CHAPTER III
RESEARCH METHODOLOGY

3.0 Introduction

Methodology can be described as the systematic analysis of the methods applied to the research study and is essential part of any research work. It is the general research strategy which outlines and identifies the way research is to be undertaken and the methods to be implemented. It is a procedure of research study for measuring the outcomes of any research study. It includes the methods and principles which are associated with the theoretical model of quantitative and qualitative techniques. The research methodology must be clearly and logically planned, researcher should be knowledgeable about the incorporated research techniques and analysis in the research study.

The methodology section must be clearly articulated for choosing a particular procedure or technique. This chapter includes the design, procedure, variables, phases of study, sample and sampling techniques, tools of data collection and data analysis methods.

3.1 Statement of the Study

Developing, implementing, and studying the effectiveness of internship curriculum based on Project Based Learning (PBL) for third year sixth semester students of civil engineering for construction field preparedness.

3.2 Title of the Study

Effectiveness of Project Based Learning for Undergraduate - Bachelor's Civil Engineering Education

3.3 Objectives of Study

- To assess the need and scope for implementing Project Based Learning for internship program at bachelor’s level of Civil Engineering.

- To develop the Project Based Learning curriculum for internship program at bachelor's level of Civil Engineering.
- To implement the Project Based Learning curriculum for internship program at bachelor's level of Civil Engineering.
- To study the effectiveness of the developed Project Based Learning curriculum for internship program at bachelor's level of Civil Engineering program.
- To study the improvement in technical competence/gained field knowledge for the conducted Project based learning curriculum at the bachelor's level of Civil engineering program.
- To study the development and improvement in soft skills for the conducted Project based learning curriculum at the bachelor's level of Civil engineering program.

3.4 Operational definition of the terms

Effectiveness in the present study was seen in terms of the gained academic knowledge or improvement in technical competence (improvement in scores for pre-test and post-test), dvelopment and improvement in problem solving and other soft skills like technical writing, communications, and teamwork.

3.4.1 Explanation of terms

Project Based learning (PBL) - PBL is a student-centered educational approach. To fill the gap from fresh graduates to technically skilled or career ready individuals the bridge needs to be incorporated in the curriculum for the students by involving them in the outside classroom field practicum which may help in developing the needed professional and soft skills such as teamwork, problem solving along with improvement in the academic knowledge.

Curriculum: As per the present study, the designed field Curriculum for the internship program incorporates the method or a program of experiential learning in the form of PBL based Internship program for individuals or small group of students to engage in the field practicum which gives an opportunity to the students

to reflect their course work learning and understanding during project practicum activities.

Implémentation : In this present study, project based learning internship program curriculum was implemented for the third year Civil engineering students. Students were divided into groups with six to seven students in each group. All the groups were engaged in field practicum activities as per researcher designed field practicum assignments for four to five hours a day for a period of fifteen days on the on the respective site/ field at construction site under the supervision of civil engineering site supervisors and the researcher. Students monitored, identified, and collected the information for the assigned practicum and submitted daily reports, weekly reports, final project reports and delivered project presentations along with appearing for Pre-test, post-test for the attended PBL based Internship program. Delayed Post-test was also conducted after three months to review the retention level of students for the gained knowledge during internship program.

Technical Competency: It is the skill or technical knowledge of area or branch in the specific industry. Technical competence or field knowledge is the gained field or technical knowledge while getting engaged in field or civil and construction engineering activities. It is measured as the understanding skills (improvement in understanding skills specific to internship practicum activities), confidence (professionalism, knowledge of field practicum, challenges, or strategic planning for finishing projects before designated deadlines), gained field knowledge (mean achievement test scores) and classroom discussions. Technical competence was measured by the difference in the mean achievement scores obtained by students for pre-test and post-test, observations made by the researcher and analyses of the feedback/evaluation forms duly filled by students and site supervisors. Technical competence or gained field knowledge for this study was measured by comparing the mean achievement scores of pre-tests and post-test of program participants, retention of gained field knowledge by comparing mean achievement scores of pre-tests post-test and delayed post-test and feedback from the post site visit questionnaire.

Soft Skills: are subtle behavior and communication styles that help make work environment or interaction with team members and supervisors comfortable. Soft skills were measured in terms of teamwork, time management, problem solving, technical report writing and communication and presentation skills.

Problem solving Skills: It is the process of conceptualizing, applying, analyzing, and evaluating the information to reach an answer or a conclusion. Learners' ability to define, analyze and evaluate the challenges or problems during the construction practicum activities showed the improvement in solution seeking skills for learners while experiencing practicum activities compared to the foreseen theoretical challenges. The feedback analysis from student and supervisor evaluation/feedback forms provided an insight about the development and improvement in the problem-solving skills of the students.

Teamwork Skills: was measured in the terms of behavior of students in rapport (building relationship, demonstrate respect), openness (work productively in diverse perspectives), effort (does fair share of group work), synthesis (drawing conclusions with other team members) while participating in their respective teams for the assigned internship group practicum of field internship program. The researcher's observation during practicum activities and analysis of students and supervisors evaluation/feedback forms gave an insight about the development and improvement of teamwork skills in the learners.

