

## Problem Based Learning in Engineering at the Institute of Engineering: Prospects cum Challenges

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**Abstract:** Despite having undergone significant transformations over the last few decades, educational institutes of Nepal are prone to using traditional teaching methods to most extent. This is particularly true of Tribhuvan University. Nevertheless there are all the same few renowned institutes of Tribhuvan University which are not merely open to educational innovations but have strong predisposition to respond positively to the augmenting demand of time vis-à-vis adoption of new educational approaches cum strategies. Institute of Engineering (IOE) is one among them. Albeit Problem Based Learning (PBL) Approach is apparently a new approach in Nepal's engineering educational scenario, IOE has brought similar approach to bear upon its educational practices in some courses. However, IOE has yet to design fully fledged student-centric problem based curricula over time, considering the efficacy and efficiency of Project based approach in enhancing professional skills, technical expertise and profound understanding of students.

This paper aims at delineating on the prospects cum challenges regarding the implementation of PBL approach in engineering programs at the IOE. However, the foremost section of the paper will briefly scrutinize the overall structure and situation of education in Nepal. The second section of the paper will comprehensively outline the educational system and courses offered at the IOE from the scratch.

The most important of all, third section will focus upon the prospects and relevancy of introducing PBL component in engineering courses at the IOE. This section will simultaneously deal with potential impediments or constraints to be encountered during the process of implementing PBL approach.

The final section of the paper will attempt to elicit a cogent conclusion with viable solutions and tentative plan to implement PBL approach effectively at the IOE against the backdrop of varied constraints.

**Key words:** *faculties*, prospects, impediments, affiliated, constituent

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### 1. Introduction

Albeit the establishment of the first school i.e., Durbar High School in 1853 marked the initiation of the tradition of modern and practical education in Nepal, education was not accessible to general public till 1950. It was only after the culmination of autocratic Rana family regime and the establishment of democracy in 1950, schooling for the general public began. Although the beginning of the Post 1950s saw comparative increment in educational institutions (most important of all, establishment of Tribhuvan University which gave a new impetus to the development of higher education in Nepal) and increase in students' enrollment and literacy rate, many schools had however, very few properly trained teachers along with highly rigid, outdated and irrelevant curricula. Realizing the inadequacy and irrelevancy of Nepal's educational system to fit into the growing demand of the economic and social development efforts of the country, the then government of Nepal started converting some secondary schools into vocational multi-purpose high schools. A more radical solution in the form of National Education System Plan (NESP) was proposed by the government in 1970, in order to establish a uniform system of

education throughout the country. The new plan took concrete steps towards establishment of a Curriculum Development Center and fund allocation for continuous revision and development of curriculum. It characterized a significant departure from traditional approach of education system vis-à-vis structure and contents of traditional education system.

Howbeit, NESP did face severe resource constraints on account of absence of practical assessment of the country's resource situation. Because of public pressure, government adopted a more "liberal policy" of privatization of education. This led to augmentation of private schools basically in the areas favored by physical infrastructures. Curriculum was highly influenced by United States models, and it was developed with assistance from the United Nations Educational, Scientific, and Cultural Organization.

There has been a rapid expansion in higher education over the last few decades especially following the restoration of democracy in 1990. Despite having introduced promising plans and undergone vast amount of changes, Nepal's educational system, in an entirety, is suffused with many problems and challenges in terms of educational management, quality improvement, access of all to education, relevance and efficiency of educational methods etc. It has become an imperative for institutions to incorporate holistic transformation in terms of use of instructive techniques in order to enhance students' ability to think creatively and investigate. Quality Assurance and Accreditation system has been regarded a sine qua non to foster quality education in Nepal. Realizing the importance of QAA, UGC Nepal, has initiated the development of the system in the country. It has been considered a very important aspect of Secondary Higher Education Project (SHEP), a national project being implemented by UGC with the support of the International Development Association (IDA) (UGC, 2008).

### **1.1 Structure of Education in Nepal**

Education in Nepal is basically structured into school education and higher education, where school education entails primary level of grades 1-5, lower secondary level of grades 6-8 and secondary level of grades 9-10. A national level School Leaving Certificate (SLC) Examination is conducted at the end of grade 10. Higher Secondary level includes Grades 11 and 12. Higher Secondary Schools run under the supervision of Higher Secondary Education Board (HSEB). Such secondary schools are privately owned. However such grades are also run under the university system in the form of proficiency certificate level.

