Best Practices Review and Conceptualisation of a 'PBL SA Schema'

For undergraduate technical education in South Asian Universities

South Asia

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Preface

Education is a fundamental human right (European Convention for the Protection of Human Rights and Fundamental Freedoms, Article 2 of Protocol 1, 1950; Constitution of India, Article 21-A, 1950, amended 2002, 2009) and is a cornerstone for sustainable development and provision of foundational schooling and quality education is a strong agenda for 'Agenda 2030'. However, it is only through higher education that the knowledge and skill required for socio-economic development, through job creation, better governance, increased entrepreneurship and overall civic responsibility, can be inculcated.

Formal educational institutions akin to modern universities, such as those in Nalanda (modern day Bihar, India) founded in 5th Century BC, and Takshashila (modern day Taxila, Pakistan) dated to 10th Century BC, flourished in the Indian sub-continent, however, they did not survive either due to natural calamities or foreign invasions. In the traditional 'gurukul' system of the Vedic era, the 'guru' or teacher-mentor directed the 'shishya' or students through two modes of learning; 'shruti', i.e. sound or oration, i.e., instructional teaching and discussion, and 'smriti', i.e., memory or recall, for contemplation, self-reflection and critical thinking on open-ended problems. Socio-political unrest and economic plundering, eventually led to the marginalisation and eventual replacement of these indigenous pedagogical traditions and institutions with formal, English education.

Though efforts to retain traditional teaching approaches were made by Nobel Laureate, Rabindranath Tagore, who founded the Vishva-Bharti University in 1921, it focussed on learning and research in non-technical areas. Thereby, leaving a gap in the contextualised learning of technical – engineering and management - studies in the region. And though the three South Asian partner nations – India, Nepal and Bhutan, largely share a common history, they do not share a convergent nor comparable standard for higher education.

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Executive Summary

In line with the goals defined by the Erasmus+ PBL South Asia project, this document titled, 'Best practices review & conceptualisation of a PBL schema', for under graduate technical education in South Asian universities, is a report on the vision of the project to imbibe sustainable development through capacity-building in higher education and a reflection on the preparation (Work Package 1), towards strengthening problem-based learning in South Asian universities.

This report entails:

- An understanding of the current scenario of technical education in South Asia, in contrast to the global goals, national policies and institutional capabilities.
- A literature review on Problem-based learning pedagogy, its best practices and an analysis of the same with respect to its suitability for South Asian context. As a result, the novel methodological approach is proposed, ' PBL SA Schema', to inculcate PBL through 'design thinking', so as to allow contextualising the learning experience to the region by identifying relevant and local real-world problems – a distinction from existing PBL practice.
- A description of application of the contexually conceptualised 'PBL SA schema' as preparation for the development and further dissemination of the project, through two events in India;
    - 2-week Workshop at IITB, Mumbai - to inculcate PBL, through experience of conducting case studies, to inexperienced faculty of Nepal and Bhutan, supported by students from all the other institutions and mentored by experienced faculty from India and Europe
    - 1-week Curriculum Design Workshop at IISc, Bangalore – to imbibe PBL elements in the design of the courses for development and implementation in Nepal and Bhutan by faculty

Composed as a booklet, this report is a handy collation of both theory, critique, contextual conceptualisation and application of the best practices, alogn with the promising results of the same. The intent behind this format is to enable academics, administrators, practioners and partners to catch a quick glimpse of the project's impact in the region and its future potential.

Higher Education in South Asia

1.1. Global Goals and National Policies

The ten members of the PBL South Asia consortium hail from countries that have committed to achieve UN Resolution 70/1, that outlines seventeen sustainable development goals (SDGs) by the year 2030. With these goals in view, the EU and the South Asian partner nations have educational process, declarations and policies aimed at improving the quality of higher education and in turn, build social capital through this Erasmus + funded project.

1.1.1 Sustainable Development Goals : Focus areas for Capacity-building

The need to strive towards sustainable development was recognized and felt in the early 1980's, which led to various worldwide attempts to define and develop action plans and guidelines. 'Our Common Future', also known as the Brundtland Report, from the United Nations World Commission on Environment and Development (WCED,1987), defined Sustainable Development as the development that meets the need of the present without compromising the ability of the future generation to meet their own needs". In 2011, the idea of SDGs (Sustainable Development goals) was proposed at a preparation event for the United Nations Conference on Sustainable Development (UNCSD), also known as Rio+20, to be held the following year. At the event, a resolution known as "The Future We Want" was reached, which paved the way towards the development of the 2030 Development Agenda titled "Transforming our world: the 2030 Agenda for Sustainable Development", set by the United Nations General Assembly and adopted by 193 member states in 2015. The Agenda outlines the 17 global goals that act as a 'blueprint' to guide development plans with169 targets and 232 approved indicators to measure the compliance and progress towards them. Sustainable Development Goal, SDG 4, stresses on "inclusive and equitable quality education and promote lifelong learning opportunities for all" (UNDP, 2017) with 'Education for sustainable development' (ESD) explicitly recognized as part of Target 4.7. SDG 8 seeks to promote "sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all" (UNDP, 2018), while SDG 11 emphasizes the importance to support "positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning" (UNDP, 2018).Thus, these goals lend a holistic picture of the effort required for capacity building in the youth and highlights the focus areas that need attention, i.e., quality education, lifelong learning, sustained and inclusive employment, and societal involvement and impact.

1.2 Education in Europe : Bologna Declaration and

The European Union and its states identified the common challenges in the EU with respect to "growth and diversification of higher education, the employability of graduates, the shortage of skills in key areas, the expansion of private and transnational education", from which stemmed the Bologna process (http://www.eees.es/pdf/bolognaEUA.pdf). As a result, the Joint Declaration of the European Ministers of Education, popularly called the 'Bologna Declaration', convened in 1999, with the intent to reform the higher education systems across 29 member states of the European Union. It aimed to create convergence while respecting the autonomy and diversity of the signatory countries, their governments and universities. The declaration outlines objectives that promote employability, mobility for pursuing study, training, etc., and cooperation in quality assurance, through strategies such as, common system of credits and degrees, wide recognition of degrees to allow ease of pursuing higher education in other countries, and development of comparable criteria and methodologies. It also stresses on the importance of higher education and research systems adapting to "changing

needs, society's demands and advances in scientific knowledge".

The EU and EACEA, through programmes such as Eramsus+, recognizes the need to implement "European policy agenda for growth, jobs, equity and social inclusion" (Erasmus+ Programme Guide, 2020) to support people in not only acquiring skills beneficial for the labour market and economy, but also for actively contributing to society and achieving individual goals. It seeks to "efficiently use the potential of Europe's talent and social assets in a lifelong learning perspective", and enhance the opportunities for "cooperation and mobility" between countries (Programme and Partner) to create a symbiotic synergy between the European and emerging economies.

1.3 Education in South Asia : Policies & Accreditation

India

The European university system was introduced to India by the Jesuits in 1542, with the establishment of Saint Paul's College in Goa. The 1813 renewal of East India Company's charter carried a duty to educate the population, which eventually led to the English Education Act 1835 by Thomas Macaulay, thereby establishing English as not only the administrative language as well as the primary medium of instruction, but strongly condemning traditional education as inadequate for imparting utilitarian skills and "useful" learning.

> Support people in not only acquiring skills beneficial for the labour market and economy, but also for actively contributing to society and achieving individual goals. (Erasmus+ Programme Guide, 2020)

The Capacity Building in the field of higher education (CBHE) action aims to support the modernisation, accessibility and internationalisation of higher education in the Partner Countries. With respect to priorities identified by the "European Higher Education in the World" Communication (2013), which are as follows:

i. Promoting international mobility of students and staff, with transparency and recognition of learning acquired

ii. Promoting internationalisation at home and digital learning, such that those unable to be part of the mobility can acquired the required skills and benefit from digital and ICT education such as Open Educational Resources (EOR), Open Course Ware (OCW) and Multi Open Online Courses (MOOC).

iii. Strengthening strategic partnership, cooperation and capacity building, such that emerging economies may leverage the high standards of European education to develop and promote affordable and inclusive innovation to tackle their societal challenges and in turn, promote market access, trade and investment for European companies.

In the following decades, large number of institutions with Western curriculum and English as medium arose and trained English-speaking Indians were deputed as teachers, while affluent families sent their children to receive higher degrees in the UK. The first engineering college of India, Thomason College (Now IIT Roorkee) was founded in 1847 and had only civil engineering. This was followed by Bengal Engineering College (now Indian Institute of Engineering, Science and Technology, IIEST). The first Universities were set up in 1857 in the three major cosmopolitan hubs of the country namely, the University of Bombay, University of Calcutta and the University of Madras, followed by universities across most states of unified India, which included, University of Punjab in Lahore (present Pakistan), University of Dhaka (present Bangladesh) as well as Rangoon University (present Myanmar).

With growing nationalistic vigor, the need to promote technical education and scientific research in the nation lead to the conception of a Research Institute of Science for India by philanthropist, Jamsetji Tata. He garnered support from the likes of Swami Vivekanda, the king of Mysore and convinced the British Government to support the establishment of the Indian Institute of Science (IISc), Bangalore in 1909. In suite,

caption of the photograph

the Banaras Hindu University (BHU), Varanasi was established in 1916 by Pandit Madan Mohan Malaviya, a scholar and reformer, with co-support from educationist, Annie Besant, and the king of Kashi, and till date remains the largest residential university in Asia.

In independent India, the National Education Policy was first framed in 1986 and a most recent version, termed as NEP 2020, has been put into effect from July 2020. The committee was ably chaired by Padma Vibhushan, Dr. Kasturirangan, the former Chairman of ISRO (Indian Space Research Organisation) and ex-Member of Parliament. Propped on the pillars of Quality, Innovation and Research, the NEP prioritises access, affordability, equity, quality and accountability and emphasises experiential learning. Under Higher Education (DNEP, Part II, pg.201-338), the policy focusses on institutional quality, restructuring and consolidation as a whole while supporting its various stakeholders, such as the students, faculty and institutional governing bodies. It outlines the need for imbibing liberal education and creating 'Optimum learning environments' for students which entails ; Innovative and responsive curriculum and pedagogy, Student support for learning and development, Open and distance learning for life-long learning and Internationalisation of higher education. It also aims to support faculty through improved engagement and capacity - building strategies, establishment of teacher education within multi-disciplinary institutes, as well as empower the governance through effective leadership development. It also highlights the need of transforming the regulatory system under a unified regime of standards and accreditation.

The Department of Higher Education (DHE), under the auspices of Ministry of Human Resource and Development (MHRD), is responsible for the basic infrastructure – both policy and planning – for higher education. It adopted a National Institutional Ranking Framework (NIRF) in Sept 2015, to rank institutions of higher education in India based on a methodology that broadly covers the following parameters - Teaching, Learning and Resources; Research and Professional Practices; Graduation Outcomes; Outreach and Inclusivity; and Perception (www.nirfindia.org).

