CHAPTER 6
SUMMARY AND CONCLUSION

6.1 NEED OF STUDY

The literature implied an overall need that graduates of engineering are and want to be creative, and the engineering industry wants thinkers and problem solvers, so likewise we should use education techniques that foster creativity in students [45]. The problem itself is taken as the starting point and the concept becomes the facilitator. The students search for the information and develop the requisite understanding by reading the literature, doing the required calculations, performing the practical work to verify and authenticate the calculations, applying the concepts so learned to reach at the solution to the problem. As against the traditional way of adopting traditional / routine ways, it is the process by which the students actively learn and contribute, as opposed to sitting passively in lecture hall, listening to, and memorizing facts [55e].

Engineers are problem solvers - this is a statement with which few educators would disagree. However, there is a disagreement as to how engineers are taught to be problem solvers [108]. Based on the evidence from over 30 years of engineering programs in Europe and North America, the answer to this question appears to be : using a PBL approach [65].

Embarking upon this path of curriculum revolution is not without its challenges. As stated by Glen O’grady at the Republic Polytechnic:

“It is not difficult to find educators who are sympathetic to the principles of PBL but what is challenging is having the will, capacity, opportunity, and the knowledge of how to apply these principles to specific contexts. For those embarking on the path of implementing PBL, the way is often unmapped and the light is dim.” [70].

According to an ancient proverb – “The journey of thousand miles starts with the first step”. This thesis work is the first step towards redesigning the curriculum of basic courses in Electronics Engineering to incorporate PBL and evaluate the effectiveness of this improved method to problem solving techniques.
6.2 PBL DEFINED

PBL education has two main components: the starting point is a problem; and a student-centered approach that affords students control over and responsibility for their own learning [74]. This is in contrast to traditional programs that are teacher-centered, where the teacher or the textbook determines what the student should know [105].

The PBL process consists of six steps, as follows:

1. Exploration of the problem and generation of hypotheses;
2. Identification of learning issues (based on prior knowledge) and information sources;
3. Information gathering and independent study;
4. Critical discussion of the knowledge acquired (in a group setting);
5. Application of knowledge to solve the problem;
6. Reflection on the process and provision of feedback [107] [74]

6.3 STATEMENT OF THE PROBLEM:

1. The intent of this study is to impart the instructions for existing curriculum of Analog Electronics (AE), Digital Electronics (DE) and Pulse, Digital and Switching Circuits (PDSC) for undergraduate students of Electronics and Communication Engineering, Punjab Technical University using Problem Based Learning.

2. Once PBL is incorporated and practiced, the intent would be to determine if the knowledge and skills of the students would significantly improve when problem based learning as mode of instruction than those students, who were taught using Traditional approach.

6.4 PRINCIPAL RESEARCH QUESTIONS:

The major research focus for this study is: Does the use of Problem based Learning has any effect on knowledge, skills and attitude when compared to students enrolled in traditional courses?

Following research questions were identified:

- Is there a main effect of pedagogy on knowledge?
- Is there a main effect of pedagogy on skill?
- Is there a main effect of pedagogy on attitude?
- Is there a main effect of gender on knowledge and skill scores?
- Is there a main effect of cognitive style on knowledge and skill scores?
• Is there a significant interaction between gender and pedagogy on knowledge and skill scores?

• Is there a significant interaction between cognitive style and pedagogy on knowledge and skill scores?

• Is there a significant interaction between cognitive style, pedagogy and gender on knowledge and skill scores?

• Are above results facilitator independent?

6.5 ASSUMPTIONS OF THE STUDY:

1. The students would participate voluntarily in the study.

2. Students entering in the study of the AE, DE and PDSC courses would have little knowledge of those particular subjects.

3. The research sample will have little knowledge of PBL.

4. The environment in terms of working conditions, resources and facilitator/teacher would be uniform.

5. The students in research sample would be a motivated throughout, so that the study could be completed.

6. The testing instruments used in the study would accurately measure the achievement, performance and student attitude.

6.6 HYPOTHESES STATEMENTS:

The null hypothesis indicated that for the control and treatment groups:

HO1: There will be no significant difference in knowledge scores between the traditional (Control) group and Problem Based Learning (Treatment) group.

HO2: There will be no significant difference in skill scores between the control and treatment group.

HO3: There will be no significant difference in the attitude between control and treatment groups.

H04: There will be no significant difference in knowledge scores between males and females.