Higher education includes bachelor, masters and Ph. D levels albeit programs like M. Phil. and post graduate diploma are also offered by some universities. Bachelor level may be of 3-5 years duration in accordance with the stream or subject. The duration of master's level is generally of two years.

There are six universities in the country at present. In addition to this, B.P Koirala Institute of Health Science (BPKIHS) and Medical Science National Academy (MSNA) are also in the process to be considered as university in the country. There are at present 87 constituent campuses and 697 affiliated campuses under the umbrella of Universities.

### **1.2 Tribhuvan University**

Tribhuvan University (TU), the oldest and the largest and a pioneering institution of higher education in Nepal was founded in 1959 as a non-profit autonomous institution under the financial aegis of the government of Nepal. On account of significant role played by the university in imparting higher education and fostering national development, TU has been entitled as a national institute of higher education. With the largest enrollment of students

(282,711 students about 90% of total higher education in the country), TU has extended its network of constituent and affiliated campuses nationwide. With the viewpoint to producing high level manpower for the nation’s overall development, Tribhuvan University's constituent and affiliated campuses have been offering higher education in variegated disciplines. The state owned university has expanded its programs in different disciplines during its 50 years long academic journey. There are at present 60 constituent campuses and 561 affiliated campuses under Tribhuvan University covering all over the country.

**2. Institute of Engineering**

Albeit establishment of Engineering School in 1942 redounded to the beginning of engineering education in Nepal, it however offered mere trade and civil sub-overseer courses within Public Works Department of Nepal Government. In fact Engineering programs did not gain much social recognition until 1959. It was only with the start up of the 2 year overseer course in 1954, the establishment of the Technical Training Institute now known as Thapathali Campus in 1965 and the relocation of the Engineering section in Pulchowk and the renaming of the section to Nepal Engineering Institute in 1967, did engineering programs begin to get social limelight and the present IOE begin to take shape (Mathe, 1996).

Despite having offered post school engineering courses in the country since 1954, it was only after 1972, that the educational institutions offering engineering courses were brought under a single umbrella viz. the Institute of Engineering of Tribhuvan University following the implementation of NESP, which aimed at bringing about uniformity in education system throughout the country. Since then the Institute of Engineering has expanded its programs cum faculties considerably. The courses being offered at the IOE are given in Table 1.

Year	Name of Institution	Course duration	Course offered
1942	Technical Training School	1 year	Civil Trade course(Sub-overseer)
1954	Technical Training School	2 years	Diploma in Civil Engineering (First batch pass out in 1059)
1972	Tribhuvan University(TU), Institute of Engineering(IOE)	2 years	Certificate in Civil, Mechanical and Electrical Engineering.
1978	TU, IOE, Pulchowk Campus	4 years	Bachelor of Civil Engineering
1994 onwards	TU, IOE, Pulchowk Campus	4 years	Bachelor in Civil/Mechanical/ Electrical/Architecture/ Electronics/Agriculture/Industrial Engineering
1996 onwards	TU, IOE, Pulchowk Campus	2 Years	M. Sc. In Urban Planning,, M. Sc. In Structural/Environmental/Power System/Geotechnical/Water Resources/Renewable/Information and Communication Engineering
2002 onwards	TU, IOE, Pulchowk Campus		Ph. D. Programs

Table 1. The courses offered at IOE

Source: IOE, Information Book, 2009

## 2.1 Enrollment of Students at Constituent and Affiliated Campuses

Starting with few students' enrollment in 1942 in sub-overseer course, today students' enrollment has reached to 960 in diploma level, 578 in Bachelor and 136 in Master level, totaling 1674 annual enrollment in constituent campuses besides 1666 in affiliated colleges. Total 5512 students are studying at Pulchowk, Thapathali, WRC, and ERC campuses, and 6664 at 8 affiliated colleges.