Technical report writing and presentation : was measured in the terms of clarity (clear and understandable expression of technical information), relevance (synchronizing the relevant material), organization (logically organize the structure with reasonable approach) of technical writing for daily reports, weekly reports, final project report of field practicum assignments and delivering as final internship project presentations for the designed practicum activities for PBL based Internship program of this present study.

3.5 Population

The population of the present study consisted of all the third year, or sixth

semester students of undergraduate civil engineering program affiliated to All India Council of Technical Education (AICTE) for the year 2017-2019.

3.6 Sample and Sampling technique

Sample: The research study was conducted in May 2018, at Vadodara City, Gujarat with thirty-three sixth semester undergraduate civil engineering students. The sample of students was selected from the technical institutes located at Vadodara City, Gujarat which offers four-year undergraduate degree program in Civil engineering. Owning to growing economy, researcher identified the abundance of improvement or development projects in civil engineering were happening in Vadodara City, which gave researcher an opportunity to locate and finalize the Internship /project practicums site for civil engineering construction activities required to implement the developed curriculum for PBL based Internship program in Vadodara City itself for the present study. Researcher had conducted PILOT study and present/main study with group of participants from different institutes who are third year students of bachelor's in civil engineering program. The sample for both studies was categorized large as number of study participants was more than 30. The sample size represents large population because the population sample represents does follow the same curriculum guidelines of AICTE's curriculum for bachelor's in civil engineering program.

Sampling technique: Vadodara is in Gujarat, India which has number of institutions which provide a great platform for higher education in the field of engineering, arts, and social science. Vadodara is a developing city and contributes towards improving the social and economic condition of the area. Maharaja Sayaji Rao university, Vadodara is one of the leading and eminent government university in Vadodara. Municipal land is also allotted by civil authorities of Vadodara city to develop IIIT-Vadodara, AICTE Training Center and Gram Sabha.

Some of the institutes which offered Bachelor of Civil Engineering program at the in Vadodara, Gujarat are:

- Babaria institute of Technology
- KJ Institute of Engineering and Technology

- Maharaja Sayaji Rao University of Baroda
- Parul Institute of Engineering and Technology
- Orion Institute of Management and Technology
- Navrachana University
- Vadodara Institute of Engineering

Researcher had approached folowing technical institutes affiliated to AICTE, offering undergraduate degree program in civil engineering in Vadodara city, Gujarat. Researcher interacted with the management and faculty members and presented the objectives and implementation plan of the present study, designed PBL curriculum for the internship program. The management and faculty of the following institutes found the designed PBL based internship program as an excellent initiative and a structured approach for the development and improvement in technical competence and soft skills by involving students in field practicum group work.

- Vadodara Institute of Engineering
- Neotech Institute of Technology
- Maharaja Sayaji Rao University of Baroda
- School of Engineering and Technology, Navrachana University

Technical institutes faculty encouraged and convinced the students about the benefits of attending this present study. After the approval and encouragement from the technical institutes' authorities, researcher interacted and discussed with the sixth semester civil engineering undergraduate students about the internship program and desired learning outcomes of the present study. Students who showed interest in attending the present study or PBL based internship program had filled up the consent form as required. Researcher approached the local civil engineering and construction firms to get their permission and approval for conducting PBL based internship program at their construction site.

AICTE Civil engineering undergraduate program curriculum: The first-year course work includes humanities, social and basic sciences, communication, and professional development, second year course work continue courses with basic engineering sciences, principles, and tools. The third-year civil engineering course

work educate the students with civil engineering core courses like geotechnical, hydraulics, environment, building construction, foundation design and construction, surveying, and transportation. The final year curriculum includes the combination of few cores and elective civil engineering courses. As per AICTE's revised curriculum internship is made mandatory and had been given credits for attended internship program

Admissions: Admissions to the undergraduate professional courses in Gujarat are done through online mode by Admission Committee for Professional Courses (ACPC). The eligibility criteria to enroll into undergraduate program is passing of standard XII or higher secondary certificate (H.S.C) or equivalent. Admission to the engineering courses is done based on merit list of GUJCET/JEE main examination, where 60% weightage is given to HSC qualifying examination and 40% to the entrance exam scores. The students who had passed 3-year diploma level course in particular branch can get lateral entry (D2D - Diploma to degree) into second year of respective branch of engineering based on a separate merit list prepared by ACPC. Students seeking admission into undergraduate programs comes from diverse socio-economic background and different medium of instruction.

Teaching and Learning: Mode of classroom instruction in most institutes is to discuss, demonstrate, focus on application of concept and memorizing the content.

Classroom learning happens in following ways but not limited to:

- Classroom lectures
- Practical sessions in laboratories
- Engineering Drawings

As per AICTE's curriculum for undergraduate engineering, learners finished general engineering course work for first two years of undergraduate civil engineering before learning the core civil engineering courses. The third and final year civil engineering course work includes the combination of core and elective civil engineering courses and project work. Students conducted practical

experiments related to course work in the institute laboratories and working on the small class projects and preparing reports.

3.7 Research methodology and design of the study

The research methodology proposed for this study was Experimental.

The design employed for the study is One Group Pre-test and Post-test.

