

# Project Based Learning in Computer Science Education

Prikshit Tekta, Deepika Dutta, Preetika Chandel and Kamlesh Dutta

*Department of CSE, NIT Hamirpur, H.P.*

*E-mail: prikshitekta@gmail.com; preetika.nith@gmail.com; deepika27dutta@gmail.com; kd@nith.ac.in*

## ABSTRACT

Project Based Learning intends to promote an approach which focuses more on the projects being assigned to the students to help them gain better clarity of the subject. This type of learning has numerous advantages especially in the field of Computer Science. The aim of this paper is to establish the importance of project based learning in CS education system which will lead to better conceptual clarity and understanding of the subject. Today, the industry requires skilled workforce and this approach ensures that the students are prepared to take on the challenges of the industry. It facilitates in retention and increases the usefulness of the skills acquired. This paper aims to promote modifications in the present teaching techniques being employed in most of the institutions. Also, it presents a detailed discussion based on the survey collected from a control set of students to establish if this approach is useful and to which extent should it be promoted. A proposed solution has been listed where we can see how the present curriculum may be modified to focus more on projects.

**Keywords:** Project Based Learning, Theoretical Learning, CS Education System.

## INTRODUCTION

The changing trends in the Software Industry presents the need to introduce substantial changes in the current teaching patterns. The ever growing competition in this industry calls for real- world experience of the potential workforce. In addition to factual knowledge and skills in the traditional education system, soft skills such as project management, communication and social competencies have turned out to be more imperative. And these skills are given less importance in the domain of Computer Science curricula. Project based learning helps students not learn solely through listening but also through facing up and dealing with the learning contents. It acts as self- organized learning with a purpose to enable the students to work in systematic manner on a concrete task.

The social skills required in today's software industry can be best learnt from team-oriented projects which mainly focuses on the growth of the students, especially the first phase of project development which involves requirement gathering, elicitation, structuring, and representing clients' and users' expectations. Providing only the theoretical knowledge has a setback in this area. Hence, project work is recognized as having many educational and social benefits, in particular providing students with opportunities for active learning.

## RELATED WORK

In the recent years significant amount of research has been done in this field. Project based learning in Computer Science is no new topic to draw researchers interest. Neither the concept of “active learning” from project work is any new. One of the active proponent of “active learning”, W.H. Kilpatrick (a graduate student of John Dewey’s), wrote a treatise in the Teachers College Record in 1918 entitled the Project Method [1]. In this article, he described the project method as “a purposeful activity carried to completion in a natural setting”.

For teachers, project work appears to have a dual purpose within the curriculum [2]. First, it is included to provide an opportunity for students to synthesize the knowledge they have gained elsewhere in the course. Second, it is added “because it mirrors the requirements of Industry.” Project work has always been conceived as a mechanism to enable Active Learning in students.

In 1995, a team-based project for undergraduate engineering students, EPICS (Engineering Projects In Community Service) program was created at Purdue University [3] which aimed to create partnerships between student teams and local community organizations. EPICS tried to include experience with design as a start-to-finish process by defining, designing, building, testing, deploying, and supporting real systems.

More examples in project-based learning in engineering are documented in the “Guide for Problem Based Learning in Engineering” [4] with 12 case studies from the UK. The benefits observed were that students could apply their theoretical knowledge to practical situations, which helped them to better understand the theory and to develop new and powerful skills. According to the evaluation, the motivation of both students and staff was higher [4]. Some of these concepts have also been adopted in Computer Science courses like EPCoS(Effective Project work in Computer Science) in the UK [5] or at the University of Hamburg [6].

A project-based learning approach to teach both programmable logic design and computer architecture has been described as the subject that is taught at the University of Newcastle, Australia. In particular, having been presented with background material on digital logic technologies, programming in a hardware description language, and an introduction to computer architecture students were asked to design their own Instruction Set Architecture and to construct an FPGA design that implements this ISA. The approach was found to be interesting and encouraged self-motivated learning of the material [7].

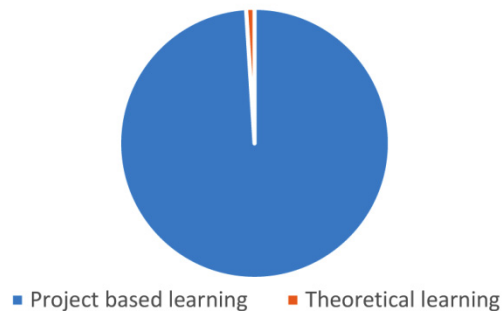
## PROJECT BASED LEARNING IN COMPUTER SCIENCE

Computer Science is one of the most swiftly developing field in area of research. Rapid advancement in technology in this field have encouraged new teaching practices to evolve. Project based learning is nothing but a model that organizes learning around projects. It helps Computer Science students deepen their understanding of concepts while working collaboratively on real- world problems. Projects in CS are complex tasks, based on challenging questions or problems that involve students to work on design, problem-solving, decision making and investigative activities. It gives students the opportunity to work autonomously over extended periods of time that culminate in realistic products or presentations. Moreover, the students feel more engaged while they come across problems that are challenging and relate to real life problems.