The MHRD also has several statutory bodies for recognising, accreditation, and quality and

standard maintenance, for institutes of higher education across the country under its purview, as follows:

University Grants Commission (UGC)

Set up by an Act of Parliament, the UGC Act, in 1956 under MHRD, is a statutory organization of the Government of India for the "coordination, determination and maintenance of standards of teaching, examination and research in university education" (www.ugc.ac.in). It conducts the National Eligibility Test (NET) for appointments of teachers in colleges and universities along with CSIR (Central Scientific Research Institute). As on 1st Feb 2020, there are 50 Central Universities, 409 State Universities, 349 Private Universities and 127 Deemed to be Universities (https://www.ugc.ac.in/oldpdf/Consolidated%20list%20of%20All%20Universities.pdf).

All India Council for Technical Education (AICTE)

It is a national-level council for technical education under DHE,MHRD established in November 1945 as an Apex Advisory board. It is responsible for development, planning and accreditation of technical and management programs ; conducts national level entrance examination called CMAT (Common Management Admission Test). It has several quality initiatives, such as; revision of curriculum, examination reforms, training of technical teachers, mandatory internship and industry-readiness, start-up and innovation focus, etc (www.aicte-india.org).

Association of Indian Universities (AIU)

Established in 1925, the AIU is an association of major universities that looks into the recognition of Degrees (3 years under-graduate in Sciences, Commerce, Education, Arts and Humanitites, i.e., BSc, BCom, B.Ed, BA; 4 years in Engineering, Technology and Management, i.e., BE, BTech, BBA; 5 years for Medicine and Architecture, i.e.,MBBS and BArch; 2 years Post-graduate in any of the earlier mentioned domains, i.e., MSc, MCom, M.Ed, MA, ME, MTech, MBA, MD, MArch; and 5 years for PhD) and Diplomas (mostly 3yrs in duration with required qualification as Secondary exam or 10th Grade pass) offered by universities recognised under UGC and equivalence of the standards and credits of foreign universities in relation to India, to evaluate admissions in India for higher education. Its key objectives are to act as a bureau of information to facilitate communication through newsletter, publications, etc. and to behave as a liaison between universities and government (www.aiu.ac.in).

National Assessment and Accreditation Council (NAAC)

It is an autonomous body established by the UGC to assess and accredit institutions of higher education in the country. It ensues assessment of an institute if it seeks Institutional Eligibility for Quality Assessment (IEQA), either at university, college or departmental level, following which seven weighted criteria - Curricular aspects, Teaching-learning and evaluation, Research, Consultancy and extension, Infrastructure and learning resources, Student support and progression, Governance and leadership and Innovative practices - are assessed (www.naac.gov.in).

National Board of Accreditation (NBA)

NBA, India was initially established by the AICTE under section 10(u) of AICTE Act, in the year 1994, to assess the qualitative competence of the programs offered by educational institution from diploma level to post-graduate level in engineering and technology, management, pharmacy, architecture and related disciplines, which are approved by AICTE. However, in 2013, it was made an independent body with the amendment of The Memorandum of Association and Rules of NBA. It conducts evaluation of programs of technical institutes on the basis of, but not limited to; institutional missions and objectives, organization and governance, infrastructure facilities, quality of teaching and learning, curriculum design and review, support services, such as, library, laboratory, instrumentation, computer facilities, etc. and any other aspect as decided by the General Council and / or Executive Committee of NBA (www.nbaind.org)

National Council for Teacher Education (NCTE)

It is a statutory body of Indian government set up under the National Council for Teacher Education Act in 1995 to formally oversee standards, procedures and processes in the Indian education system. It was first conceptualised as a part of the National Policy on Education (NPE), 1986 and was later established in 1973 with its Secretariat in the Department of Teacher Education of the National Council of Educational Research and

Training (NCERT). The main objective of the NCTE is to achieve planned and coordinated development of the teacher education system throughout the country, the regulation and proper maintenance of Norms and Standards in the teacher education system and for matters connected therewith (www.ncte.gov.in).

India

In addition, there are several domain-specific societies, associations and councils, such as: FTII (Film and Television Institute of India, registered under Societies' Registration Act of 1860), AIMA (All India Management Association), MCI (Medical Council of India), etc., that look into the quality of education and practice of these fields in India.

India is the third largest higher education system in the world, next only to China and the USA. Its socio-cultural, environmental and economic diversity permeates across the nation with college density (i.e., the number of colleges per lakh eligible population in the age-group of 18-23 years) varying from 7 (in Bihar) to 53 (in Karnataka) across states. The all India Gross Enrolment Ratio (GER) is around 26.3% with 48.6% being females (AISHE, 2018-19). In spite of 78% colleges running in Private sector; aided and unaided taken together, it caters to only 66.4% of the total enrolment. For the year 2018-19, more than 47,000 foreign students were enrolled in India of which students from Nepal constituted the highest, of about 26.88% of the total, followed by, Bhutan (3.82%) at fifth place.

In India, emphasis of tertiary education lies in the areas of STEM with 13.5% undergraduates in Engineering and Technology, while students opted more for Management stream at post-graduate level. For PhD, however, maximum enrolments were in Science stream but only 2.5% colleges run doctoral programs, of which 21.6% are supported by Institute of National Importance, such as, Indian Institute of Science(IISc), the Indian Institutes of Technology (IITs), Indian Institute of Engineering Science and Technology (IIEST), National Institutes of Technology (NITs), Indian Institute of Science Education and Research (IISERs), University of Delhi (DU), Indian Institutes of Management (IIMs), University of Calcutta (1857), University of Madras (1857), University of Mumbai (1857) and Jawaharlal Nehru University (1969). With 0.6-0.7% of the nation's GDP committed towards research, several initiatives such as GIAN (Global Initiative for Academics Network), HEFA (Higher Education Financing Agency), EQUIP (Education Quality Upgradation and Inclusion Programme, 2019-2024), RISE (Revitalising Infrastructure and Systems in Education (by 2022) and UGC's LOCF (Learning Outcome-based Curriculum Framework) are in motion to support these institutions. But there exists stark disparity between these and the regional, state and private institutions, in terms of quantity and quality of resources and infrastructure. Therefore, India's foremost challenge in higher education is the equitable dissemination of available knowledge and holistic development of resources and infrastructure across the nation.

Nepal

Nepal's higher education system was influenced by then British India. The history of higher education in Nepal dates back to 1918 with the establishment of Tri-Chandra College (its name in the beginning was "Chandra Intermediate College" established by then ruler Chandra Samsher) in Kathmandu, affiliated to Calcutta University, India, in the beginning and later to Patna University, India. Education as a whole was not easily accessible and meant for the general people under the rule of Rana dynasty (1846 AD to 1951 AD) in Nepal. The environment became more favourable for higher education with the overthrow of Rana regime in 1951. The Ministry of Education, Science, and Technology was established in 1951 for the overall development of education in the country. It is responsible for formulating educational policies and plans, and managing and implementing them across the country through the institutions under it.

Looking briefly at the status of Higher Education, it comprises of a 4-year Bachelor's degree, 2-year Master's degree, one and a half-year M.Phil degree and 3-5 years of Doctor of Philosophy (Ph.D.). There are altogether 11 Universities and 6 Academy as Deemed University. Tribhuvan University (TU), the first university of Nepal, was established in 1959. TU was the only university of the country providing higher education for a considerable period after its establishment. Other constituent and affiliated colleges in different fields of study were established under TU in different parts of the country in this period. Nepal Sanskrit University, the second university of Nepal, aimed at study of Sanskrit language and

indigenous humanities subjects was established in 1986 at Dang. In 1991, Kathmandu University (KU) was established as the first private university of Nepal; and was followed by several other universities across the seven provinces of the country, with the intention to decentralise and provincially spread equitable educational opportunities. namely; Purbanchal University (1993), Pokhara University (1997), Lumbini Buddhist University (2005), Mid-Western University (2010) , Far-Western University (2010), Agriculture and Forestry University (2010), Open University (2016) and Rajarshi Janak University, Janakpur (2017). Nevertheless, TU has been the oldest and largest university in Nepal.

The Ministry of Education (MoE),Nepal, as the apex body of all educational organizations in Nepal, is responsible for overall development of education in the country. The Prime Minister is the Chancellor of all the universities in Nepal. Similarly, the Education Minister is Pro-Chancellor of all the universities. The Chancellor appoints a Vice-Chancellor for each university. Moreover, there is a Registrar, Deans and so on in each university for its functioning.

application of an umbrella Act. The major highlights of the new policy in higher education in 2019, prepared, approved and published by MoE, Government of Nepal are as follows:

• Ensure equitable education and promote life-long learning opportunities for all, under SDG4 Education 2030: "ensure inclusive and equitable quality education and promote life-long learning opportunities for all",
• Introduction of "Quality Assurance and Accreditation System" (QAAS) & credit transfer system.
• Promoting Science, Technology, Engineering and Mathematics (STEM) education system.
• Curriculum revision, improving teaching/learning methods, maximize the use of Information and Communication Technology (ICT) in teaching/learning processes.
• Universities to be managed at province level.
• A major focus to "Research and Development".
• Student exchange programs with other universities around the globe.
• Social service through "National Development Service" to all the graduates.
• Make Nepal a hub of eastern philosophy, civilization and culture.

The first engineering college of India, Thomason College, now become IIT Roorkee, was founded in 1847.
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There are 96 constituent and 1,180 affiliated colleges under nine universities and four health science institutes providing higher education in Nepal. According to MoE, 118 educational programs are also being run after obtaining affiliation from different foreign universities. In 2019, the Government of Nepal unveiled the much anticipated National Education Policy, drafted by the MoE to reform Higher Education in Nepal (www.moe.gov.np). Apart from this, Nepal has also launched a National Science, Technology and Innovation Policy and a Digital Nepal Platform, as discussed by Joint Secretary of MoE, Deepak Sharma at the PBL SA Dissemination Seminar, 27th Dec 2019, held at Kathmandu, Nepal.

This Education Policy aims to make higher education more accessible, competitive, effective, qualitative, research-oriented and well-managed, the document says, adding that the policy will also support the effective management and

• Strengthen "National Qualification System" as student support system.

In addition to the MoE, the primary governing and accreditation body in the higher education system of Nepal is the University Grant Commission (UGC) while several accreditation council bodies exist who regulate the activities of educational institutions for the accomplishment of the objective of higher education policy, such as:

National Center for Education Development (NCED)

NCED was established in 1993 under the Ministry of Education (MOE), as an apex body for human resource development. Since then, the center is undertaking activities related to teacher development, capacity development of educational personnel under the Ministry of Education and conduction of research activities in education.

The Council for Educational Human Resource Development, headed by the Minister of Education, provides policy guidelines to NCED (http://www.nced.gov.np/index.php?option=Home) .

