity.

To investigate this hypothesis, we conducted the Mann–Whitney U, for girls and boys groups. According to obtained results of girls and boy's data, tables 4.41, 4.42 and 4.43 shows a significant difference between girls and boys groups in the scores of creativity. That is Experimental group (in post test administration), boys has higher mean score in comparison with girls in the development of student's creativity. Thus, the null hypothesis is rejected.

11. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's problem solving.

To investigate this hypothesis, we conducted the t-test, for girls and boys groups. According to obtained results of girls and boy's data, tables 4.44, 4.45 and 4.46 shows there are no significant difference in experimental group between girls and boys in the scores of Problem Solving in post PBL administration. Thus, the null hypothesis is accepted.
12. There is no significant difference between girls and boys groups in experimental group (pre and post PBL administration) in the development of student's team-collaboration.

To investigate this hypothesis, we conducted the Mann–Whitney U, for girls and boys groups. According to obtained results of girls and boy's data, tables 4.47, 4.48 and 4.49 shows a significant difference between girls and boys groups in the scores of team-collaboration in post test administration. That is boys group's score is higher than girls group’s score in the development of student's team-collaboration. Again, the null hypothesis is rejected.

RECOMMENDATIONS

Recommendations for Teachers:
Considering the difficulty of guiding and controlling the students in classroom, it would be better to use project-based learning in the class with small number of students or more than one teacher. In addition, the number of students in the groups can be increased while the number of groups can be reduced. With respect to time, it should be taken into consideration that in the early stages particularly, time problems emerge, and thus planning should allow for ample time.

The teacher should give the students assignments that involve doing research. In situations in which it is not suitable to implement project–based learning in class, teachers can assign these project s to students, either individually or in groups, as term projects. They can then establish frequent meetings with students in order to help them and provide them with the necessary guidance.

Recommendations for National Education Ministry:
Time allotted for the science subject in the current curriculum was not sufficient to implement this project. (Especially after reduce time to 5 days). During the preparation of the curriculum, the time allotted for the subject should take into consideration
the kinds of studies the teacher would like to undertake, such as project-based learning.

**Recommendations for Textbook Writers:**

The textbooks used in schools, there can be the maximum possible number of project examples. The calculations are needed and the instructions for the project can be placed in student workbooks. Hence, teachers would have the opportunity to develop pre-existing projects and adapt themselves to their own situations instead of creating a project from scratch.

**Recommendations for future researchers:**

Experimental studies may be conducted to reveal the dynamics of PBC to compare individual work with group work. It was recommended to replicate the findings in different contexts with a variety of students for example: different grade levels, cultural backgrounds and educational experiences. The research suggests that there are strong advantages to do PBL, for example the students develop a level of shared knowledge and skills that prepare them to undertake actual project, also students are likely to develop more flexible levels of skills and understanding. In addition if students know they will be completing real project in their community they are motivated to learn. Since the students in this study experienced project-based learning for the first time, they had difficulties at the beginning. It should be conducted in the group of students who have prior experienced project-based learning.

In this research besides the gain in formal knowledge, it was found that PBL contributed to the experimental group students' meaningful learning in additional aspects as well: The students considerably expanded and enlarged their content knowledge base, they improved their higher order thinking, the science design process was learnt and developed to significantly high levels; it was for them a very surprising and enjoyable process of learning and doing science. The students' positive attitudes towards science improved to a large extent.
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### Table 1. Questions of thinking skills

<table>
<thead>
<tr>
<th>Thinking skills in higher level</th>
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<tbody>
<tr>
<td><strong>1.</strong> Alexander Fleming discovered penicillin while observing the moulds on the experiments' dishes instead of throwing them out he thought about them. If you were him what would you do?</td>
</tr>
<tr>
<td><strong>2.</strong> We make some bread from dough but they are half-cooked and half-burned and the breads aren't good. How will you solve this problem?</td>
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<tr>
<td><strong>3.</strong> Pick up the bottle, pour half of the water and mix the milk and yoghurt equally and put the bottle in the opposite of sun for 4 days. It will change to yoghurt and water after 4 days. What change has happened? Please explain. (Do this experiment at home later).</td>
</tr>
<tr>
<td><strong>4.</strong> In your opinion are there any cases in the terms of material changes (chemical &amp; physical) which, you still didn’t understand. Please mention it.</td>
</tr>
<tr>
<td><strong>5.</strong> How the chemical changes of materials are effective in yours survival? Please explain and give example.</td>
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</tbody>
</table>
Table 2. Questions of Creativity

<table>
<thead>
<tr>
<th>Creativity</th>
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</thead>
<tbody>
<tr>
<td>2. Suppose you are living in a world where chemical changes don’t happen. (There are not any chemical changes) How will be the life in this situation?</td>
</tr>
<tr>
<td>3. On the page no 25 in the science book the chemical changes are shown, it has used picture of 2 leaves one, is green and another is yellow. In your opinion, whether this picture is suitable to show the chemical changes or not? Why? Please explain.</td>
</tr>
<tr>
<td>4. Write a story about materials change and conclude it. (Real or non-real).</td>
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<tr>
<td>5. If you were able to do 3 changes in your classroom, home, or around environment, what will be there 3 changes?</td>
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<tr>
<td>Team-Collaboration</td>
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<td>-------------------</td>
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</table>
Table 4. Questions of Problem Solving

<table>
<thead>
<tr>
<th>Problem Solving</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When I’m trying to solve a problem:</td>
</tr>
<tr>
<td>I search the solution quickly but I try to reach the path step by step.</td>
</tr>
<tr>
<td>Very much □ much □ moderate □ low □ very low □</td>
</tr>
<tr>
<td>2. If I were a teacher, I would prefer to teach the subjects which:</td>
</tr>
<tr>
<td>deal with facts and real situations of life.</td>
</tr>
<tr>
<td>Very much □ much □ moderate □ low □ very low □</td>
</tr>
<tr>
<td>3. When I have to solve the science’s problems:</td>
</tr>
<tr>
<td>I try to understand the problem well, and then I’ll solve it.</td>
</tr>
<tr>
<td>Very much □ much □ moderate □ low □ very low □</td>
</tr>
<tr>
<td>4. When I’m learning a new subject,</td>
</tr>
<tr>
<td>I try to find associations between that subject and other subjects and past</td>
</tr>
<tr>
<td>discussions.</td>
</tr>
<tr>
<td>Very much □ much □ moderate □ low □ very low □</td>
</tr>
<tr>
<td>5. When I am solving a problem in the team I am more interested in:</td>
</tr>
<tr>
<td>Thinking on the solution’s results and implementing that in the other large path</td>
</tr>
<tr>
<td>Very much □ much □ moderate □ low □ very low □</td>
</tr>
</tbody>
</table>