O_1 - X - O_2 ……. O_3

X = Group of sample students of third year Civil Engineering undergraduate program for PBL based Internship Program.

O_1 - are scores of the students in the researcher designed made achievement Pre-test, administered before implementing the PBL based internship Program.

O_2 - are scores of the students in the researcher designed made achievement Post-test, administered after implementing the PBL based internship Program.

O_3 - are scores of the students in the researcher designed made achievement delayed post-test, administered after three months of conducting of PBL based internship Program.

Pre-test and Post-test were researcher made achievement tests and were conducted before and after implementing PBL based internship program. Researcher conducted the delayed post-test after three months of implementation of PBL based internship program. The mean achievement scores of pre-tests and post-tests of the students were compared to calculate the t values (t values are values which are calculated from sample data) which were compared with t-table critical values for the findings of the study (by comparing the data under the null hypothesis). The mean achievement scores of pre-tests, post-test and delayed post-test were compared to identify the retention of the gained knowledge for the present study.

3.8 Variables of the Study

A Variable is not something that can be measured but also something that can be varied and controlled. An independent variable is sometimes called as predictor variable while dependent variable is sometimes called as outcome variable. Dependent variable is dependent on independent variable.

Dependent Variables for this present study:

Dependent variable: Test Scores

The dependent variables of the present study are the achievement scores obtained by the students on pre-test, post-test, and delayed post-test (conducted after three months of implementation of post-test)

Independent Variables for this present study:

Independent variable: Proposed internship curriculum

The researcher's designed curriculum for summer field internship program for third year civil engineering students of undergraduate program.

3.9 Delimitation of the Study

This study was delimited to the third-year civil engineering undergraduate students who had attended the PBL based internship program and conducted practicum activities for three weeks as per researcher's designed curriculum and practicums.

3.10 Hypothesis

The assumed null hypothesis was as follows:

1. There will be no significant difference between the mean achievement scores of Pre-tests and Post-test of third year civil engineering students at 0.05 level (95% confidence level)
2. There will be no significant improvement in technical competence level or gained field knowledge of third year civil engineering students at 0.05 level.
3. There will be no significant development and improvement in the soft skills of third year civil engineering students at 0.05 level.
4. There will be no significant retention observed in mean achievement scores of delayed post-tests of third year civil engineering students at 0.05 level.

The t-test value is calculated from sample data during a null hypothesis and compares the calculated t values against standardized/critical t values. A t value of 0 indicated the sample results equal to null hypothesis. The more is the t value; the more is the evidence to reject assumed null hypothesis.

3.11 Components of the developed curriculum for present study

The AICTE curriculum chart showed that students acquire the theoretical technical knowledge of core professional courses like Surveying, Geotechnical, Foundation, Building design structures and Hydraulics till third year or six semester of undergraduate civil engineering course. The topics like precast construction and construction management practices were also included in the project practicum activities with an intention to provide overall knowledge of construction practices, materials and challenges and scenarios. The curriculum for internship program had been designed with an intent to use the classroom theoretical learning undergraduate courses in the construction site practicums to develop, improve and refine the knowledge and skills in the students.

The program was structured to provide the knowledge to the students for the procedures and practices to be followed for design and construction of engineering projects. Researcher included the topics from project site selection, surveying and ground investigation, Soil testing, Foundation design, Excavation activities, Foundation construction to the final stage of building construction development projects to provide students an insight of the complete development process for civil engineering projects. While conducting project practicums, the focus was also to make students explore and be knowledgeable of the national, state regulations, norms, standards and permits required at various stages of construction development projects.

With this insight in mind, the researcher had selected the following areas to be covered in three-week Project based learning internship program offered for third year of undergraduate civil engineering program.

1. Site Survey and Ground Investigation
2. Construction Site Excavation Activities
3. Soil Testing Reports, Foundation Design, Coordination construction plans
4. RCC Foundation Construction:
5. Building Construction Activities
6. Precast Structures
7. Construction Management and Administrative practices

The details about the offered PBL based internship program's curriculum and implementation are discussed in chapter 4.

3.12 Tools of Data collection

The following are the tools used for data collection for this present study:

- Pre-test
- Post-test
- Daily reports
- Weekly reports
- Project Report and Presentations
- Student Evaluation form
- Field Supervisor Evaluation form
- Delayed post-test
- Delayed Post site visit questionnaire

Construction of Tools

- Pre-test - researcher constructed pre-test to evaluate the students present field knowledge of the construction site practicum for the same topics (Site Survey and Ground Investigation, Construction Site Excavation Activities, RCC Foundation Construction, Building Construction Activities, Precast Structures, Construction Management and Administrative practices) as the similar post-test was administered. Pre-test was administered before the implementation of the PBL based internship program and the format of the pre-test included the brief questions and multiple-choice questions for all the designed sections or topics of the present study's curriculum. The pre-test is enclosed in Appendix 5.
- Post-test - researcher constructed the post-test to evaluate the improvement and gain in the technical field knowledge in students for the conducted construction site practicums for the PBL based internship program. The evaluation was done by conducting the post-test after the completion of PBL based internship program. The post-test's format and test questions were similar to the designed and conducted pre-test. The post-test is enclosed in Appendix 7.