University Grants Commission (UGC)

The University Grants Commission was established after the implementation of the multi-university concept in Nepal. The UGC Act was approved by the Parliament on BS 2050 Mangsir 7, and it came into functioning during BS 2051. UGC is responsible for the allocation and disbursement of grants to the universities and their campuses, regulating their activities and formulating policies and programs on the establishment of new universities. Apart from that, it also develops coordination among universities, makes necessary arrangement on the exchange of scholarships, fellowships, etc between the universities and educational institutions within or outside Nepal, formulates necessary policies and programs for the maintenance of standards of higher education, and takes appropriate steps for the promotion and maintenance of standards of higher education in Nepal. (http://ugcnepal.edu.np/). It was launched the Quality Assurance and Accreditation (QAA) program, as an important aspect of reform in higher education in Nepal. Accordingly, a "Quality Assurance and Accreditation Committee" (QAAC) has been formed for the development and implementation of QAA activities in higher education in Nepal. The QAA Division in UGC has been established to facilitate QAAC and to perform regular activities related to QAA. Apart from QAA division, there are other specific divisions that are working to fulfill the objectives of the UGC (http://www.ugcnepal.edu.np/).

Nepal Engineering Council (NEC)

Nepal Engineering Council was formed under the Nepal Engineering Council Act, 2055 promulgated by His Majesty the King on B.S. 2055/11/27 (11th March 1999 A.D.). As per the Act, NEC has been vested with the statutory authority for the planning, coordinated development and monitoring of the engineering profession and education in the country. The objective of the Nepal Engineering Council is to make the engineering profession effective by mobilizing it in a more systematic and scientific and also to register the engineers as per their qualifications. Its main duties and responsibilities are; to prepare policies, plans, and programs for the smooth functioning of the engineering profession and to execute them, to grant permission and approval to carry

out engineering education to those engineering colleges and institutions that meet the required norms and standards and to honor their degrees and certificates, to monitor and inspect the quality of engineering education provided by the engineering colleges and institutions, etc. (https://nec.gov.np/)

Apart from these organizations, there are other councils for different technical and non-technical education fields. For instance, Nepal Medical Council for medical education, Nepal Nursing Council for maintaining quality nursing education, Nepal Pharmacy Council to make the pharmacy profession effective through systematic and scientific operation, Nepal Bar Council to promote, protect and regulate the activities of law practitioners, and Council for Technical Education and Vocational Training (CTEVT) to develop a competent workforce for national and international market needs.

The political instability and frequent changes of government in the country during the 1990's, hampered the higher education in the country and the sector became highly politicized, with students' unions and teachers' unions affiliated to various political parties in the universities and their constituent and affiliated colleges. This has been a hurdle in the overall development of education sector in Nepal. The earthquake of 2015 also caused severe impediments to the development of the nation. Thus, in spite of Nepal's focus on increasing people's access to the education and creating a standard compatible to international level, in recent decade the number of Nepali students seeking higher education abroad has grown seven folds with over 300,000 students seeking permission to go abroad (Nepal Education, Science and Technology Ministry and Foreign Education Department, 2019). This number excludes the students who study in nations that do not require visa, such as, India and Bangladesh. Higher education remains a system based on conventional class-room lecture delivery and students' assessment through three-hour written examinations. Inspite of identified policies and objectives promoting skill development, self-learning through visits and internships, and modifications in course content, the extent of implementation and success of the same in Nepal's higher education system is unclear. Experts from Institute of Engineers (IoE), Tribhuvan University, outlined the evident gap existing between lectures and group work and highlights the need to facilitate tutorial session, practice reflection on the task or project and promote asking questions at the PBL SA Dissemination Workshop, 27th Dec 2019. Therefore, adequate teacher training, student exposure and supporting resources and infrastructure – both physical and managerial – are key challenges for higher education in Nepal. Therefore, adequate teacher training, student exposure and supporting resources and infrastructure – both physical and managerial – are key challenges for higher education in Nepal.

Bhutan

As per the Constitution of the Kingdom of Bhutan, Article 9, Clause 15 requires the State to provide education to improve and increase the knowledge, values and skills of the entire population for a more holistic development of the human personality. While Clause 16 states that the 'The State shall provide free education to all children of school going age up to tenth standard and ensure that technical and professional education is made generally available and that higher education is equally accessible to all on the basis of merit.' The rapidly changing socio-economic development, both at home and abroad, more than ever before demand further growth and expansion of a sound tertiary education system in the country (Tertiary Education Policy of the Kingdom of Bhutan, 2010).

The National Education Policy (2019) of Bhutan acknowledges that monastic education has served the social, economic and spiritual needs of the country for centuries. It was the main form of education, prior to the introduction of modern English education in Bhutan in 1961. Monastic education contributed towards several areas beyond religion, such as, language, art, literature, philosophy and was viewed as a means to attain liberation and transcendental wisdom. Around 1914, the first King of Bhutan, Gongsar Ugyen Wangchuck, who was a great patron of education, institutionalised monastic education in the Dzongs (fortress temples) under various Je Khenpos or dharmaraj, and in separate shedras ("place of teaching"). His Highness also sent a group of 46 students to attain modern education in India and became the key torch bearers for higher education in Bhutan. In the following year, two schools were started, one each in Bumthang and Haa, and the close comradery remained with

several teachers from India teaching in Bhutan while several students continued to receive education in India. Modern education in a more systematic approach began with the first five year development plan (1961-1966) which led to the adoption of English as the language of instruction, being changed from Hindi. The first technical institute in the country, Don Bosco Technical School was established at Rinchending (Kharbandi) in Phuentsholing, under Chukha Dzongkhag on 1st May 1965, which was later renamed as Kharbandi Technical School and finally as the Royal Technical Institute.

rate to 80% and establish a system of continuing lifelong education opportunity. Further, two broad policies for strengthening education in Bhutan are National Education policy (2019) and Tertiary Education Policy(2017). Various Tertiary Education Policy(2017). Various colleges were later established throughout the country, and these eventually led to the establishment of the Royal University of Bhutan in 2003, with universities and colleges offering courses within the guidelines of the Bhutan Qualifications Framework (BQF).

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Education in Bhutan experienced yet another landmark change with the infusion of Gross National Happiness (GNH) values and principles in schools, enacted by the Constitution of Bhutan in July 2008 as a national goal.

A new project called 'Educating for GNH' was launched. The following is its vision and mission statement - "The Principle and values of Gross National Happiness will be deeply embedded in the consciousness of Bhutanese youth and citizens. They will see clearly the interconnected nature of reality and understand the full benefits and costs of their actions. They will not be trapped by the lure of materialism and will care deeply for others and for the natural world" (Educating for GNH workshop, 2009). To this end, all schools have started giving special attention to inculcate principles and values including *"critical and creative thinking, ecology literacy, practice of the country's profound ancient wisdom and culture, contemplative learning, a holistic understanding of the world, genuine care for nature and others to deal effectively with the modern world, preparation for right livelihood and informed civic engagement"* (Education for GNH workshop, 2009).

The department of education drafted the country's first education policy and curriculum policy in 1976. Two of the Education Policy Objectives for the 9th Plan (2002-2007) were: to develop a higher education system under the umbrella of a national university, and increase the literacy

The Department of Adult and Higher Education (DAHE) of the Ministry of Education in Bhutan has the mandate to oversee all aspects of tertiary education, non-formal education and adult education in Bhutan, while the following bodies oversee and ensure the upkeep of the quality of tertiary education in Bhutan.

Tertiary Education Board (TEB)

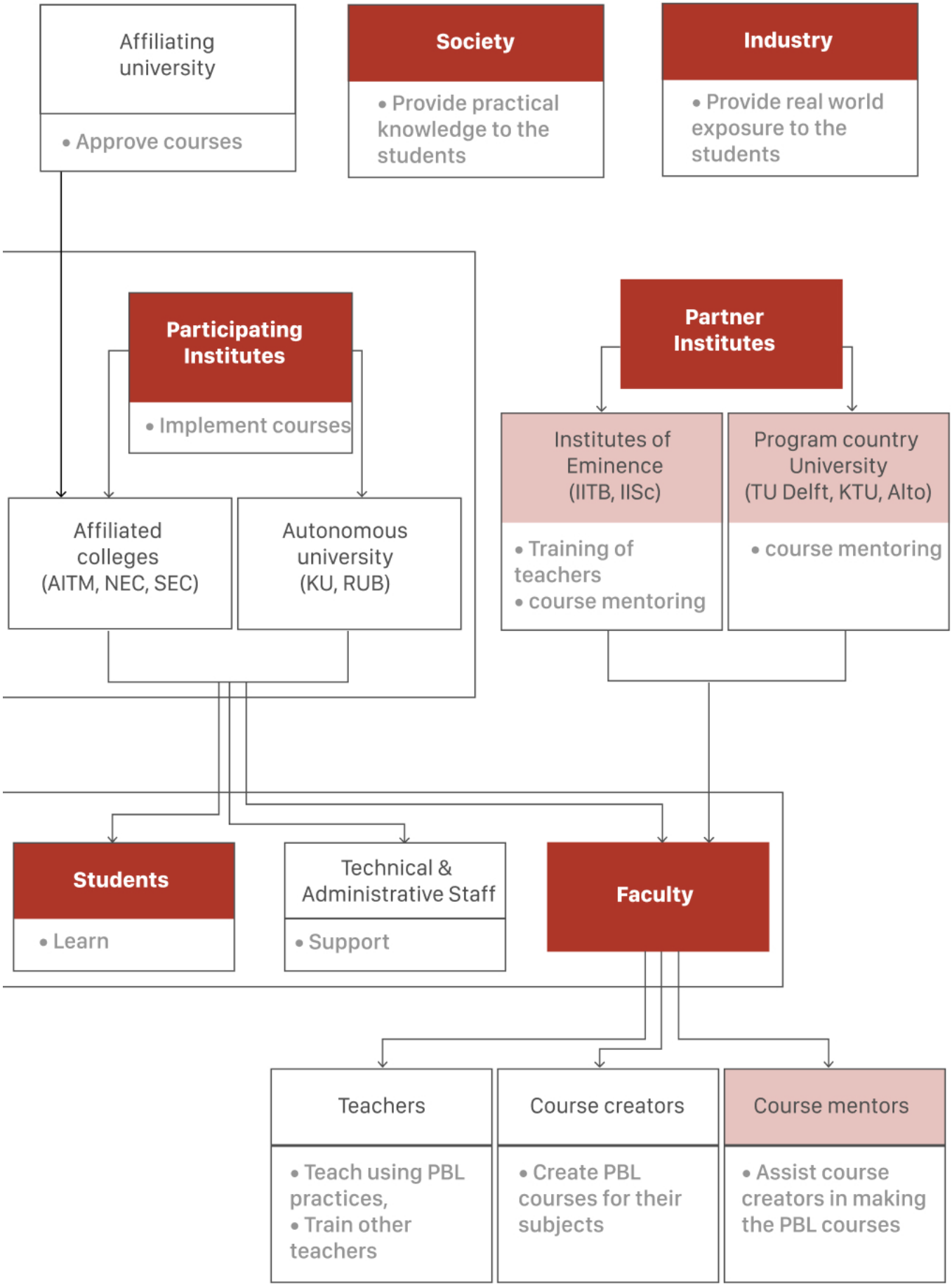
The TEB is the highest executive decision-making body in terms of managing Tertiary Education System in the country through planning and funding, quality assurance, and registration and licensing of both public and private Tertiary Education Institutions. The Board is established via an Executive Order issued by His Excellency the Prime Minister based on the Tertiary Education Policy of the Kingdom of Bhutan 2010. The Hon'ble Minister for Education chairs the Board. The Department of Adult and Higher Education serves as the Secretariat to the Board.