## 2.2 Research Works at the Institute of Engineering:

- Ongoing PhD program, which started from 2002, is being supported by NUFU Norway for 12 candidates. Out of 12 candidates 5 of them have already received PhD and 3 of them are in the final stage of completion while the remaining ones have targeted to complete it within December 2009. For this project, fund amounted to 5.5 million NOK.
- Trans-Himalayan University Network for Education and Research (THUNDER) is a collaborative program for academic capacity building through research at Tibet University and Tribhuvan University. The agreement was ratified by NTNU Norway and the IOE, TU on March 25, 2008. The total amount to be spent by THUNDER Nepal is NOK 1.15 million for Doctoral degree research for the 5 IOE faculties at the IOE, TU.
- Solar Radiation and Aerosol in Himalayan Region-for study of Nepal and Tibet region has established 4 stations in each country. 3 faculties from Nepal are involved in research in Ph.D. Cost of the Project is 60 million NOK.

## 2.3 Students Admission Criteria and Fee Structure

Admission is based on merit on entrance exam result. In regular category, applicants have the choice to select the subjects as per their interest and scores whereas full fee paying students will have to compete with their own category. Regular and full fee students get admission entirely on merit basis within their own category. 10% of the total seats are allocated for girls where competition is held between mere girls on merit basis. Some seats are reserved for disadvantaged group of remote areas.

Full fee students of Civil, Mechanical, Electrical, Architecture, and Agriculture pay tuition fee NRs. 29,790.00 (US\$396.14) per semester, and, Electronics and Computer pay NRs. 33,540.00(US\$ 446.01) per semester whereas regular students only pay NRs. 1,706.00 (US\$ 22.69) per semester as has been depicted in table 2. But, TU affiliated private engineering colleges have tuition fee of about NRs 50,000.00 (US\$ 664.89) per semester in an average.

Program	Tuition fee per semester			
	Regular	Full fee	Sponsored	Foreign Students
Diploma level	NRs.1,193.00	NRs.10,970.00		NRs. 20,665.00
Bachelor level	NRs.1,706.00	NRs.29,790.00		NRs.45,565.00
M. Sc. level	NRs. 11,500.00	NRs.37,000.00	NRs.85,000.00	NRs.85,000.00

(Exchange Rate NRs. 75.20= US\$1.00 as of date November 8, 2009).

Table 2. Fee structure at the IOE Source: IOE, Information Book, 2009

## **2.4 Support of Different International Agencies**

To begin with, 2 years diploma course was offered in 1959 with the support of Indian Cooperation Mission which helped run courses as well as develop faculties and design curriculum. Later 2 years course was upgraded to 3 years course. In 1970, the ILO/ITU/UNDP contributed towards the development of faculties training and infrastructure. With the help of Asian Development Bank and ODA, UK, the Eastern Region Campus began operating in Dharan in 1984. With the help of World Bank and UNDP/ILO the Western Region Campus began operating in Pokhara in 1987. 4 years bachelor course was started with the help of World Bank, ODA UK in 1978. Four more bachelor programs viz. 4-years bachelor level courses in Electrical, Electronics, and Mechanical Engineering and 5 years bachelor level course in Architecture were started in 1995 with the support of World Bank, Swiss Development Corporation (SDC) and Canadian International Development Agency (CIDA). Later, Master level courses were offered with financial help from Norwegian University of Science and Technology, NTNU. PhD program supported by NUFU Norway for 12 candidates started from 2002 and will be completed at the end of 2009.

## **2.5 Sources of financial Support**

Education budget of Nepal government has ranged around 13% to 17% of the total budget during the study period of 2000 to 2009. In fiscal year 2007/08 and 2008/09, education budget allocated for higher education accounted to 1.7% and 1.64% of the total budget respectively (Source: GON, MOF, Red Book 2008/09). Tribhuvan University is the state funded institution and receives 89% of the total higher education budget for 90% of the total students' enrollment for higher education. The other new universities do not have obligation to provide free education for common people. 56% of the IOE's total budget covers grant form the Government through TU and 44% from its own internal income generation sources. Income from full fee covered 43% and 37 of the total budget in 2007/08 and 2008/09 respectively. Fee from regular students accounts to about 2% of the IOE budget. IOE has to give attention on the other sources of income as well viz. research consultancy, continuing education etc for income generation.