H05: There will be no significant difference in skill scores between males and females.

H06: There will be no significant difference in knowledge scores between Field Dependent and Field Independent students.
H07: There will be no significant difference in skill scores between Field Dependent and Field Independent students.
H08: There will be no significant interaction between gender and pedagogy on knowledge scores.
H09: There will be no significant interaction between gender and pedagogy on skill scores.
H10: There will be no significant interaction between cognitive style and pedagogy on knowledge scores.
H11: There will be no significant interaction between cognitive style and pedagogy on skill scores.
H12: There will be no significant interaction between gender, pedagogy and cognitive style on knowledge scores.
H13: There will be no significant interaction between gender, pedagogy and cognitive style on skill scores.

6.7 DESIGN OF THE STUDY

The study was aimed at studying the effectiveness of Problem Based Learning Instructions on knowledge and skills of students of Undergraduate program in Electronics and Communication Engineering at Chitkara Institute of Engineering and technology in three subjects – Analog Electronics (AE), Digital Electronics (DE) and Pulse Digital and Switching Circuits (PDSC). The Institute is affiliated to Punjab Technical University, Punjab. The experiment was carried out in above three subjects over a period of four semesters, as described in the layout of sample base.

The factorial design of 2x2x2 was used because it permits to evaluate the combined effect of two or more independent variables simultaneously. The layout of the factorial design is given in figure 6.1.
6.8 SAMPLE

Since the total of engineering students across India is unmanageable to experiment with, a representative of the population is drawn for this study. Sampling refers to selecting relatively small number of individuals, called subjects, to find out something about entire population that the subjects represent.

In this study sample were chosen from different batches of students. Each batch contained approximately 67 students. Each time the class was divided into two threads – PBL Thread (known as Treatment Group) and the Traditional Thread (known as Control Group). Each time the random table procedure was used to select students for PBL thread. The same teacher handled both the threads each time. “Teacher 1” in above table refers to the researcher herself. Teacher 2 is a different facilitator, when the experiment is repeated with a fresh batch of students.

The Group Embedded Figures Test - GEFT (Appendix A) was administered on each batch and the students were classified into Field independent and Field Dependent cognitive styles. The attitude of the students were measured on attitude scale form. The End semester knowledge test and End Semester skill test were conducted at the end of each semester for all the students. The result so obtained was then analyzed using Three Way ANOVA to find the effect of pedagogy on Knowledge and Skills of the students.
The formation of the Traditional thread was quite traditional, with the students sitting in the classroom in rows, facing the teacher. The demarcation of lecture, tutorial and practical classes was quite clear. The teacher gave lecture in lecture classes, made the students practice closed ended problems in tutorial classes and the students do experiments in the practical classes, in a typical laboratory set up.

The students in PBL thread were first asked to form their groups with minimum 4 and maximum 5 students in each group. The class had circular tables, with chairs around them and a scribble board placed in the centre. The set-up thus facilitated interaction and discussion amongst the groups [67] [29]. A small library was also built in the classroom. The students were free to use internet on their laptops and search for any data and information required. They could use simulation software and laboratory equipments in the class itself for achieving any practical Learning Objectives.

6.9 TEACHING PEDAGOGY

(a) The teaching pedagogy for the Traditional thread continued to be “traditional” using Lecture, Tutorial and Practical classes, with the teacher as “Sage on Stage” [4]. The teacher made the Lecture plan and Lab Plan – an hour wise, lecture wise, lab wise schedule, for delivery of the whole syllabus, right from knowledge level to the application level. She also delivered the course in accordance to the same. The quasi-open-ended-problems, as given in the section VI, were changed into more closed-ended-ones and given to the traditional group for practice, in the tutorial classes. These problems were in addition to many other analytical questions, which the students practiced in tutorial classes. The lecture and tutorial sessions were interlaced throughout the semester. The content delivery in the Lecture classes was one way - from teacher to students. However the students were allowed to work in groups, practice analytical problems and discuss the issues in Tutorial classes. The practice session for a particular topic was always after the concept was delivered and understood by the students in the Lecture classes. The practical sessions in the Lab classes had objectives, again, determined by the prescribed study scheme and syllabus of the affiliating University and the teacher. All in all, there was a clear demarcation in the Lecture, Tutorial and Lab classes in terms of the delivery of content, what the students performed.