Bhutan Accreditation Council (BAC)

The BAC is the agency for establishing the broad criteria that governs admissions, the granting of degrees, and the educational standards for all tertiary educational institutions in Bhutan, and for monitoring adherence to those criteria. It is responsible for the granting, renewal or withdrawal of accreditation of all tertiary education institutions in Bhutan based upon their adherence to the criteria established for that purpose. In addition, the BAC also has the responsibility for monitoring the development and main-

tenance of those specific aspects of tertiary education institutions that it considers vital to tertiary education's objective (such as libraries, information systems, the feeding and housing of students), and shall include its evaluation of these components in its evaluation for purposes of accreditation. The Bhutan Qualifications Framework (BQF) was established by the BAC to facilitate among others, the comparison of programmes and transfer of credits.

The most unique feature of the National education policy of Bhutan is the strive to balance modern and traditional values in education. The unified governance and structure for all technical education under the RUB, along with the national strategy to promote innovations and manpower development towards GNH, is a major positive. However, like Nepal, curriculum changes and faculty proficiency, and akin to India, need for developing resource and infrastructure are the major challenges in higher education in Bhutan.


Affiliating university
• Approve courses
Society
• Provide practical knowledge to the students
Industry
• Provide real world exposure to the students
Participating Institutes
• Implement courses
Partner Institutes
Affiliated colleges (AITM, NEC, SEC)
Autonomous university (KU, RUB)
Institutes of Eminence (IITB, IISc)
• Training of teachers
• course mentoring
Program country University (TU Delft, KTU, Alto)
• course mentoring
Students
• Learn
Technical & Administrative Staff
• Support
Faculty
Teachers
• Teach using PBL practices,
• Train other teachers
Course creators
• Create PBL courses for their subjects
Course mentors
• Assist course creators in making the PBL courses

Summary of the chapter

The Bologna declaration states that, "successful learning and studying in higher education should involve students in deep learning". To meet international standards of quality education, recognised degrees and collaborative research, the South Asian partners not only require capacity building of human resources, i.e., faculty, staff and students, but also require long-term, self-sustainable infrastructure to support continuous development of high quality educational content and strategies.

'Strengthening Problem-based learning in South Asian Universities' is an endeavour to address these pressing concerns of education quality, employability and overall sustainable development of the region, through the introduction of problem-based learning (PBL) approach which is known to foster deep learning capabilities.


पद्मविहार अतिथी गृह
Padmavihar Guest House
NO PARKING

Current Undergraduate Education

Engineering is a popular course of study for many students across the world. With the emergence of new fields of engineering, more specialized training in very niche fields are the order of the day. Conversely, these new fields of engineering promote "inter-disciplinary" fields of study where the students are applying concepts of core engineering to a wide array of problems. Engineering education is usually a four year affair at the undergraduate level leading to a degree in any of the specializations (e.g. Computer Science, Electrical, Electronics Mechanical, Civil) or a combination of specializations as prescribed by particular universities. Universities also usually offer a masters level specialization degree in specialized areas of the core engineering areas as well. These graduate studies range from one to two years. The terminal degree in the areas usually leads to a PhD which are focussed on very specific topics in a specialized area.
This pattern is more or less common across the world. The challenges involved in the engineering education and pedagogy are multi-fold and they tend to revolve around the value addition imparted to the students as a result of undergoing the training.

Conventional engineering curriculum and teaching approach is saturated with too much amount of information and yet less relevant with industrial practice and a lifetime of learning as it fails to foster real-world/ professional problem-solving skills in the students. In conventional classroom scenario, problems are pre-defined, well-structured and encountered at the end of chapter after reading text or hearing the lectures; communication happens one way (i.e. from teacher to students, lack of interactive environment); mostly assignments problems are asked to solve individually, and assessment questions evaluate retention ability of students rather then transfer. Mills and Treagust (2003) enlisted the common yet critical issues in traditional engineering education, as summarized below:

Programs:
- Content driven instead of need-driven
- Do not provide sufficient design experiences to students.

Students:
- Lack of communication skills and teamwork experience
- Lack of awareness about social, environmental, economic and legal issues

Faculty:
- Lack of practical experience (not able to adequately relate theory to practice or provide design experiences)
- Having outdated teaching and learning strategies

As a result, students fail to apply or integrate knowledge in real world problem solving. Conventional methods of teaching and assessment in engineering universities inhibit the development of important skills like problem-solving, critical thinking, creativity, collaboration and communication. Different reports have identified the above-mentioned skills as important skills required in the future workforce. Because traditional teaching techniques has failed to develop the skills required by industry into the students, it has raised needs from industry people to make existing education more effective and efficient.

2.1. Global scenario (as per literature) – issues faced

Curricula in engineering across the world aim to develop students into excellent engineers who apply the principles of science to everyday world. The objectives mainly involve the imparting of fundamental theories and principles involved in a particular stream of engineering. At an undergraduate level, the primary focus is significantly on developing the acumen related to analytical ability and exposure to various theories related to the engineering stream. Such an approach usually translates to an emphasis on assessment of students based on their understanding of the fundamental principles.

The problems of students not being employable at the end of the course is a major concern, as highlighted by various forums. Add to it, the issues of rote learning, insufficient exposure to real-life problems, the development of soft-skills and the unawareness of sustainabilit contexts is prevalent in South Asia as well.

The engineering education over time has evolved predominantly into a teach and learn method where the significant principles are explained in a class room. Such learning is usually a "broadcast-subscribe" model. The students register for a course and the teacher decides on what to be taught in the class. Such structured classes and curriculum are important for uniform evaluation and assessment of students. However, such models have inherent limitations. First, such mode of learning tend to expose students to only well-structured problems. That is the contours of the problems are usually given with a number of assumptions to simplify the problem for class study and the students are expected to use a principle (typically involving application of a formula/ algorithm/ method) to solve a given problem.

Second, the existing approaches tend to focus on the solution of certain given problems/challenges rather than formulation of such problems. Third, the courses usually focus on individual learning rather than the learning in team. Finally, such courses are usually quite insulated from the vagaries involved in the real-life problem definitions. Such limitations have led to some pertinent problems in engineering education.

There is question of the readiness of the engineering graduates to the absorbed by the industry. The questions on the skills developed during the undergraduate/graduate courses in terms of their use and utilization in the industry remains. The industry feels that sometimes the technical prowess and competency required are not really reflected by the grades in their respective courses. Reasons could be faulty assessment methods based on rote learning rather than application among many other reasons. The curriculum also do not provide sufficient exposure for the students to understand the gravity and scope of real-life application of the technical principles involved.

A case in point is the technical design courses across the world where the focus is more on the methods involved understanding the response of a system given some loading conditions. Though this is an essential skill, it does not complete the picture. The loadings are usually given to students where the students role comes into picture to translate such loads to responses. However, the students are not usually exposed to ways to determine the loading conditions and loads in the first place.

Another important limitation is the focus on individual learning in curriculum which unneces-

sarily lays a huge weight on individual brilliance rather than teamwork. Many problems in the real world involve teams to solve them. Such skills like communication, team behaviour etc. are usually lacking in the students.

Lastly, the students are seldom exposed to larger context. The engineering education is usually restricted to technical aspects and the larger social, environmental, economic and legal issues are usually ignored from the curriculum.

Such limitations usually makes the engineering education incomplete. Further, the courses overtime leaned more towards theory rather than hands-on do and learn and thus rendering an inadequacy in terms of practical application and pragmatic skills required by engineers in solving a problem in general. The courses have become focussed and usually missed out on embedding the problems in real-life contexts to give meaning to the principles and appreciate the uncertainties and complexities involved in modelling the physical world into engineering models.

2.2. Local (South Asian) scenario

The South Asian nations have imbibed engineering education very seriously. There are a number of engineering colleges/universities in the countries which impart world class engineering training and education to aspiring students in various streams of engineering.

The countries of India, Nepal and Bhutan have a very similar institutional context when it comes to engineering education. The engineering education and curriculum development is usually overseen by a national level body on technical education (e.g. All India Council for Technical Education – AICTE in India; Nepal Engineering Council - NEC). The engineering courses are offered on university campuses or in affiliated colleges. While the independent university campuses enjoy a relatively greater freedom in designing and execution of curriculum for engineering courses (based on broad guidelines from the national bodies), the affiliated colleges are constrained to use the syllabus prescribed by the university to which they are affiliated. Further, the evaluation schemes vary differently between deemed universities.

The university based engineering courses have greater flexibility in assessment schemes, whereas the affiliated colleges are more restricted to follow the guidelines for the universities.

The engineering assessment is usually done by a common exam across all affiliated colleges within a university. Thus, the teaching in colleges are geared up in preparing the students for these common examinations. The limitations discussed in global context are applicable to the South Asian engineering education as well. The problems of students not being employable at the end of the course is a major concern, as highlighted by various forums. Add to it, the issues of rote learning, insufficient exposure to real-life problems, the development of soft-skills and the unawareness of sustainabilit contexts is prevalent in South Asia as well. Further, the focus on examination and grades rather than learning is a major concern for this part of the world. This is compounded by the fact that in countries like India, the majority of employers for engineering graduates are in IT and services sector across various streams of engineering, thus leading to the questions among students the usefulness of core engineering courses as compared to industry ready courses.

The employability of students is a huge concern. This has led to a phenomenon in the industry where the companies recruit the graduates based on their general aptitude and technical competency rather than industry ready hard and soft skills. This shows the lack of confidence of the industry in direct deployment of students in the industry without making them ready in such prolonged training exercises.

2.3. Strengthening Problem-based learning: Partner Needs & Goals

Survey from faculty across the partner HEIs of Nepal and Bhutan highlights that the students lack skills needed to be industry ready due to insufficient practical experience and mitigation capabilities, lack of collaboration and good communication skills and unawareness of larger socio-economic contexts. Hence, they face difficulty in getting employed after graduation and if placed, then struggle during their employment.

In contrast, faculty have little or no exposure and training in non-conventional teaching methodologies, such as PBL, that are practised elsewhere and have been found capable of meeting these afore mentioned shortcomings. Problem-based Learning (PBL) is a pedagogical approach that is established as a means to mitigate these above-mentioned shortcomings and develop the necessary skills that fosters life-long, deep learning capabilities.

The survey revealed that the undergraduate curricula across South Asian universities are predominantly instructional and not adequately hands-on due several constraints, such as:

- University directed lesson plans with heavy syllabi to cover and restricted time for practical activities,
- Dearth of motivation in students to self-learn and innovate during the stipulated practical hours within a course,
- Poor critical-thinking ability due to a general lack of awareness on sustainable development goals and their local implications in the students,
- Less number of co-instructors to guide in practical, real-world issues that can be addressed in courses
- Fewer collaborations in programs/courses
- Poor communication skills

Therefore, inadequate number of trained personnel with proficiency to develop and implement non-conventional PBL courses; lack of resources and infrastructure for operationalising non-conventional teaching frameworks, such as PBL, that suits the local context and enable students at par with international standards, as well as disseminating the same for building regional capacity, and insufficient regional support to further develop capacity, summarises the existing needs in the South Asian higher education at large.