- Delayed post-test - was constructed to assess the retention of gained field knowledge by the students of the PBL based internship program after the gap of three-month period. The retention evaluation for the students was conducted after the gap of three months by conducting the delayed post-test. The format and questions delayed post-test was similar to the previously conducted pre-test and post-test. The delayed post-test is enclosed in Appendix 12.
- Daily Reports - was constructed to assess each group's learning and clarity for the assigned and conducted field practicum in technical field knowledge and technical report writing on the daily basis. The assessment was measured in the terms of gained field knowledge and technical writing format reported in the daily reports and the effort and contribution of all team members as a teamwork while preparing the technical daily reports of PBL based internship program.
- Student Evaluation form: this form was constructed to evaluate the students clarity on the level of technical competency and learned and improved soft skills like communication skills, problem solving skills, teamwork skills attained after participating in the designed PBL based internship program. Students provided self-evaluation feedback, responded to the open-ended questionnaire for the level of skills attained in the communication, problem solving, technical competence, teamwork, and their overall learning experience for participating and attending the present study or PBL based internship program. The student evaluation /feedback form is enclosed in Appendix 8.
- Site Supervisor Evaluation form: tool was constructed to assess and evaluate by the construction site supervisors for the gained field knowledge or technical competence and the soft skills like communication, problem solving, teamwork of the PBL based internship program students. Site supervisors observed and provided the feedback for the open-ended questions for any improvement and attained skills in the communication, problem solving and technical competence in students after conducting project practicums for the PBL based internship program. The site supervisor evaluation/feedback form is enclosed in Appendix 9.

- Weekly progress report: this tool was constructed to assess students' progress in gained technical knowledge and describing it in technical writing in the form of report on the weekly basis. It was made mandatory for all the students to individually submit the weekly progress reports. The assessment was measured on how well the students had followed the format of the technical report writing by including graphics, explaining technical terms, organizing content, and reporting on the field practicum procedures and queries for the assigned and conducted field practicum assignments for PBL based internship program.
- Project report - this tool was constructed to assess and measure the progress in the improvement of organizing the content, format, clarity, and precision in technical writing skills of PBL based internship program students. The assessment of project report writing of students was assessed by evaluating the organization of the technical content, flow, and the clarity of the technical writing as per the provided format and designed rubric. The project report format and rubric are enclosed in Appendix 10.
- Project presentation: this tool was constructed to measure the format, organization, clarity, and delivery of the prepared project presentation content in a professional and in the confident way of PBL based internship program students. Each student advocates the learning about the acquired experience and knowledge during conducting field practicum activities and the evaluation of delivered project presentation was based on the students' and team's performance as per the provided presentation format and the designed rubric. The project presentation format and rubric is enclosed in Appendix 11.
- Delayed Post Site visit questionnaire was constructed to assess the retention of gained field knowledge by the students of PBL based internship program after the time gap of three months. The reflectiveness and the retained field knowledge attained during the conducted PBL based internship program was measured and assessed by the delayed post site visit questionnaire feedback from the students during their post site visits. The project report format and rubric is enclosed in Appendix 13.

3.12.1 Validation of Tools

Designed tools of the study were reviewed and validated by five experts. Two experts from civil engineering education reviewed the course work to be covered, designed achievement tests, developed daily field practicums. Third expert was from civil and construction engineering and had reviewed the developed daily field practicum for this PBL based internship program. Fourth expert was from education area and had reviewed the language and educational/pedagogical tools of the PBL based internship program. The fifth expert was from an engineering education field and had reviewed the theory and field practicum activities for the desired learning outcomes of proposed PBL based internship program.

Researcher had involved Expert 1 from the initial planning phase of field activities to final design of curriculum phase of field work activities for students. As additional supervision for students on construction site, field expert suggested to involve a Civil engineering instructor or tutor along with the researcher to monitor and supervise the students while conducting project practicums for PBL based internship practicum. Expert 2 suggested for AUTO CAD technical drawings to be incorporated instead of internet or printable images for better clarity and authenticity and to incorporate project practicums for concrete testing facility for more practical knowledge in building construction. Expert 3 had suggested that the learning objectives need to be revised for more clarity, to include testing of materials and incorporate about reinforcement bars grade testing. in addition to the bar bending schedules and construction practices for other building components.

Expert 4 suggested for couple of long sentences in learning objectives to make short and clear, project activity time to be mentioned as hours and minutes (2hours and 30 mins) instead of only hours (2.5 hours), to incorporate examination style common format and general instructions for Pre-test and Post-test.

Expert 5 suggested that students to give feedback, in addition to a quantified scale for learning about the specific outcomes about each area of developed curriculum. Expert advised on putting a request to field supervisors during internships program for their feedback with regards to learning progress or improvement in field knowledge of students for each section of developed curriculum. The expert

suggested during data analysis that the supervisor's feedback comments can be utilized to categorize the improvement in field knowledge or soft skills for the developed sections of PBL based internship program.