General trend of teaching CS to B.Tech students at NIT Hamirpur requires a mandatory project based assignment at two instances:

- (a) Major project to be submitted twice in final year
- (b) Internship project after the completion of third year

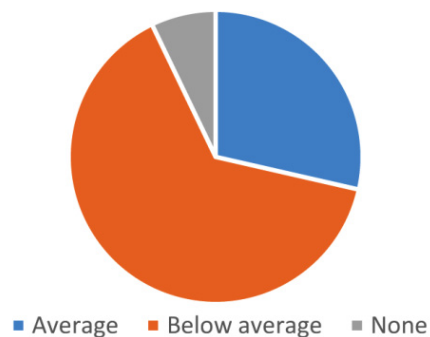
A survey response was collected from the final year students as shown in Figure 1 which indicated that given a choice between theoretical and project based learning, an overwhelming majority of students preferred latter which may be because of the experience of working on such projects which proved out to be more relevant.



**Fig. 1:** Project based learning vs Theoretical Learning

work has always been conceived as a mechanism to enable active learning in students. While the project is being commenced the students face many problems and to solve those problems they look into various possible techniques that could be employed. This approach helps the students to gain a lot of conceptual clarity while the project is going on. It gives an opportunity of active learning while working on the project. It is observed that students learn at each step of the project, every stage is a crucial stage which increases the knowledge of the students and boosts up the morale of the students.

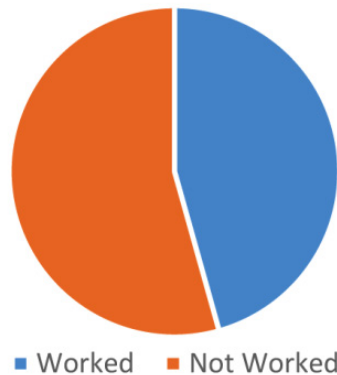
The students who participated in the survey submitted a response which indicated that the students feel that project based learning in the current curriculum could be given a wider coverage than it is being provided at the present as seen in Figure 2. It indicated that learning through project making should be given more importance and be introduced in all the subjects where it may be plausible to do so.



**Fig. 2:** Project based Learning in Present Curriculum

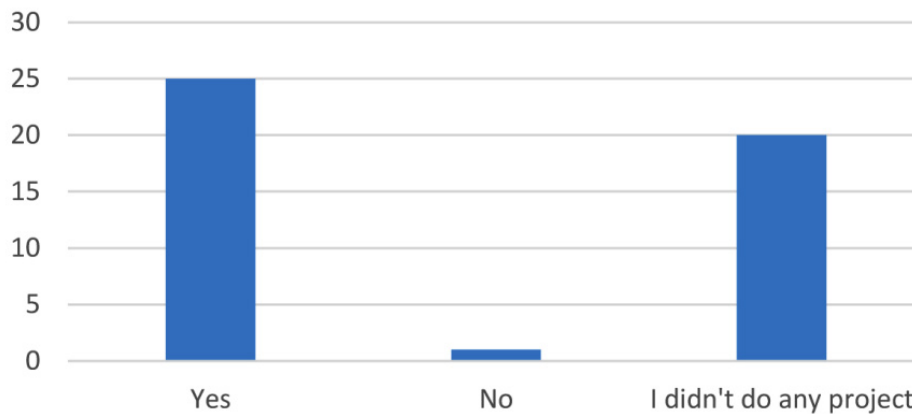
## SURVEY RESULT ANALYSIS

A survey was conducted on a control set of 46 students. They were undergraduate students at the Department of Computer Science and Engineering, NIT Hamirpur. All the students had attended DBMS (Database Management System) Lab as a part of their curriculum but few students worked on a project in the lab while others did the regular exercises. They were asked to fill response to a survey aimed at studying the effectiveness of project based learning and based on a collective study the following inferences were drawn.



**Fig. 3:** No. of Students Who Worked on a Project

The response indicated in Figure 3 pointed that the control set for this survey had participants who had worked on a project as well as those who did not work on a project during the DBMS lab.