The South Asian partner HEIs of this project hail from different levels of administrative autonomy and academic affiliations, each having their own sets of capabilities and constraints. Kathmandu University, Nepal, a deemed university, and Jigme Namgyel Engineering College (JNEC), a college under RUB that amply supports internationalisation of curricula and teaching, are fairly independent for development and implementation of PBL courses and receiving recognition for the same. In contrast, public university affiliated colleges such as Nepal Engineering College (NEC), Nepal, affiliated to Pokhara University, and

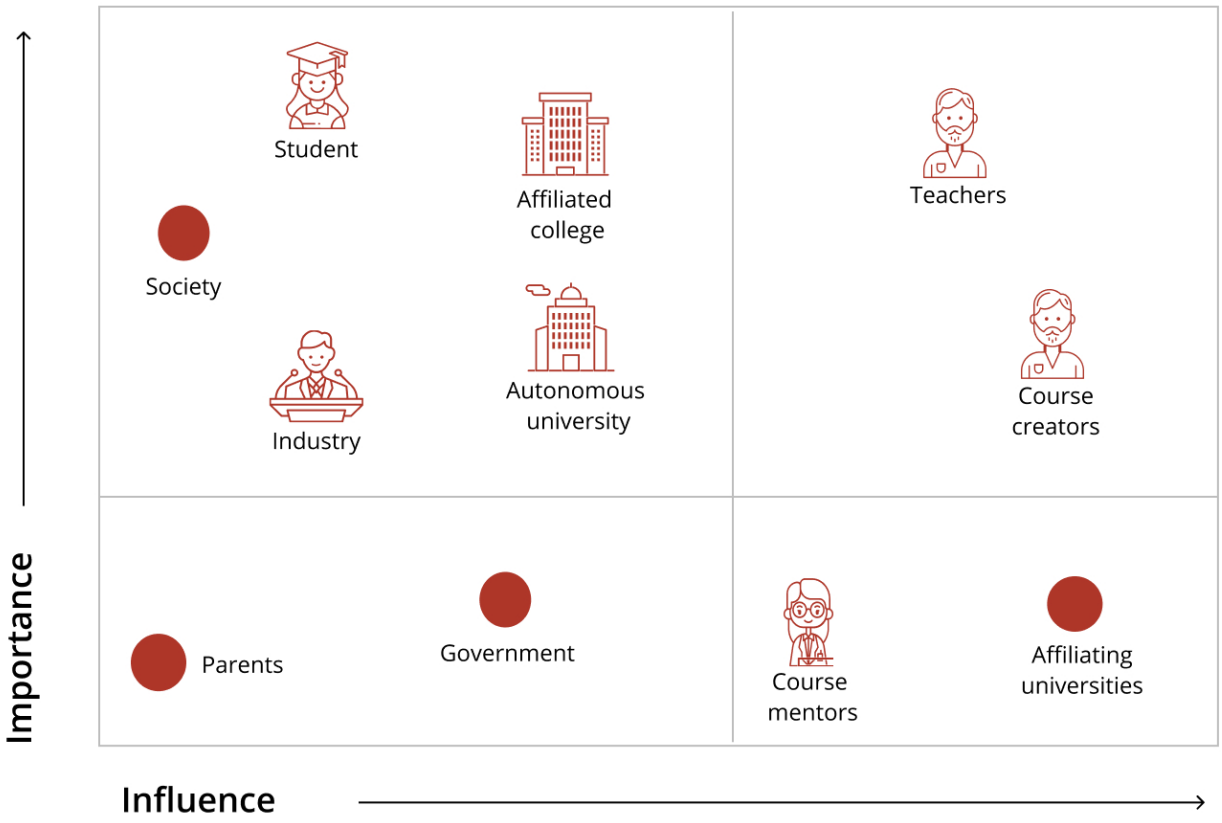
Sagarmatha Engineering College (SEC), Nepal, affiliated to Tribhuvan University, though capable of introducing electives and implementing changes in teaching methodology of existing course, require approval from their affiliating university to implement course content changes. The college of Asian Institute of Technology & Management (AITM), is presently undergoing change of affiliation to university and hence, are not in a position to implement or seek recognition in the engineering streams. However, it has an undergraduate program in International Tourism and Hotel Management, in collaboration with International Management Institute (IMI), Switzerland, under which the Enterprise Development Project (EDP) course is an ideal testing ground for PBL teaching and for capacity building of faculty of other streams. All these partners lack trained faculty and require infrastructural support.

The Indian partner HEIs, namely, Indian Institute of Science (IISc), Bangalore and Indian Institute of Technology Bombay (IITB), Mumbai, are both Institutes of Eminence (IoE) recognised by the MHRD, holding the top positions under the NIRF rankings and in the QS World Rankings.

The pedagogical culture across theses Institutes reflects the inculcation of PBL across courses and programmes, with experience of up to 25years in PBL practice in domains of design and engineering. However, many of these courses are tailored for post-graduate and above level students, with a focussed number of highly motivated students. These courses are largely conceptualised and driven independently by expert-faculty, therefore difficult to replicate or easily disseminate.

These institutes are deemed universities, thereby functioning in autonomy which, on one hand, makes in very flexible and open to imbibing changes to courses, curricula and teaching methods, on the other hand, poses the difficulty of disseminating the same across other institutes in the country which are mostly affiliated colleges and not autonomous. And since, these institutes are government funded with studentship offered on merit or scholarship basis, the availability of infrastructure, equipment and other resources – lab space, equipment, materials and support staff - are strained across multiple disciplines and courses.

Thus, these institutes lack adequate infrastructure and physical resources, while the country and region lack a network to leverage on the experiences of these institutes.



Student Case presentations, IITB, Mumbai

Summary of the chapter

Upon consideration of the number of students undergoing technical education annually in South Asia, the number of PBL expert-educators are few; resources and infrastructure to support training, teaching, practice and dissemination of PBL are low; and the advent of collaboration and networking is inadequate.

Therefore, the project goal is defined to empower the students and faculty of the South Asian partner universities through PBL courses (or curricula) designed : to motivate students towards self-learning and industry-readiness; to support faculty in teaching, organising and conducting PBL courses/ projects; to establish network of PBL educators, practitioners and partners for building regional capability, but most importantly, to leverage the regional expertise and competencies of fellow Partner institutes who have well established PBL methodologies and courses, to re-design for the needs of the region.

NEEDS	INSIGHTS
• Implementable solutions which dont need major change in structure • Bridge the gap between academics and industries. • Switching from conventional type curricula to practical and student-centred learning curricula. • Students need to have both fundamental and new 21st century skills • Need to create a positive impact to students on both pragmatic skills development and community contribution	• Universities feel a gap between their current education system & requirements of the industr • Affiliated colleges can't make core curriculum changes as higher university management have pre-defined curriculum. To make necessary changes and amendments, it has to go through management hurdles and takes a long time • The conventional curricula doesn't incorporate practical learnings efficiently • There is an untapped scope to involve the society and encourage students towards community service.
• Minimise the gaps in the teaching - learning methods • Training in PBL methods.	• Students don't always understand what is taught by the teachers • Teachers are new to the PBL method and need to build confidence through training.
• Improve the experience of getting employed after graduation • Students may find it hard to relate the theories and concepts with the real world • Gain more practical knowledge in college • Have evaluation methods which test more than just bookish knowledge • Learn through more interesting mediums of education	• Getting jobs require more skills aparrt from theoretical knowledge which students are unable to get. • Students may find it hard to relate the theories and concepts with the real world • Classroom education system gets monotonous and boring for students • Importance is given to only theory based exam This may reduce the motivation of students to spend time and effort in gaining practical knowledge since that is not being evaluated
• Reduction in the investment required from the industry's side in training the fresh graduates. • Better quality of students who know life skills like team work, critical thinking and soft skills to work in an office environment.	• Industries do not want to invest resources and time in training the students again once they have joined the company. • Industries value life skills like critical thinking, team work and soft skills in their employees.
• Need cooperation of other stakeholders for course development • Should be implementable	• They prioritise practicality over perfect but un-implementable concepts • They need to interact with other stakeholders in order to design the curricula

REQUIREMENTS

Institutes

Teachers

Students

Industry

Curriculum creators

R1 Courses shall be adaptable for insititutes which don't have the power to make major change in structure.

R2 Teachers shall be trained in PBL methods and soft skills for communication and be enabled to train others

R3 Courses shall have practical elements, improve communication skills and team work, and encourage the students to be updated about the world.

R4 Non traditional teaching methods shall be utilised to deliver knowledge and increase students' interest

R5 Students shall be evaluated wholistically including their soft skills and critical thinking

R6 Curriculum shall reduce the gap between the education system and industry requirement.

R7 Curriculum creators shall be provided cooperation of the other stakeholders

Problem-based learning

Problem-based learning (PBL) is a leaner-centered approach (Savery,1999) where students strive to resolve *"real world problems"*(Torp and Sage, 2002). PBL methods are reported to support the development of specific skills, such as, critical thinking; complex problem solving, self-learning; collaboration and people management; and communication (Duch, Groh and Allen, 2001). These skills are also recognised as top skills for 2020 and the upcoming decade by the World Economic Forum (2016).

3.1. A brief history of PBL: Introduction in clinical practice

Problem Based Learning (PBL) is an innovative teaching method which was developed and implemented in McMaster University (medical school) around 1965 and then became popular in among medical institutes. Later, this approach was adopted in other fields like MBA, law, engineering, education, etc.. It was derived from the theory that, learning is a process in which the leaner actively construct knowledge (Gijselaers, 1996). It is a method where students in a small group understand, discuss, study and solve real life problems under the supervision of tutor. Learning is organized around a problem.

3.2. Definitions, Characteristics and Learning Principles:

Problem-based learning (PBL) is defined as a *"focused, experiential learning organized around the investigation and resolution of messy, real-world problems"* (Torp and Sage, 2002), in which *"students learn through facilitated problem solving that centers on a complex problem that does not have a single correct answer"* (Hmelo-Silver, 2004).

It is important to note that PBL is "not problem-solving" (Savery,2006) alone but is an "instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem" (Savery, 1999).

Barrows (1996) identified six core characteristics of PBL, explained as follows:

1. Learning is student-centred: students take responsibility of their own learning, identify the knowledge that required to learn and determine the way/ resources to get information by themselves.
2. Learning occurs in small student groups: A group generally consists of five to nine students who work together along with a tutor. Students share their knowledge and learn from other and learning happen in collaboration.
3. Teachers are facilitators or guides: tutor asks students the kinds of questions to better understand and manage the problem.
4. Problems form the organizing focus and stimulus for learning: Problem represents the challenge students will face in real-life and provides the relevance and motivation for learning. Students realize what they will need to learn in order to solve the problem.
5. Problems are a vehicle for the development of problem-solving skills: the problem format is in same way that it occurs in the real world (ill-structured, complex) which allow students to inquire the problem in deeper. The students don't restrict to a single subject rather, they focus for integrating information from many disciplines.
6. New information is acquired through self-directed learning: the students are expected to learn from the world's knowledge and accumu-

lated expertise by virtue of their own study and research.