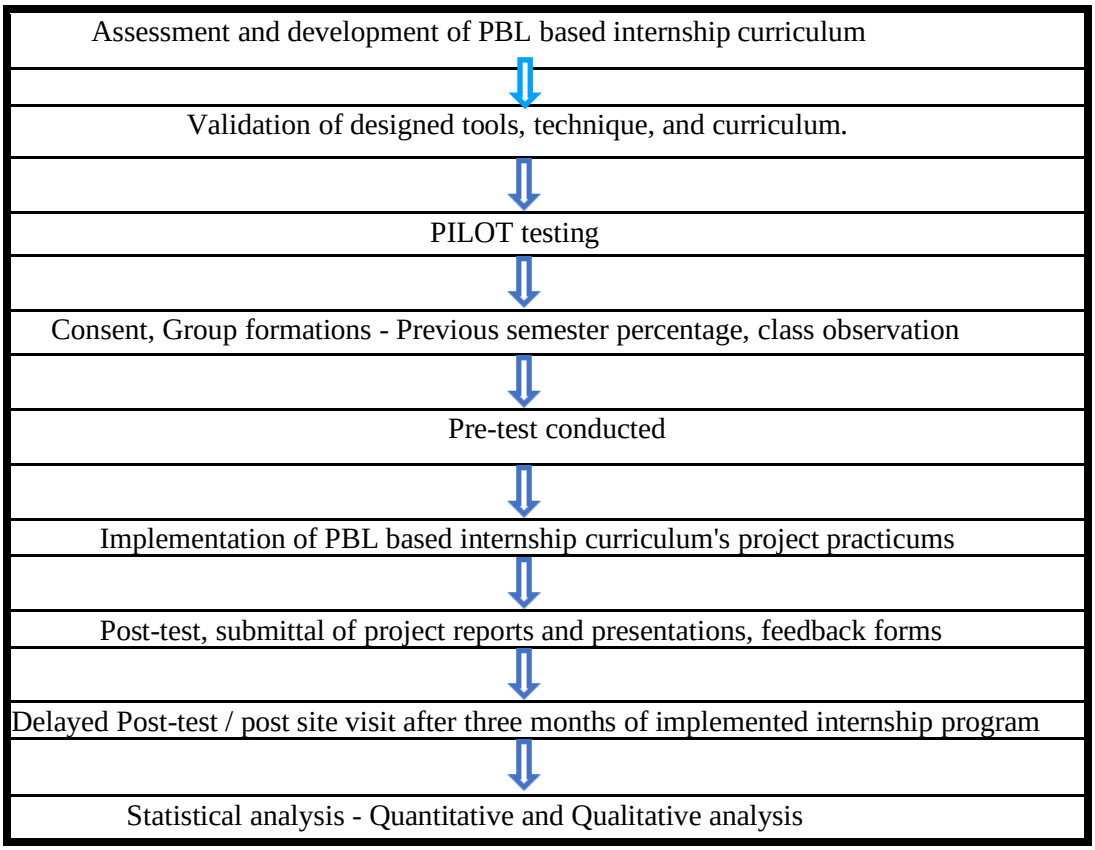
Experts' suggestions had been incorporated in the tools, technique, and design of study by doing amendments to learning objectives, theory material diagrams, assigning more time for construction/project site project practicums, testing of materials, and incorporating sections in student and supervisor feedback /evaluation forms. The list of experts for validation of tools is enclosed in Appendix 1.

3.13 Process of data collection

The process of data collection was done in separate phases as shown in phase diagram below.

Table 3.1

Flow chart for process of data collection for the present study.



The details of the procedure are broadly explained below in following steps.

Phase I: Need assessment and development of PBL based internship program curriculum

In perspective of civil engineering, Internships are viewed as an effective platform for engineering students for experiencing about the corporate world. Training through project-based learning has long been identified and recognized as one of the fundamental and key processes within the construction industry to assist organizations and meet the need of construction professionals with these qualities. Internships are designed or structured in a way to provide students practical work experience and exposure to the field challenges. The students get an opportunity to explore various areas of its professional education and provides them an insight to explore, choose and focus on the career path in their professional area.

PBL based Internship program curriculum was developed to improve the technical competence or knowledge of subject matter while observing and participating in the field practicum activities. The objectives of this program are:

- Students will be able to perform topographic survey and ground investigation of the site.
- Students will be able to monitor site construction excavation activities as per site building plans and planned schedules.
- Students will be able to analyze the soil testing report for the existing soil profiles in the area.
- Students will be able to reflect the classroom learning for site building foundation design and construction.
- Students will be able to examine the (BBS) bar bending schedules and concrete mix design grade for foundation construction as per foundation design drawings.
- Students will be able to identify the concrete mix pouring methodology as per standards and regulations.
- Students will be able to monitor the construction practices of building components such as beams, lintels, slabs, columns etc. as per site building design drawings.

- Students will be able to identify the advantages and disadvantages of Pre-cast concrete components in civil engineering construction practices.
- Observance of work hours, the importance of punctuality virtue of the individuals and its implementation in an organization.
- Observance of time management skills as preparing and submitting the reports on scheduled time and meeting deadlines of the projects.
- Enhancing presentation skills which includes appropriate expression, presentation, oral and written communication, and self-confidence.
- Industry needed skills like ability to adapt, decision making and teamwork.