The facilitator designed open–ended Technical Problems (TPs) and got them
authenticated by a group of senior teachers. While designing TPs, care was taken that
the scope was broad enough so that the students could achieve all the Technical Nodes
and Learning Objectives in the conceptual space, while attempting to solve them.

Students grappled with these fuzzy Technical Problems (TPs) – one at a time, and tried
to understand the scope, issues and concepts stemming from or inherent in the TP before
attempting to identify the learning points that would guide them towards the formulation
of an eventual response [100] (in the form of a theory, hypothesis, solution or argument).

There was no demarcation of Lecture, Tutorial or Practical classes and the total time
available for the course was divided into several two hour PBL-sessions. The students
developed an understanding and also found the solution to the TP while traversing the
conceptual space, covering the technical nodes and also learned to work in teams. The
role of the teacher was changed from the “content-delivery-person” to a facilitator. The
students worked on their Technical Problems, trying to find out one of the many possible
solutions, determining and achieving their own theoretical and practical Learning
Objectives. The teacher remained and worked as “guide-by-side”, truly taking up the
role of a facilitator. She carefully monitored each and every step of the groups and
remained aware of the progress made by the teams. At times, when the facilitator felt
that all the students encountered the same kind of bottleneck at some point, she even
delivered a structured lecture or called upon all the students to perform the same
experiment, so that they all could proceed further.

Moodle™ software was used for online submission of assignments and presentations for
both the threads and also to extend the discussion among students even beyond the class
room.

6.10 ANALYSIS OF DATA

The data was analyzed using descriptive statistics such as Mean, Median and Mode, SD,
skewness and kurtosis. To draw statistical inferences, and to test hypotheses, three-way
ANOVA was employed. The p-value analysis showed that pedagogy significantly
contributed to knowledge and skill gains of the students. It also showed that the females
responded better to pedagogy for their knowledge gain. There was no effect of cognitive
styles on the dependent parameters. The Attitude scale form was used to measure the
attitude of the students towards pedagogy. PBL students showed very positive attitude towards learning. The statistical results achieved are tabulated in Chapter 5.

6.11 CONCLUSIONS

1. The students taught through PBL achieved better scores in Knowledge and Skill tests in the three subjects of Analog Electronics, Digital Electronics and PDSC.
2. The students in the PBL class also showed better attitudes towards learning and utilizing the class time more effectively.
3. The cognitive styles of the students did not influence the knowledge gain and skills of the students under study.
4. There was no significant interaction in pedagogy and cognitive style.
5. There was a significant interaction in the gender and pedagogy. The females responded better to PBL than the males, but only in knowledge gain.
6. There was no significant interaction between pedagogy, gender and cognitive styles.

6.12 IMPLICATIONS OF PRESENT STUDY

1. The urgently needed paradigm shift in teaching pedagogy from Teacher centered to Student centered approach, from teaching to learning, has been justified with this study. Although lacs of students are undergoing technical education in India, there have been no concentrated efforts to evolve structured and scalable changes in the pedagogy.
2. All the above results indicate that the pedagogy of PBL can be and should be used on a wider basis for imparting technical education. The two hassles that are seen for wide range application of PBL are faculty training and the higher cost associated in handling PBL classes. Widespread and versatile scalable models should be developed for making PBL more prevalent.
3. Care must be taken to carefully draft the open ended technical problems so that all the technical nodes and learning objectives are touched upon in the scope of the TP, then only the syllabus of that particular subject is covered. A documented procedure and the maps to develop the TPs should be generated so that PBL curriculum can be generated for wider range of subjects and areas.
6.13 SCOPE OF FUTURE STUDY

1. The effects of pedagogy, gender and cognitive styles on the knowledge, skill and attitudes have been studied in this research work. Learning in humans is dependent on and related to many factors – cognitive style being one of them. Other factors, viz. learning styles, problem solving styles etc. can be studied for their influence on knowledge and skill gains.

2. Further, the study to measure the problem solving abilities – specifically- of engineers can be taken up, with the same parameters.

3. The effect of enhanced learning capabilities and their effect on performance of these PBL students when they work in industry on real life problems can be studied.

4. The pedagogy – PBL is to be made scalable so as to handle large classes. The teacher training issue to be addressed at a larger platform. Specific models can be developed to do so.

5. Similar studies can be taken up in other branches of engineering.

6. Use of technology can be explored to handle collaborative and Problem Based Learning. Development and use of Content Management Systems (CMS) and Learning Management Systems (LMS) in this context can be taken up.