PBL is an approach to learning which is well matched with prescribed principles of cognitive and constructivist theories of learning. PBL process promotes the activation of prior knowledge and its elaboration.
Also, discussion of a relevant problem in a small group facilitates processing of new information. This problem-oriented study allows mastery of principles and concepts such that that can be transferred to solve new problems. Solving problems via PBL method enhance integration of different subject/ domain knowledge.

Also, PBL makes learning intrinsically interested and keep students self-engaged in learning. These propositions underlying PBL have been validated and have empirical basis (Schmidt et.al. 2011, Schmidt, 1993; Norman et.al., 1992).

3.3. PBL compared to other learning approaches

The difference between conventional learning and PBL learning are tabulated (Table1) below:

The key differences between PBL and Project-based learning are:

• Project tasks are closer to professional reality and therefore take a longer period of time than problem-based learning problems (which may extend over only a single session, a week or a few weeks).
• Project work is more directed to the application of knowledge; whereas problem-based learning is more directed to the acquisition of knowledge.
• Project-based learning is usually accompanied by subject courses (eg maths, physics etc. in engineering); whereas PBL is not.

PBL has profound implications on the motivations of the student to learn, stating that "the freedom to select their (students) own resources to answer the learning issues, which gives them ownership over their learning" (Dolomons, et al., 2016).

Traditional/ conventional learning	Problem-Based Learning
Teacher centric	Student centric
Passive learning (teacher transfers knowledge)	Active learning (teacher facilitates the learning process)
A subject-oriented approach	A problem-oriented approach
Discipline-oriented	Interdisciplinary
Based on basic and applied technical knowledge	A complex understanding of technological knowledge
Isolated	Group + Individual tasks
Individual tasks	Contextualized

• Management of time and resources by the students as well as task and role differentiation is very important in project-based learning; as opposed to PBL.
• Self-direction is stronger in project work, compared with problem-based learning, since the learning process is less directed by the problem.

The key differences between PBL and Case-based learning are ;
• Case-based or case study Learning is predominantly task oriented, with activity often set by tutor; while in PBL, problem is usually provided by tutor with the students defining the 'what' and 'how' they learn.
• In Case-based, tutor supervises while in PBL, tutor facilitates
• In Case based, students are required to produce a solution or stategy to solve the problem which maybe a worked example; while in PBL, focus is on the problem 'management' rather than problem solving, which is just a part of the process, with no clear or bound solution
• In Case-based learning, supporting lectures to undertake the activity is pivotal; while in PBL, students are expected to define the required knowledge to solve the problem and usually, lectures are not included.

3.4. Effectiveness of a PBL Approach: Measures and Metrices

Earlier studies revealed that the 'level of knowledge tested', as a learning outcome, was found to be equivalent to that of traditional approaches, however, students who experienced PBL showed; (i) improvement in problem-solving skills (Albanese and Mitchell, 1993; Vernon and Blake,1993) and (ii) increased engagement and motivation to learn, as they preferred PBL to the traditional methods of teaching (Denton, Adams, Blatt, & Lorish, 2000; Torp & Sage, 2002).

Dolomons et.al. (2016) study, across curriculum-wide PBL implementation and single-course PBL implementation, noted similar findings to the earlier studies, where PBL has profound implications on the motivations of the student to learn, stating that "the freedom to select their (students) own resources to answer the learning issues, which gives them ownership over their learning", and has capability to foster deep learning. Thus, the onus falls on the shoulders of the students as peer teacher (Caswell, 2017) to ensure the motivation of the team is maintained. Several studies in engineering provide empirical support that students learning gains for conceptual understanding is higher than traditional lectures (Yadav, 2011). PBL approach offers the opportunity for students to enhance their critical thinking and self-directed learning skills, and engages students in solving problems (Williams,1999). Students' perceptions that the curriculum encouraged critical thinking significantly increased after PBL curriculum was conducted (Birgegard, 1998). Students' critical thinking skills are fostered through their group discussions (Rideout and Carpio, 2001). Yuan (2008) suggested that PBL encouraged them to share their opinions with others, analyze situations in different ways and think of more possibilities for solving problems.

Schmidt et. al. (2009) reported that students and graduates from the curriculum perform much better in the area of interpersonal skills, and with regard to practical domain skills. In addition, they consistently rate the quality of the curriculum as higher. Moreover, fewer students drop out, and those surviving need less time to graduate. Smith et.al. (2009) verified that peer discussion enhances understanding, even when none of the students in a discussion group originally knows the correct answer.

As percentage of students failing the course and average of final grade are the direct measure of long-term knowledge retention ability and problem- solving skills; pre-test and post-test are very useful to check relative change in the pursued skills by students. Skills like Critical Thinking can be evaluated using California Critical Thinking Skills Test CCTST, Motivation and engagement of students can be evaluated using Motivated Strategies for Learning Questionnaire (MSLQ) Manual (Pintrich, 1991), effectiveness of group activities and interpersonal skills, i.e., Collaboration, can be evaluated with Team Assessment Tool (Moore et.al. 2006), while Problem-solving and communication skills maybe assessed (summative) by peer, mentor and expert/jury across the duration of the course or curriculum.

3.5. The PBL Process

There are many variants of PBL as it can be moulded according to institute traditions and individual course requirements. In order to make learning experience most effective for various kind of students, PBL approach can be modified according to domain or subject. Also, PBL can be implemented at a chapter level as well as entire course level. Having flexibility in teaching and learning, PBL process have been developed by many researchers dividing it into several steps and sub steps. However, broadly speaking, all these representations can be addressed with three basic phases which are analyzing a given problem, identifying information, and applying and discussing new knowledge to the given problem. Here, we present a detailed process model of PBL.

The process starts with an ill-defined, real life problem formulated by tutor/ teacher. Students in a small group starts analyzing the problem systematically. The terms and concepts are understood and clarified first. Students in a group have agreed opinion on meaning of the problem. Then, students construct a tentative theory explaining the phenomena or events described in the problem-at-hand in terms of its underlying principles or mechanisms. Students then identify the facts that they already know and what they require to know in order to solve the problem. Learning issues for individual study are formulated. These learning issues usually consist of questions arising from the discussion. Students search and evaluate resources which can be useful to learn problem domain.

Students pursue learning issues through individual, self-directed learning usually using a variety of resources: books, articles, movies, and Internet sites where, tutor scaffolding takes place. Students return to their tutorial group, review and share what they have learned, propose the solution and elaborate different aspects of it. Explore to what extent the students' understanding of the problem has developed and whether misconceptions remain that need to be addressed. Students self-evaluate and evaluate others in the group (peer evaluation).

Though the above process is blending of collaborative learning phase and self-directed learning phase, it is important to note that a single phase alone has insufficient impact on learning in PBL (Schmidt et.al., 2009).

3.6 Role of Tutor /Mentor in PBL

Traditionally, teachers have been teaching the concepts as well as applications of the concept whereas PBL methodology asks teachers to be facilitator and help students to manage meta-cognitive activities. Thus, adopting PBL is difficult for teachers as they must transform the whole methodology that they have been following for years.
Being a mentor, faculty has to keep in mind that learning is a constructive, not receptive process. They need to permit students to discuss issues. They need to ensure that learning issues are raised and discussed. Being a tutor, faculty should not stifle students' discussion by giving mini-lectures or factual information, asking stream of questions, giving answers or telling students whether they are right or wrong in their thinking, telling students what they ought to study or read, etc.

Broadly, through literature, the role of the the faculty maybe as follows;:

- Tutor / Lecturer - where the teacher delivers lectures and provides tutorship on a specific subject,
- Demonstrator - where the teacher demonstrates an activity or method or skill, which is the praactical aspect of the course,
- Mentor / guide - where the teacher guides and step-by-step mentors the student(s) progress with mild hand-holding, offering directions and critique, but does not interfere in the natural process of the student
- Facilitator - where the teacher only coordinates the course but does not offer any subject expertise, and
- Delegator - where, like the Facilitator, the teacher doesn't directly participate in the student's learning, however, does delegate tasks, assignements, and other needed mitigative actions for conducting the study,

Howeve, a teacher oftens takes on several such roles through the course.

Have I	Yes	No
Selected appropriate content?		
Determined availability of resources?		
Written a problem statement that:		
a. is developmentally appropriate?		
b. is grounded in student experience?		
c. is curriculum based?		
d. allows for a variety of teaching and learning strategies and styles?		
e. is ill-structured?		
Chosen a motivation activity?		
Developed a focus question?		
Determined evaluation strategies?		

Table 2 : Checklist for Developing a Problem Delisle (1997)

3.7. General guidelines for problem formulation in PBL

Delisle (1997) prescribed the general guidelines for problem statement formulation in the form of checklist (Table2). Marchais (1999) identified criteria for constructing problem and subsequently evaluating them. (e.g. Stimulating thinking, analysis, and reasoning, assuring self-directed learning, using previous basic knowledge, proposing a realistic context, leading to the discovery of learning objectives, arousing curiosity etc.).

Gijselaers (1996) identified the features of problem that make PBL ineffective. (i.e. description of problem have questions which are substituted for students generated learning issues, title of problem is same as title of the book chapter, problem is too simple (well- structured/ having only one acceptable solutions) which can be completely resolved during initial analytic process.

Curriculum Design Workshop, IISc, Bangalore

Summary of the chapter

In the design domain, it is observed that problem-finding is as important at problem-solving and requirement identification, i.e., "right problem", is critical for seeking appropriate and satisfactory solution. However, in existing PBL approaches, a problem is defined, though ill and often complex, whilst leaving the activity of problem solving open-ended and the expected solution. This raises serious reservations on the 'self-learning' process of undergraduate students in technical schools across South Asia as course syllabus is heavy, which may inadvertently demotivate the students and they aren't naturally inclined to question.

Therefore, an exposure to design i.e., problem-finding and problem-solving, has potential to imbibe reasoning, questioning, curiosity, and drive the students to pursue a valuable problem, with motivation and purpose.

It is also noted that certain attributes of other approaches, such as, application of knowledge, accompaniment of lectures and management of time and resources are noteworthy and should ideally be inculcated into technical teaching through PBL methodology.