**Fig. 4:** Students who Think Project Work Helped Them Gain a Better Understanding of the Subject

It can be clearly seen from Figure 4 that a clear majority of students who worked on a project find this method to be effective in gaining better conceptual clarity and understanding. Project based learning aims to clear the concepts of the students through practical implementation.



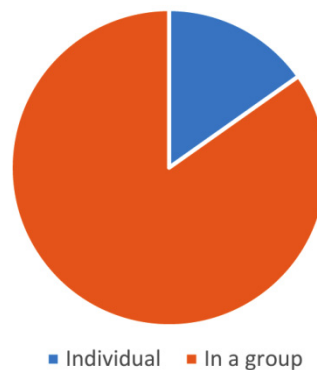
**Fig. 5:** Would Project based Learning have Helped in Clearing the Concept in a Better Way

From Figure 5 it can be concluded that the students find the opinion of working on projects to be helpful.



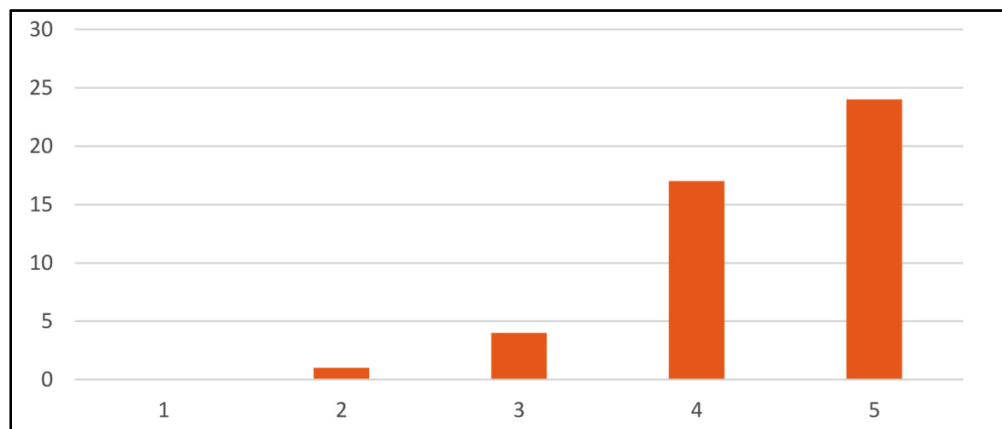
**Fig. 6:** Opinion of Students Regarding Project based Learning

The undergraduates who took part in the survey unanimously agreed that project based approach is a useful method and should not be considered a burden at all as shown in Figure 6. A curriculum that is designed in a manner which focuses more on project based learning might make the students feel inquisitive about learning.



**Fig. 7:** Working Preference

Importance of Collaborative learning can be seen in Figure 7. Though, there are students who prefer to work alone on a project but a clear majority prefers a group task, which helps to develop group dynamics in an individual.



**Fig. 8:** Rating Given to Project based Learning on a Scale of 1-5 based on its Importance

Figure 8 presents the first-hand experience of students who emphasized on the importance of project based learning and are looking forward to see changes in the current curriculum.

## EXPECTATIONS FROM COMPUTER SCIENCE GRADUATES

The organisations today, demand students who possess high order thinking skills and good management skills. Every year many students graduate and have to face a stiff competition in the industry. The IT industry expects the students to have a good knowledge base so that they can justify the very purpose for which they are being hired and hence no prior experience of working on a project would be a major setback to the students. To have a bright career in this field, students must acquire interpersonal communication skills, team skills, and management skills as appropriate to the discipline. With the changing environment for graduates, it is clear that students need both theoretical knowledge as well as practical skills to succeed. Thus it is seen that there is huge demand for high - performance employees who can plan strategically, collaborate and communicate in teams.

Going through the experiences of students on an online portal [internfeel.com](http://internfeel.com) [8], it was observed that a purposeful act of learning can be achieved while working collaboratively, as students are given exposure to real world problems through projects. The project assignments gave them confidence and a viewpoint about how the industry works. They felt that the best way to understand a framework was to work on a project as it was the most efficient way to learn.

## PROPOSED SOLUTION

The present Computer Science curricula at NIT Hamirpur involves a course plan of 36 subjects wherein a decent amount of projects can be assigned to the students to enhance their technical skills. In the current education system, projects are made mandatory in the final year course

only. Though, there is a scope of introduction of projects at an early stage during the second and third year of the degree.