Phase II: Field testing of developed PBL based internship program as PILOT program

The PILOT program is the field trial out of the main developed and designed study. The field try out represents the prepared curriculum of the main study and allows the researcher to observe the learning experiences and desired outcomes of the planned field practicums for students. It also helped to identify the challenges that come across during the implementation of designed PBL based internship program.

PBL based internship curriculum was implemented in the form of PILOT program and conducted with third year civil engineering undergraduate course students who had attained the theoretical knowledge for the civil engineering core professional courses as per AICTE's curriculum. Based on their completed professional course work and theoretical knowledge, researcher had developed the PILOT program with both theory and field practicum curriculum for the period of 40 hours. This program includes reviewing theoretical material related to field practicum, onsite or field practicum assignments under the supervision of the site supervisors and expert lectures related to the field or site practicum. Researcher had approached and requested the local civil engineering companies for the permission to conduct field practicums at their ongoing construction projects and to arrange an expert lecture related to the field practicums for this PILOT program from the senior and experienced civil engineers.

The details are given in chapter IV.

Approaching technical institutes: researcher started the implementation of the PILOT program by contacting the approachable four technical institutes affiliated to AICTE that offer undergraduate degree program in civil engineering in Vadodara City, Gujarat and briefing the program details and learning objectives to institute authorities and faculty. Institute authorities and faculty found the developed PILOT program as an opportunity for the students in developing and improving the technical competence and soft skills by involving them in real life field or practical group work activities. Researcher interacted with students and explained the PILOT program curriculum, interested students showed their interest and filled the consent form (Appendix 2a) to attend the developed PBL based internship PILOT program.

Pre-test and Project Based grouping: Researcher conducted class observations, got faculty suggestions and previous semester's percentage attained as a basis to make group formations for the sample of thirty students. Each group had average, below average and bright students as per previous semester grades. Each group has a team leader to lead the group in field practicum assignments.

Implementation of PBL based internship's curriculum as PILOT program: PILOT program student participants were given instructions; refresher materials and discussion sessions were conducted daily with each group for the related background theory for scheduled field practicum by the researcher. Students had observed, monitored, and inquired about the scheduled and assigned field practicum assignments in their respective groups as per developed PBL based internship program curriculum. Students kept the logbook for noting or reporting down the discussions done with the site supervisors for the observed construction site procedures and the field challenges. Students prepared the daily project practicum reports, final group project reports and delivered group project presentations.

Assessment of PBL based internship program as PILOT program: The learning outcomes of the PILOT program were assessed by conducting quantitative analysis by comparing the mean achievement scores of pre-tests, post-test, and delayed post-test for the students. Qualitative analysis was done for the Project

reports, Project presentations and the evaluation and feedback forms received from the students.

Challenges faced during implementation of developed PBL based internship curriculum's PILOT Program.

The conducted PILOT program for this study gave the researcher an opportunity to identify the shortcomings or challenges that may appear for the proposed study. Researcher had faced few challenges during implementation of Pilot (field try out) program.

- First challenge was to locate the local accessible and available sites for ongoing construction projects as per the designed PBL based internship PILOT program curriculum
- The PILOT program was conducted on weekends during ongoing semester so, it was challenging to coordinate the weekend project field practicum with students and ongoing construction sites.
- Small scale sites do not have different phases of construction going on. So, some groups had to wait or were send to nearby sites to perform field practicums which was challenging for researcher to observe all the students being at different sites.
- Due to the work responsibilities and busy schedules of the field or site supervisors it becomes challenging for them to devote time to the students conducting field practicums on the construction sites.

Amendments in the implementation of present study as per the PILOT program challenges.

Most of the challenges faced during PILOT program were sorted out and amendments were made accordingly.

- Researcher had looked for the local large scale construction site where all the formed groups can conduct field practicum for designed curriculum of PBL based internship program at the same site. Researcher was able to locate one of the largest developer and civil engineering construction company of Vadodara City where the ongoing construction work activities were in various stages, and it very well synchronized with the PBL based internship program's curriculum. Researcher approached the management of civil engineering construction

company and was to convince and get approval for conducting field practicums for developed PBL based internship program at their civil engineering construction site.

- The final PBL based internship program was conducted during summer vacation period and as it was convenient for the students to attend.
- Researcher approached and interacted with construction site supervisors and engineers, requesting for their guidance and supervision in involving the students in exploring and learning the construction scenarios knowledge. The designed detailed proposed schedule of daily construction site field practicum for different participant groups was discussed with the site supervisors and engineers to finalize the schedule of PBL based internship program's field practicum with the civil engineering and construction site's ongoing projects schedule.
- Researcher assured the site supervisors that complete discipline and all safety measures will be followed by the students on the construction site during conducting the field practicum for PBL based internship program.

The PBL based internship program had been designed to reflect student's classroom theoretical course work learning till third year of their undergraduate civil engineering.

Phase III: Implementing of PBL based Internship program's curriculum

PBL implementation in the form of internship program was conducted with thirty-three third year or sixth semester civil engineering undergraduate students. The students had acquired the required competences of core civil engineering undergraduate courses and the PBL based internship program was developed to reflect their classroom learning in the field/project practicums to develop, refine and improve the technical competence or field knowledge and soft skills.