## **2.6 Education System**

Following the adoption of new education system in 1972 throughout Nepal, semester system was applied along with continuous evaluation of student through number of assignments and quizzes; division of marks were 20% for continuous evaluation and 80% for final exam and in practical/lab/workshop 100% marks were given to internal evaluation. Teachers were responsible for all the evaluation system and campuses were responsible for conducting final exams and evaluation. Nevertheless due to disparity in marking system from teacher to teacher and campus to campus, Tribhuvan University had to change the existing system by centralizing exams. But in the case of IOE, it has received autonomy to conduct exams. Hereby, the IOE is continuing the same system adopting more effective ways of teaching and learning, inviting experts from different organizations. In most of the courses, practical and theory are separate but course work and evaluation are done by the team of instructors. Practical and theory go simultaneously. Depending upon availability of lab equipment, volume of work and cost of lab expenses, students have to work individually or in a team of 4 to 5 members. Pedagogical method incorporated by the IOE can be summarized as follows:

Lecture 75%		Practical 20%		Project 5%	
Internal assessment 20%	Final exam 80%	Continuous evaluation 80% (in average)	Final examination and or oral 20% ( in average)	Continuous evaluation 67% (in average)	Final viva 33%( in average)
				Evaluation is done in group and individual basis.	Specialists are invited for evaluation

Table 3. Pedagogical method at the IOE, TU in B.E. (civil).

### 3. Problem-Based Learning Approach at The Institute Of Engineering

Problem-based learning is an approach to learning where the curricula are designed with the problem scenarios as central to student learning in each component of the laboratories support the inquiry process rather than transmitted subject-based knowledge (Savin-Badan, 2007).

#### 3.1 Prospects of PBL Implementation

Problem-based learning viz. “process of learning by doing” can be a significant impetus in engineering education in Nepal. Although PBL approach happens to be an outright new concept in the field of engineering education in Nepal, nonetheless similar approaches have been incorporated by the Institute of Engineering in the form of project works. Besides on account of its flexibility vis-à-vis openness to innovations, IOE can be the best place for implementing PBL approach. Some of the strong grounds supporting the possibility of fruitful implementation of PBL at the IOE are as follows.

##### 3.1.1 Students’ Inclination toward Project Works

Realizing the importance of project in fostering the employability of graduates, at least one project has to be done compulsorily by every student at the end of the year in bachelor level courses in all faculties of engineering. Upon completion of all the courses till fourth year, part one; students are given choices to select projects of their interest in a group of 3 to 4 members. They bring all the theories and lab work experiences previously achieved to bear upon their projects.

Although project is compulsory for all the faculty students in the final year, however, Civil Engineering students have to undertake two projects during their course period. Students are provided with the choices to opt from within the given array of topics. Basically, in Nepal’s context, there are many projects coming up, ranging from the small projects to large projects. Besides, the civil graduates have to perform independently in remote areas of the country where they have to carry out feasibility study, design and construction in variegated areas viz. construction of community building, rural water supply scheme, small hill irrigation system, village roads, trial bridges etc. These civil graduates are trained in such a way that they are highly capable enough to pursue their projects independently. However, in civil engineering survey projects, students do not even have the choices of forming their groups to their will. Instructors work as mere facilitators. Students finally get to learn many things from the project. Some of the benefits acquired by the students from the project can be mentioned as follows.

- In-depth understanding of the subject;
- Acquiring of working experience in a group;
- Build-up of decision making capacity;
- Knowledge on project implementation procedure;
- Development of leadership capacity.

During the period of 2003, an opinion survey was conducted among the students. Students were asked whether or not project works are helpful in developing their confidence and their better understanding of projects, 51 out of 65 responded “strongly yes”, 13 said “yes” whereas only a student reacted negatively. With regard to question whether or not project works are essential for their course, 52 out of 65 responded ‘strongly yes’, 11 said ‘yes’ and mere one student gave a negative response. Students highly felt that they get to learn much from projects comparatively to other traditional methods. They were also enthusiastic to work and learn in the group project. Willingness of students to undertake projects however can be a strong ground for them to react positively towards the implementation of PBL components in their educational courses.

### **3.1.2 Faculty strength at the IOE:**

Faculties of the IOE are experienced and have exposure to international educational experience. Most of the faculties have received degrees and pedagogical training from abroad. At present altogether 585 faculties are working at the four constituent campuses for 5312 students in total. Teacher student ratio is 1:9 in an average. This ratio can help obviate skepticism regarding inadequacy of manpower for the implementation of PBL at the IOE.

Constituent Campus	Total Teachers	Total Students
Eastern Region Campus	99	720
Thapathali Campus	106	1056
Western Region Campus	109	1680
Pulchowk Campus	271	1856
Total	585	5312
Teacher student ratio	1:9	

Table 4: Teacher student ratio at the IOE

Source: Dean’s office, Institute of Engineering.