Learning via the means of project making can be introduced in the following subjects in different years of engineering period:

**Table 1:** Subjects in which Projects can be Introduced during Respective Course Years

S. No.	Years of B.Tech	Subjects
1.	Second	Computer Graphics, Operating systems, Computer Architecture
2.	Third	Database Management System, Modelling and Simulation, Compiler Design, Software engineering, Digital Image Processing, Computer Networks
3.	Fourth	Information Security, Artificial Intelligence, Information Retrieval, Data mining, Mobile Computing, Wireless Sensor Networks

The present requirement of IT (Information Technology) sector calls for the need to switch from theoretical learning to a more practical approach. Therefore, the introduction of projects in the subjects shown in the Table 1 above will help students to develop their programming as well as concept understanding skills, which forms the basis of major skills required in today's market. Also, there is a scope for designing the laboratory curriculum which goes hand in hand with the theoretical courses in such a manner that most of the project work is done in the lab itself. The lab assignment plan can be set in a way that it covers almost all the core subject understanding through simple yet effective projects.

Depending on the credibility of the projects, they can be implemented at college level and also at larger scales, this would surely motivate students to cultivate the habit and enjoy the project work as their efforts will be valued later in this way or by the means of extra credits.

In addition, specific project based communities/clubs can be introduced to provide a platform where likeminded people with an idea or solution to any problem could work together. They can exchange experiences, build a powerful network and form teams that work on projects to offer unique structure to compliment traditional learning strategies and spark innovative thinking.

## CONCLUSION

Project based learning has proved out to be of great help to the students. Many a times the ideas suggested by the students turn out to yield some exceptional results. As the competition in the IT industry is rising and becoming more and more stiff, the graduates should be given exposure to project work to help them understand the underlying concepts clearly. This demands the present curriculum of the students to be modified and incorporate more project work. Most teachers and students believe that teaching with project based learning has its own benefits especially in the field of Computer Science. Students after acquiring theoretical knowledge can apply that knowledge and improve their practical skills. They can get involved in team processes and understand the team dynamics while working on the project.

## REFERENCES

- [1] Bonwell, Charles C and Eison, James A Active Learning: Creating Excitement in the Classroom ERIC Digest ED 340272, 1991.
- [2] Page, M Active Learning: Historical and Contemporary Perspectives, unpublished dissertation, University of Massachusetts, 1990.
- [3] L. Jamieson, W. C. Oakes, and E. J. Coyle, "Epics: Serving the community through engineering design projects," in Learning to Serve: Promoting Civil Society Through Service Learning , L. A. K. Simon, M. Kenny, K. Brabeck, and R. M. Lerner, Eds. Norwell, MA: Kluwer Academic Publishers, 2001.
- [4] PBLE, A Guide to Learning Engineering Through Projects . Nottingham: University of Nottingham, 2003.
- [5] P.K. Linos, S. Herman, and J. Lally, "Service-learning program for computer science and software engineering," in Innovation and Technology In Computer Science Education, ITiCSE Conference, Thessaloniki, 2003.
- [6] M. Janneck and W.-G. Bleek, "Project-based learning with commsy," in Conference on Computer Supported Cooperative Learning, Boulder, CO, 2002.
- [7] Christopher M. Kellett, "A Project-Based Learning Approach to Programmable Logic Design and Computer Architecture," in Education, IEEE Transactions on (Volume 55, Issue: 3), 2012 [8] InternFeel, <http://internfeel.com/>, 2015.

## Prikshit Tekta

*B.Tech Undergraduate, National Institute of Technology, Hamipur, Himachal Pradesh*



**Prikshit Tekta** is a final year B.Tech undergraduate at National Institute of Technology, Hamirpur, H.P. in Computer Science and Engineering Department. He was born in Shimla, Himachal Pradesh in 1994. After completing his schooling from D.A.V. Public School, New Shimla, he was lucky enough to score a good rank in All India Engineering Entrance Exam and managed to secure a seat at NIT Hamirpur in 2012. In the beginning itself, he realized his dexterity in programming and was inclined towards Computer Science education. With keen interest in programming and learning new technologies he is familiar with most of the present technological trends and also has good hands on various programming languages like C, C++, javaScript and PHP which helped him to achieve the post of WEB HEAD in college, responsible for designing and maintaining the college fest websites. Prikshit Tekta is also the Head Training and Placement Representative of 2012-2016 batch of NIT Hamirpur. Apart from the academics, he is fond of the Himachali folk dance, NAATI and has also performed the same on various occasions in college. Inspired from his father who is a Principal in Govt. School, he also wants to pursue a career as an academician and intends to be more technologically strong in the future.