Approaching construction companies: Researcher had approached the local civil engineering companies for the present study. After observing the construction site, meeting the project engineers, site supervisors and confirming that upcoming schedule of ongoing construction activities synchronized with the PBL based internship program's field practicum curriculum, researcher requested for the

permission of conducting internship program at the selected construction site location from the civil engineering company. After getting the permission and approval letter (Appendix 3) for conducting PBL based internship program at the construction site, researcher moved forward to next step of implementation.

Approaching technical institutes: Researcher started the next step of implementation process by approaching technical institutes affiliated to AICTE, offering undergraduate degree program in civil engineering in Vadodara City, Gujarat. Researcher interacted with the management and faculty members and present the objectives and implementation plan of the present study. After the approval and encouragement from the technical institute's authorities, researcher interacted with the sixth semester civil engineering undergraduate students and discussed with them about the implementation plan of the present study and desired learning outcomes of the present study. Researcher found the students had shown great interest in attending the present study or PBL based internship program and were then instructed to fill the consent form with signatures from institute faculty and their parents **(Appendix 2b).** Students had availability during summer, so internship program was scheduled for 3 weeks, 15 days on construction site from Monday thru Saturday from 9 am to 1 pm. Students underwent pre-test, post-test and submitted project reports (daily, weekly, and final) and project presentations during the present study.

Pre-test and Project based grouping: Researcher began with the class observations and interactions with the interested students. After interaction and class observations of students, pre-test was conducted, and the group formation was done with six-seven students in each group. Grouping of students was based on the percentage attained by the students in the previous semester, class observations. Each group had bright, average, and below average students and all groups were instructed to choose a group leader for each group.

Implementation of PBL based internship program field practicum: The implementation of PBL based Internship field practicum began with construction site orientation to the program participants. The groups were instructed about the internship location, schedule of field practicum, internship timings, safety

precautions and construction site discipline to be maintained. The program participants introduced themselves in groups and get familiarized with internship site, cconstruction manager, project engineer and site supervisors. For each group of students' researcher forwarded the schedule for field practicums and related theory material a day before to review and refresh the background knowledge of related topic before conducting field practicums. Before conducting field practicum, program participants were given instructions, teaching and discussion sessions daily for the background theory related to scheduled field practicum with each group of internship program participants. Participant groups were instructed to meet the assigned site supervisor to discuss, review and conduct the assigned field practicum. Researcher arranged the site visits to GERI (Gujarat Engineering Research Institute) and Precast Manufacturing Plants for envisioning them about other related aspects of construction engineering. Civil engineering field expert lecture and class discussion was also arranged to give the learners or interns an insight about the field experience and skills needed in professional career progression. The schedule of project practicums for PBL based internship program can be found in Appendix 6.

Assessment of PBL based internship program: The learning outcomes of the PBL based internship program were assessed by conducting quantitative analysis and comparing the mean achievement scores of researchers conducted pre-test, post-test, and delayed post-test of the students. Qualitative analysis was done for the self-evaluation and feedback forms received from the students, site supervisors, submitted final project reports, delivered project presentations and researcher's onsite observations during PBL based Internship program.

Researcher had observed and monitored the students while they are conducting assigned project practicums in their respective groups. Students were instructed to explore and understand the construction site related information on the internet along with the related theoretical material (provided by researcher) for the field practicum assignments and be knowledgeable about the construction practices so they can clarify the topic related doubts or queries with the construction site supervisors during conducting field practicum assignments.

The details of the developed and conducted project practicums for each section of PBL based internship program's curriculum are included in chapter IV.

Phase IV: Determination of effectiveness of PBL based internship program's curriculum.

The effectiveness of implemented PBL based internship program was determined by administering the tools of data collection.

Achievement tests (Pre-test, Post-test, and Delayed post-test): Researcher designed the achievement tests Pre-test, Post-test, and delayed post-test as tools of data collection. The sample of students was single large group that appeared for the initial test (pre-test) and followed by field internship (PBL) and re-administration of similar test as final test (post-test) and then later as delayed post-test or retention test (after 3 months). Since, the initial and final tests were responded by the same group of individuals, so the data collected was correlated. The achievement tests comprise of short answer and multiple-choice questions related to the sections or topics of PBL based internship program's curriculum. The difference in the mean achievement scores of administered pre-test and post-test measured the improvement and gain in technical field knowledge of the sample students for the conducted construction site group project practicum.

Delayed post-test administered after the time gap of three months from conducted PBL based internship program assessed the retention of gained field knowledge by the students after the time gap of three months.

Student self-evaluation and supervisor feedback forms: Student evaluation form (Appendix 8) was filled by the students (Appendix 21 filled by a student participants) after the completion of the PBL based internship program. Students provided the self-evaluation feedback on Likert scale and also responded to the open-ended questionnaire. This form is the feedback provided by the students for the improvement in technical knowledge and the level of soft skills attained for their future career plans and goals. Researcher requested the site supervisors for their evaluation and feedback for the students' performance from the beginning of the program through the end. Site Supervisor evaluation form (Appendix 9) provided the feedback (Appendix 22 filled by internship site supervisors) for the gain in field

knowledge and the level of soft skills attained in the communication, problem solving and technical competence in the students after attending the PBL based internship program. Researcher's observation and monitoring the student groups on the site, students' queries, engagement, interest, exploring and reflecting background knowledge with the ongoing field practicum, gained field knowledge, group leaders and team members suggestions have been summarized under relevant topics in next chapters.