TABLES
RESET
STAGE
STAGE

Design Thinking for PBL

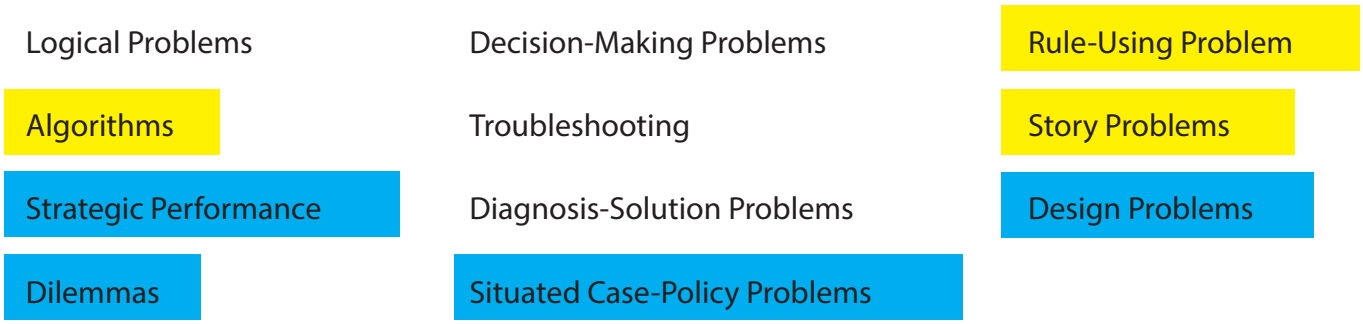
Chi & Glaser (1985) defined problem as a situation in which one is trying to reach some goal and must find a means for getting there. Problem-solving is one of the important skills that humans need to learn. Learning which helps human to improve living condition and comfort.

4.1. Classification of "problem": Types and Attributes

The problems that students learn to solve during the classroom teaching and test in conventional engineering education and the problems exist in everyday practice are different. Jannassen (2000) classified the problems into various types (i.e. logical problems, algorithms, story problems, rule-using problem, decision-making problems, troubleshooting problems, diagnosis-solution problems, strategic performance, situated case analysis problems, design problems, dilemmas). On one hand, story problems and algorithms are typical classroom problems that are well structured, procedural and predictable in nature. On the other hand, design problems and situated case analysis problems are real-world, ill-structured problems. The above discussion leads to the conclusion that there is a need of modern education system where students can get exposure to learning to solve more meaningful real-life problems.

More recent research in situated and everyday problem solving makes clear distinctions between thinking required to solve well-structured problems and everyday problems. Dunkle, Schraw, and Bendixen (1995) concluded that performance in solving well defined problems is independent of performance on ill-defined tasks, with ill-defined problems engaging a different set of epistemic beliefs. According to Jonnassen (1997), the problems which are at the end of textbook chapters in schools and universities are well structured, less complex (less no. of issues, functions, or variables involved) and domain-specific problems which cover a finite number of concepts, rules, and principles being studied to a constrained problem situation, whereas the problems encountered in everyday practice are ill-structured, more complex and cover knowledge of multiple domains. Shin et. al (2003) discovered that solving well-structured and ill-structured problem needs different mental skills. This shows that the performance of classroom problem-solving skills is independent and learning of which does not necessarily help to solve practical real-life problems. Hong, Jonassen, and McGee (in press) found that solving ill-structured problems in a simulation called on different skills than solving well-structured problems, including metacognition and argumentation. Jonassen and Kwon (in press) showed that communication patterns in teams differed when solving well-structured and ill-structured problems. Clearly more research is needed to expand these findings, yet it seems reasonable to predict that well-structured and ill-structured problem solving engage different intellectual skills.

Real-life problems are ill-structured and complex. Problem complexity is defined by the number of issues, functions, or variables involved in the problem; the degree of connectivity among those properties; the type of functional relationships among those properties; and the stability among the properties of the problem over time (Funke, 1991). Therefore, the different types of problems enlisted below have been broadly identified as 'well structured and simple' (in cyan highlight) or 'ill-structured and complex' (in yellow highlight), as visible in the next page.



4.2. Importance of the right problem for the right impact

A problem is usually a description of a set of phenomena or events observable in the real world that are in need of an explanation in terms of a theory, an underlying principle, process, or mechanism. The two critical attributes of a 'problem' are:

i. A problem must be an unknown entity in some situation (the difference between a goal state and a current state).vary from algorithmic math problems to complex social problems, such as violence in the schools.

ii. Finding or solving for the unknown must have some social, cultural, or intellectual value, i.e., someone believes that it is worth finding the unknown.

4.3. Design Thinking as a strategy to inculcate PBL

Awang and Ramly (2008) used creative thinking approach, a sub-set of Design Thinking with focus only on 'problem-solving', for implementing PBL in the classroom and found that the combination of both enhanced creative skills and technical abilities. Thereby suggesting complementarity between the PBL methodology and the methods of design practitioners, i.e., Design Thinking.

By taking review of top technologists, Halfin (1973) identified total 17 mental process used by practitioners, as follows ; defining the problem or opportunity operationally, observing, analyzing, visualizing, computing, communicating, measuring, predicting, questioning and hypothesizing, interpreting data, constructing model and prototypes, experimenting, testing, designing, modelling, creating and managing. Here Haflin refers to 'designing' as an activity or task, while latter literature clarifies that, "Design is a type of problem solving in which the problem solver views the problem or acts as though there is some ill-defined-ness in the goals, initial conditions or allowable transformations" (Thomas and Carroll, 1978). Cross (2001) describes designing as, 'finding' appropriate problems, as well as 'solving' them, and stressed that it includes substantial activity in problem structuring and formulating, rather than merely accepting the 'problem as given' (Cross, 2001). He further adds that, designers' behavior is characterized by their treating the given problems as 'ill-defined', for example, through exploration where goals and constraints are changed even when they could have been treated as well-defined problems.

Williams & Williams (1994) reported the similarities between PBL and design process, i.e. large no. of stages, identification of problem as an opening phase, require motivation, organization skills and capability to initiate things, open-endedness to outcomes, group work and collaboration. While PBL is an instructional, curricular approach where the problem is defined and given with the intent to stimulate learning, Design is a cognitive process of 'finding' an appropriate, 'ill-defined' problem. Thus, supporting students to identify contextually grounded 'real life problems' and accordingly seek solutions, enables them to go beyond Remember-Understand - Apply, towards Analyse-Evaluate-Create, hierarchically identified by Bloom's Taxonomy () as key learning objectives, and further enhances their ability to contribute to society.

There are several Design Thinking models, of which the most popular are; Stanford's d.d. school Design Thinking process [20] and IDEO Human-centered Design Model [21] for generic design, and Pahl and Bietz [22], Hubka and Eder [23], Cross [24], Dieter and Schmidt [25], Eppinger and Ulrich [26] for systematic design process stemming from engineering. These models are either descriptive or prescriptive and use varied terminologies to guide the design process. However, the common approach of all these models maybe summarised into 4 steps as follows :

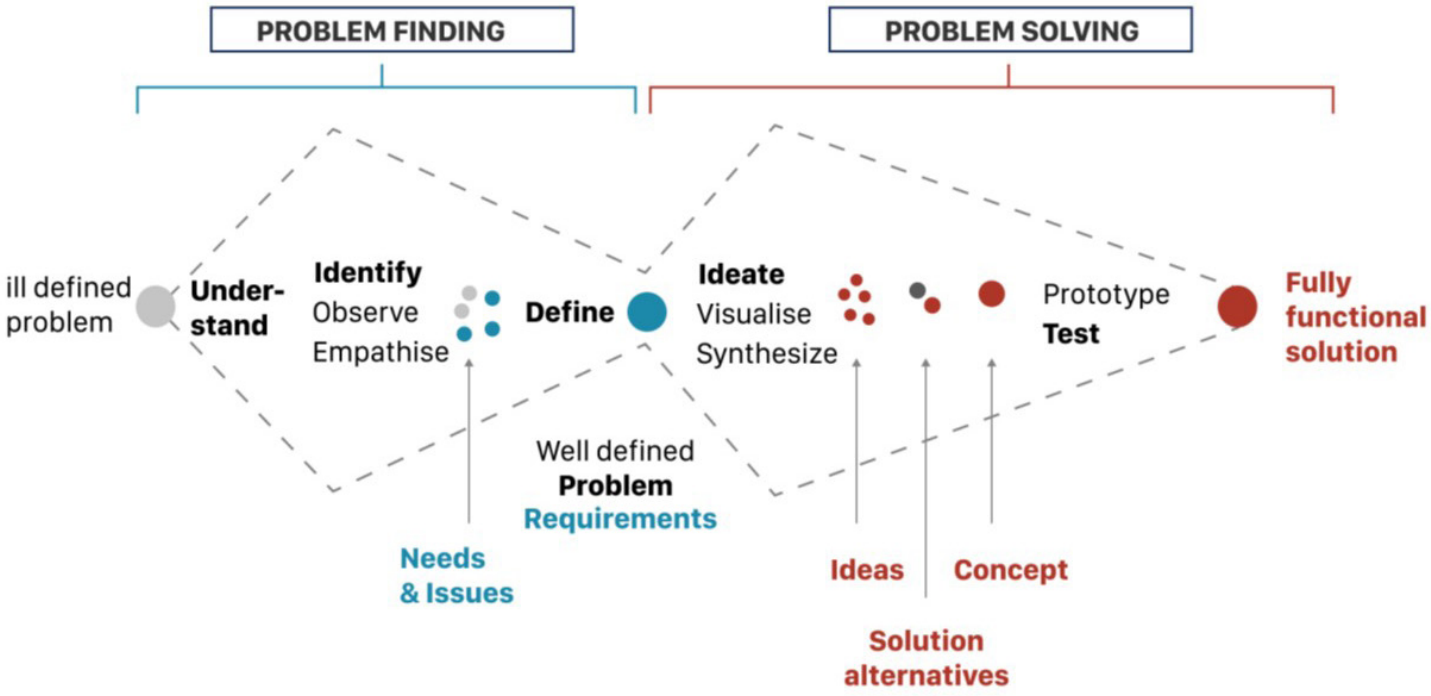
Step 1 - (common terms : Understand, Observe, Define, Empathise) : Needs, insights and requirements are identified through methods, such as, observations, interviews, role-play, stakeholder analysis and checklists;

Step 2 - (common terms: Ideate, Visualise, Synthesize, Co-create) : Solutions, at different levels of detail, are ideated through creative methods, such as, Brainstorming and SCAMPER;

Step 3 - (common terms : Build, Prototype, Simulate, Model) : Solutions are further consolidated into feasible or working solutions through methods such as, TRIZ and Morphological Chart method, and physical or digital solution-alternatives are made to assess its functionalities;

Step 4 - (common terms : Test, Validate) : Selection of the most promising solution as concept from amongst all other alternatives, upon evaluation by methods such as, Weighted-objectives and concept selection methods, is performed.

Thus, Design Thinking was employed as a strategy to inculcate Problem-based Learning (PBL) into undergraduate educational practices and content, across South Asian Universities, through workshops.



First Cut - making of a MOOC , IISc, Bangalore

4.4 Leveraging Regional Capabilities: Workshops in India

The previous sections described the various aspects of the PBL best practices how PBL based pedagogy should be adopted in curriculum with a special focus on the engineering education in South Asian countries. In the following sections, such aspects were further strengthened and clarified by immersing them in a prototype/ scaled down model workshops conducted at IIT Bombay and IISc Bangalore. These workshops aimed at preparing the HEIs of South Asian countries to various aspects of PBL with a special focus on understanding how PBL should be customized to South Asian HEIs.