### **3.1.3 Training on PBL**

Faculties from the IOE are not yet trained in PBL system. Erasmus Mundus External Cooperation Window 2009 – project will be commenced from December 2009 in different categories of Master, PhD, Post doc and faculty training. This program will establish sound relation with Aalborg University, Denmark and other partner universities. The students/participants involved in this mobility will experience Aalborg model of PBL. In fact, this project will open avenues to implement PBL at the IOE to most extent.



### **3.2. Constraints in PBL Implementation**

At present, many engineering institutions in different countries all over the world are either in the process of, or, have successfully implemented PBL approach of varied models or the ilk in their educational system. Notwithstanding its successes, however, PBL continues to find itself under pressure as the higher education sector reacts to external interventions in enrollment policies, funding, cost control and quality assurance (Cowdroy et.al, 2007). Even the Institute of Engineering may encounter several constraints during the process of implementation of PBL approach. Some potential impediments can be synopsized as follows.

Difficulties may arise in convincing faculties prone to embracing traditional methods of teaching and learning for a long time.

Lack of trained personnel, having deeper insight of PBL approach, may stand as a major constraint to PBL module implementation. Teacher training including staff development programs have to be provided before formally introducing PBL module in curriculum.

Moreover, in PBL approach, projects are developed in small groups of students each requiring physical spaces where teams convene and work out plans, practice presentation etc. More spaces are required to offer projects to large number of teams. Nevertheless most of the class rooms of the IOE campuses are built for a group of 48 students. Existing classrooms may not be adequate to undertake projects for increasing number of groups.

Students' profile can be another constraint for successful implementation of PBL approach. Students at the IOE are of two types viz. regular students, who have attained high scores in entrance exam and full fee paying students, who have scored less in entrance exam. On account of heterogeneity in students' ability, problems may arise in terms of group formation. In addition, "students' autonomy and lack of preparation" as mentioned by Oliveira (2007), can add more fuel to the problem.

Institutional approval (Subject Committee, Faculty Board and T.U. Council) is an imperative to introduce as well as implement a new system into an existing system.

Finally, financial constraint can impede smooth operation of PBL approach at the Institute of Engineering. Existing project works assigned to students of IOE involve extra cost, comprising teachers' remuneration and students' stationery expenses. Total cost of project works covers 50% of teachers' honorarium and 50% of students' expenses. All these expenses have to be borne by the campus itself. Cost borne by the campus per student amounts to about Rs. 10,000.00. IOE may confront with financial constraint in implementing PBL model that are exorbitant in terms of cost.

### **Conclusion**

Notwithstanding several constraints in the implementation of PBL approach at the IOE, these constraints can be overcome however, making PBL approach a promising model to the development of students' personal and professional capabilities. Viable solutions and tentative plan to implement PBL approach effectively at the IOE against the backdrop of varied constraints can be summarized as follows.

- Cost-effective or the least expensive PBL model can be introduced to engineering courses at the IOE if viable, or else, the IOE should go for cost sharing approach with students and Tribhuvan University. In the long run, to make PBL approach successful, tuition fee will be increased for more than 50% regular students whose fee contribution is absolutely negligible hitherto (see table 2). Besides income generating research activities and projects will be fostered for sustainable PBL implementation at the IOE.
- Faculties and management staffs should be allowed exposure to different models of PBL approach and faculty development. Most important of all, operation of Erasmus Mundus External Cooperation Window 2009, in collaboration with Aalborg University, Denmark, will provide opportunity for altogether 25 faculties and students of Nepal in obtaining comprehensive knowledge cum practice on PBL approach obviating the constraint of lack of trained personnel.
- Workshops and meetings can be organized to delineate upon benefits of PBL approach, paving way for the institutional approval and the attitudinal changes toward teaching and learning among faculty members, teachers and students.
- With regard to PBL implementation plan, few faculties will be given exposure to PBL, to begin with. PBL will be gradually introduced to curricula of varied disciplines starting with one subject in each discipline. Following the introduction of PBL in engineering courses, continuous evaluation will be carried out. Since marking system at the IOE is completely different from conventional TU marking system, marking system will adhere to the prescribed format of the IOE which comes to close proximity to PBL system. Ultimately, considering the results of PBL system, PBL approach will be expanded to more subjects in variegated disciplines.

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