Daily Report and Weekly Report: Daily group report (Appendix 15) and weekly reports (Appendix 16) measured each student's and group's learning and clarity for the assigned and conducted field practicum in technical field knowledge and technical report writing on the daily basis and weekly basis. The assessment was measured in the terms of gained field knowledge reported in the daily and weekly reports and the effort and contribution of all team members while preparing the group report.

Project Report and Project Presentation: The effectiveness of the project report (Appendix 17) was assessed and measured with the progress and improvement in organizing the content, format, clarity, and precision in technical writing skills. Project presentation (Appendix 18) was evaluated based on the format, organization, clarity, and delivery of the prepared project presentation content in a professional or confident way. All the groups had submitted the project report and Project presentation for the PBL based Internship program for their respective teams and the effectiveness was measured based on designed rubric for project report and project presentation.

Delayed post-test and post site visit questionnaire: The effectiveness of the implemented PBL based Internship program was measured by conducting the delayed post-test similar to administered pre-test and post-test after the gap of three months from the implementation. The scores of the delayed post-test were compared with the pre-test and post-test scores and students' responses to the post-site visit questionnaire to measure the reflectiveness and retention of the gained knowledge or technical competence during the implemented and attended PBL based internship program.

Researcher's observations: Researcher observed and identified the soft skills that students had developed while working as a team member while conducting field practicum assignments, taking notes, taking pictures, interacting with site supervisors, preparing project reports, and presenting project presentations. Researcher regularly observed, discussed, inquired about the queries and their understandability with the students and with the site supervisors to get an insight about their perspective for improvement in the technical competence or field knowledge and soft skills after attending PBL based internship program.

3.14 Data analysis:

The data of the present study was analyzed qualitatively and quantitively. The effectiveness of PBL based internship program and improvement in technical competence was measured by comparing the mean achievement scores of Pre-tests and Post-test. The development in soft skills and other industry needed skills such as teamwork, problem solving, time management, technical writing, project presentation was determined by researcher's observation and monitoring during the implementation of PBL based internship program. The evaluation and feedback forms filled by students and field supervisors, project reports and project presentations submitted and presented by the students for the conducted PBL based internship program. The detailed data analysis is presented in chapter V.

3.14.1 Quantitative analysis

Technical competence was measured and analyzed by comparing the mean achievement scores of administered pre-test and post-test and by calculating and comparing critical t values with t-table critical values (Appendix 19) for significant and insignificant gain in technical knowledge. Delayed post-test was conducted to analyze the retention of the gained field knowledge after the time lapse of three months from the administered internship program.

The sample of students was single large group that appeared for initial test (pre-test), followed by experimental treatment and implementation, re-administration of similar test as final test (post-test) and conducted delayed post-test (after the time

gap of 3 months from implementation of PBL internship program). Since, the initial and final tests were responded by the same group of individuals, so the data collected was correlated. The difference in the mean scores of achievement tests measured the improvement and gain in technical field knowledge of the sample students. The difference in mean achievement scores, standard deviation and calculated t values identified the significant or insignificant gain for measuring the improvement in field knowledge or technical competence of the students.

3.14.2 Qualitative analysis

Soft skills such as teamwork, problem solving, time management, technical writing, project presentation was qualitatively measured and analyzed from the feedback/evaluations from the field supervisors, students' self-evaluation/feedback, researcher's observations daily, weekly, and final project reports and project presentations for the attended PBL based internship program.

Field supervisors had observed and provided the feedback on the students' performance and improvement in students during conducting the project practicums in the supervisor evaluation and feedback form. Students' evaluation and feedback form, Project reports and presentations were submitted by the students after the completion of the PBL based internship program. Part of descriptive analysis was conducted for the feedback responses received from the students and site supervisors for the conducted practicums. Technical writing, organization and delivery of content and communication skills for the project report writing and project presentation were evaluated and analyzed based on developed rubric for the PBL based internship program.

3.14.3 Researcher's observations of students during the PBL based internship program's implementation.

Researchers observed the students coordinating, collaborating, and conducting assigned field practicums with teamwork and submitted daily reports, weekly reports for the assigned field practicum on time. The daily teaching and discussion sessions with students before and after the field practicum gave the researcher an

insight of students' progress in gaining field knowledge, development, and improvement in soft skills. A delayed post-test and delayed post internship visits \practicums were conducted for ongoing construction project sites after the gap of three months from the implemented PBL based internship program. Students feedback responses to post site questionnaire measures their retention and reflectiveness of the gained field knowledge attained during the conducted project practicums for PBL based internship program.

3.15 Summary

Chapter three demonstrates the path followed for the research methodology, techniques, plans or procedures and variables of the present study. It provides the detailed information of the research methods, process of data collection, tools used for collecting data and the development and implementation of PBL based internship program for the study sample of third year civil engineering undergraduate students. The next chapter presents the PBL based program's prepared curriculum and its detailed implementation plan.