While the IIT Bombay workshop consisted of testing the development of prototype case-studies by students and faculty of Nepal, Bhutan and India with students and faculty from the European partners, the workshop at IISc Bangalore focussed solely on issues related to curriculum development in Nepal and Bhutan with partners from India and Europe playing a facilitator role to understand the complexities involved in implementing PBL in the context of Nepal and Bhutan. Two workshops were tailored such that the following needs were addressed:

- The need to clarify and provide understanding, know-how of processes and methods, and hands-on experience of PBL, and
- The need to contextually appropriate the PBL experience with respect to both, the domain of study and the socio-cultural context that determines the prioritises and problems of a community or region.

In the first workshop, aimed at participants without prior knowledge or training to receive a first-hand experience of PBL, participants successfully completed the PBL cases by following Design Thinking. They reported that they were overall satisfied with the case experience and had made some to significant progress with respect to skills developed. Armed with this experience and confidence, the faculty members from the participating institutes of Nepal and Bhutan, mentored by Indian and European partner universities, designed and developed PBL course proposals with the use of a Design Thinking approach, which are now being implemented at their home institutions.

(i) Case Studies and Workshops at IITB, Mumbai

The first workshop in terms of the preparation for the project was conducted at Mumbai in August 2019. It was hosted by IIT Bombay and spanned for two weeks. A total of 70 participants from all the partner universities marked their presence in the workshop. The participants include a mix of faculty as well as students from each of the university. The students from European & Indian universities largely had prior exposure to PBL based curriculum. Such participation was done by design so that the knowledge transfer to the South Asian HEIs would happen at faculty as well as student levels. Most of the participants are faculty from Nepal and Bhutan, as case participants. Some faculty from IITB (as expert mentors), Aalto, KTU, IISc and TU Delft participating as mentors. The rest of the participants are students from Aalto, KTU, IISc, IITB and TU Delft participating as case participants. There were 7 cases in total with 7 mixed teams of students from (Aalto, KTU, IISc, IITB and TU Delft) and faculty members from (NEC, SEC, RUB, AITM, KU) participated. Each team is about 6-8 members and very diversified in terms of its composition: across ages, skill-sets, hierarchies, roles in their home institution and also project, disciplines, cultures and so on which is interesting case in itself. Most of the case participants from Nepal and Bhutan were relatively new or unknown to the working concepts, relevance, methods and tools of PBL. A mix of different fundamentals of PBL was introduced through PBL working sessions and PBL based experience sharing and actual case works.

Participants at IIT Bombay workshop

The participants worked on case studies related to four broad areas in sustainable development, namely:

- Liveability in slums
- Affordable Housing
- Construction and Demolition Waste
- Accessible Healthcare
- Net zero energy development – rehabilitating sustainability

Each team went through an extensive series of lectures and workshops primarily focused on design thinking and PBL methods. The teams worked for two weeks to discover socially acceptable and sustainable solutions to problems given to them. During this journey, they were facilitated to interact with the social communities to whom the problem assigned to team was related. Moreover, they talked with non-governmental organizations and NGOs for having a broad understanding about the problem and various stakeholders involved. In the concluding session of the workshop, each team presented the solutions developed by them. The workshop presented some key directions in terms of implementation of PBL in South Asian universities. The key findings which are important are:

• Faculty from being teacher in a course to a mentor in a PBL based curriculum

The transformation of faculty from teachers to mentors was appreciated the most significant factor in terms of shifting to a PBL based curriculum. As discussed in the earlier sections, the mentor's role is quite different from that of a teacher. The hands-off approach where the students are allowed to freely discuss the issues with minimal intervention and direction by the mentor is the key to self-learning. However, it is a difficult role as the mentor still has to balance the learning objectives of course while allowing students to explore freely and define their problems/spheres of work.

• Upfront uncertainty in goal setting may not be comfortable to students

The important dynamic observed the faculty from Nepal and Bhutan who transformed themselves as students for this workshop is that the upfront uncertainty in the early stages of the case-study where the goals are not defined and

where the problem is ill-structured is a big challenge for both students and teachers. The mentors' major role is to keep the morale and motivation of the team going so as to meaningfully achieve the learning objectives and still expose students to the uncertain nature of the problem definition in real world. Tools to get constant feedback from the students especially like a mood meter is essential to understand the team spirit to create quality problems.

• Appreciation of learning objectives is a natural outcome of PBL process

The students (including the teachers from Nepal and Bhutan) acknowledged the effectiveness in PBL based methodology in appreciation of the learning outcomes. The workshop was geared up towards sustainable development goals. The case studies made the teams contact local communities and interact with NGOs and various other entities on the field. Such interactions have sometime led to a drastic change in their case-study objectives. The interactions also helped dispel some of the initial notions and biases that existed in the team. The teams were naturally passionate about their solutions by the end of the case study exercises and owned their work in a much better fashion than normal learning method.

Finally, the participants, especially the faculty, from Nepal and Bhutan felt that such method could be implemented in their countries. The ned for a proper assessment scheme for students in a PBL based course is a concern which the faculty have pointed out. Overall, the workshop has concluded on a positive note with a good feedback on the PBL practices important for Nepal, Bhutan and India.

The case studies were then followed by a more focussed workshop in IISc Bangalore where the participants are only faculty from partners to develop PBL based curriculum for their respective universities/colleges.

(ii) Design Curricula Workshop at IISc, Bangalore

The design curricula workshop at IISc Bangalore is a focused workshop by faculty of the partnering HEIs to focus and develop a curriculum especially for the Nepal and Bhutan HEIs. Centre for Product Design and Manufacturing (CPDM), Indian Institute of Science (IISc) hosted the PBL South Asia Curricula Design Workshop for 14-18th October 2019. Representatives from the ten partner HEIs (higher education institutions) – Aalto University, Finland; TU Delft, Netherlands; KTU, Lithuania; IISc and IITB, India; JNEC, Bhutan and AITM, NEC, Sec and KU, Nepal - participated in the Erasmus+ funded project, Strengthening Problem-based Learning in South Asia (PBL-SA). Overall, about 30 participants attended the weeklong workshop in October 2019. The workshop included components of experience sharing by some the partnering HEIs who had experience in implementing a PBL based course combined with a hands-on workshop by the teams.

The workshop was conceptualized under preparation, led by IISc and supported by IITB, for the implementation of PBL in curricula across South Asia. Its main objectives was to apply 'design thinking' strategies to collaboratively design the curricula suitable for each of the beneficiary HEIs, across disciplines, in Nepal and Bhutan. The European and Indian institutions presented on their know-how in the area of PBL, and faculty and research associates mentored sessions to co-create courses. The long-term aim is to build a strong network of PBL practitioners and collate best practices across partner institutions, to improve the implementation and dissemination of PBL in the South-Asian context.
Some key points raised and addressed during the workshop are:

• PBL is best suited for project based courses which are usually at the end of the course in fourth year projects for undergraduate students

• PBL has been adopted with some success in core engineering courses as well. Some experience in this regard was shared by a few partnering HEIs

• The scoring schemes should reflect the work

Participants as IISc Bangalore works...

done through out the project and have weightage for even failed prototypes etc.

• PBL is excellent method especially if the course involves teams working on inter-disciplinary areas

• The number of students registered should not have a bearing on the pedagogy. PBL has been shown to be adopted on class sizes of more than 100 as well. However, as the class size increases, there is a need for specific mentors for teams which are usually about 5-6 students strong. Thus there is a need for strong mentors as day-to-day facilitators and a overall course instructor who guides the philosophy of the course. For smaller number of students, the faculty can double as mentors for the teams

• A lot of discussion on the course evaluation is necessary to capture the assessment in line with course objectives. Usually a combination of continuous evaluation throughout the course study with a final assessment based on one or a combination of presentations, peer evaluations, prototype fairs and presentations to the community would be warranted in the case of a PBL based course.

• A template was designed for the HEIs to structure their new course adoption under the PBL mode. The template is given later in this document.

Summary of the chapter

The two workshops aimed at imbibing PBL in experience, and later those expereinces into the course elements.

Through the case expereinces, tailored in Mumbai with institutional and industry partners, a majority, i.e., 56.4% of the participants responded positively about their experience of PBL, while predominantly, positive feedback was received ranging from 'some progress' to 'significant progress', upon being asked to self-evaluate on certain areas and skills through the workshop experience.

The use of the Design thinking driven, 'PBL SA Schema' propelled the faculty course-designers from institutes of Nepal and Bhutan, mentored by Indian and European partner universities, to identify several issues from different perspectives, ideate large number of solutions, consolidate them into viable solutions and select the most promising one to further detail. The proposed courses were conceptualised through a systematic approach that helped mitigate conflicts between current practice, University demands and the unorthodox approach of PBL.

Outputs & Outcomes

Problem-based Learning (PBL) is proposed as a pedagogical methodology to be introduced in South Asian undergraduate programs to foster deep learning and develop the top skills essential for being industry-ready. However, the dearth of know-how and experience of PBL in the South Asian partner universities prompted the novel proposal of using Design Thinking to inculcate PBL into existing course content and pedagogy, and in tuen, conceptualise a 'PBL SA Schema' that is contextually appropriate .

Apart from the on-ground progress, the project has also recieved appreciation and acclaim in the academic circle with the publication of two International Conference papers, as below:

1) Acharya, S., Bhatt, A.N., Chakrabarti, A., Delhi, V.S.K., Diehl, J.C., Mota, N.J., Jurelionis, A., and Subra, R. (2021). Design Thinking as a strategy to inculcate Problem-based Learning (PBL) in undergraduate education across South Asian Universities. Proceedings of International Conference on Research into Design. Springer, Singapore.

2) Acharya, S., Bhatt, A.N., Chakrabarti, A., Delhi, V.S.K., Diehl, J.C., van Andel, E., Jurelionis, A., Stasiuliene, L., De Jussilainen Costa, L., and Subra, R. (2021). Problem-based Learning (PBL) in undergraduate education : Design Thinking to Re-design Courses. In Proceedings of International Conference on Research into Design. Springer, Singapore; recipient of "Most Distinguished Paper Award".

Acknowledgments and participants

Acknowledgements and Reflections

Problem-based Learning (PBL) is a potent approach to imbibe and inculcate self-learning, along with several other top skills in demand by industry from young graduates. In turn, self-learning empowers a nation's young workforce for lifelong growth and overall sustainable development of the nation, a major priority for the highly populated South Asian nations. Thus, a Best Practice Review was conceptualised, beyond a report, as a handy guidebook to lean on for both the teacher and learner as they navigate the pressing challenges of the emerging post-pandemic landscape.

On this endeavour, we received support from all our partners across India, Nepal, Bhutan and Europe and to them, we extend our heartfelt gratitude. We would also like to thank all participants of the Case study and workshop at IITB, Mumbai and Curriculum Design Workshop at IISc, Bangalore, who helped us compose and corroborate the proposed schema.We especially commend the teams from Aalto University, IISc Bangalore and IIT Guwahati for the beautiful compilation of this work.

In retrospect, this compilation is the first step towards developing a stronger PBL culture in South Asia and empower the youth towards crafting a sustainable future.

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