State of the Art on

Active Learning in Engineering Education

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Content

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I. INTRODUCTION

This report has been produced by the partners of the ALIEN consortium. Its purpose is to analyze the current national situation in relation to the predominant teaching/learning methodology at tertiary level in Europe and Asia, in particular engineering higher education, and explain existing social/cultural bias towards/against active learning approaches with focus on problem-based learning (PBL).

In addition, it considers the existing national initiatives to promote PBL at universities and presents best practices in the use of PBL. Furthermore, it provides an overview of the existing initiatives at the partners' institutions.

The present Report is based on:

- Desk research regarding the national situation and best practices conducted by each partner.
- Field research organized when necessary to complement the data from the desk research.

The complete series of national reports has been then synthesized in this document. The final version of the document will be published as a book.

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II. OVERVIEW OF CURRENT UNIVERSITY TEACHING/LEARNING MODEL IN RELATION TO ENGINEERING HIGHER EDUCATION

II.1. Bulgaria

According to the Strategy *for* Development *of* Higher Education in the Republic of Bulgaria for the 2014-2020 period (https://rio.jrc.ec.europa.eu/en/library/strategy-development-higher-education-republic-bulgaria-2014-2020-period) some of the problems related to the quality of higher education are:

- Lag of teaching/learning methods behind the innovative trends in the development of students' skills and modernization of curricula.
- Lack of motivation of young university lecturers.
- Ageing academic staff.
- Mismatches between existing curricula and labor market and industry demands.

There are some other national reports and strategies regarding higher education in Bulgaria that highlight the inadequacy of teaching/learning model at tertiary level and stress that globalization, Industry 4.0 and the new type of young learners, the so called Net-generation, require a new learning environment where the traditional roles of a teacher/lecturer and a student should be completely modified, as well as the physical learning environment and the teaching/learning methodology as the latter appears of vital importance for the successful acquisition of both professional and employability competence being the bridge between the person who teaches and the person who learns. There are a number of recommendations how that change could happen such as introduction of innovative teaching methods (case studies, project work, discussions, career guidance, learner-centered learning, etc.), further training of university lecturers, broad introduction of ICT into the classroom, etc.

However, when it comes to the implementation of those outlined strategies, practice shows a completely different picture. Even though Bulgarian academic staff, especially the ones in the field of engineering sciences, speak everyday (at work, at home or at conferences) about cloud

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computing, Internet of Things (IoT), and cyber-physical systems (CPS), the predominant teaching/learning model in the classroom still follows traditional patterns – a professor delivering her/his lecture in front of large audience of passive note takers for about 40 minutes plus a period of 5 minutes intended for responding to questions where raising issues is a rare case. In labs activity and excitement are higher with some "question-and-answer" moments and spontaneous brief discussions and yet individual assignments are prevailing over team project work.

The situation described above is confirmed by an on-line survey conducted by the Ministry of Education and Science in 2017 within an Erasmus+ Project "Innovative tools to improve the skills of university lecturers so as to enhance the quality of higher education in Bulgaria". It included 1425 academics and 1826 university students from different Bulgarian universities. 22.2% of academics come from engineering sciences, including computer science, and 36% are 50+. 19.6% of the students follow an engineering degree course, including computer science. The results show that 88.5% of university lecturers use traditional lectures in their classroom. Nevertheless, half of them are willing to improve their teaching competence by getting trained in innovative teaching/learning methods, as well as their foreign language skills. On the other hand, 97.3% of university students admit that the method of teaching they face every day is the "lecture" in its traditional form.

Some tools of active learning such as case studies, problem solving, structured discussions, team projects, etc. have recently begun to establish themselves as useful teaching instruments in a number of Bulgarian universities but mainly in computer science, medicine, business, and management, social science, law, and humanities. And here comes the paradox. Why an applied science as engineering is still behind the other applied sciences mentioned above, namely computer science and medicine, as regards the introduction of active and problem-based learning since it itself involves problem solving and interdisciplinary team work? The answer to this question is not quite simple as it seems to be.

First, the eight technical universities in Bulgaria which provide engineering degree courses are public universities. In general, they are characterized by a high level of hierarchy where most of

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the academic staff is aged 50+. The ageing of the university lecturers is due to the fact that less young people are willing to follow an engineering degree course since, on one hand, the science has become more interdisciplinary and demanding, and on the other hand, engineers are often underpaid. The decreased number of engineering students results in shrinking the academic pool of the universities thus recruiting less and less young lecturers. In addition, young lecturers themselves are also underpaid at the universities and, respectively, unwilling to apply for a vacant position if any.

Second, traditionally Bulgarian society is marked by a high level of hierarchy and power distance. This holds true, even to a greater extent, to academic circles. In this sense, university lecturers, especially those over 50, feel fear of losing control over the audience/class/group if they are not the main agents of teaching and the primary transmitters of knowledge in the lecture room, which in turn, reflects on the lecturer-student relationship. Most of them still provide students with almost no choices, no shared responsibilities, no collective decision making powers, and no opportunities to discuss current controversial and societal issues. Therefore, it is not common for a student to have a close and familiar relationship with teachers or to question their knowledge and experience. To sum up, it is hard for lecturers who are used to teaching in an authoritative manner in a country of high level of power distance to embrace the change in power structure by agreeing to transfer authority and responsibility to their students, which actually is one of the underpinning principles of learner-centered methods such as active and problem based learning (APBL).

Third, most academics, especially those teaching engineering subjects, do not have any pedagogical training. They graduated engineering degree courses which are intended to provide a career as an engineer in industrial settings. It turns out that they are taught by themselves how to deliver the course material to their students (methods, tools, environment, etc.) on a trial and error basis. Furthermore, the Bulgarian Evaluation and Accreditation System for universities and the universities' attestation systems for academic staff assigns higher priority to scientific research and scientific papers rather than teaching. As a result, academics are under pressure to do research and write scientific articles to be published in journals indexed in

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Thomson Reuters and Scopus. Hence, they have neither time nor motivation to study and introduce innovative teaching/learning methods in their classrooms.

Fourth, many 50+ university lecturers lack foreign language skills, in particular English, which prevents them from delivering lectures in other overseas universities where they might observe how an engineering class is managed and taught and gain some experience in up-to-date teaching approaches such APBL.

Fifth, assessment methodologies being used for evaluating students' progress are mainly based on end-term written and oral exams, which generally require memorized information. In this sense, APBL-based classroom activities are not involved in the assessment process thus being often neglected by academics.

Sixth, the limited financial resources prevent universities from buying cutting-edge equipment for APBL labs. Of course, it could be bought through various EU programs but initiatives are very rare.

To conclude, the need for the application of innovative teaching/learning approaches such as APBL in higher education has already been identified and the Ministry of Education and Science has started some initiatives to promote modernization of the teaching process in higher education. However, APBL is not a structured way of teaching in Bulgarian universities and its potential is still not well recognized by academics. If there are some initiatives they are done by individual lecturers, mainly with fairly closed tasks, rather than being a university strategy, although some exceptions do exist. Private universities are doing better in introducing non-traditional teaching/learning methods. APBL tools are mainly experimented in social sciences, computer science, and medicine. However, open-learning environments which require students' own initiative, planning, experimentation, elaboration, and self-evaluation still seem to be rare. Most technical universities offering engineering degree course are behind the latest pedagogical and methodological developments. Thus, APBL approaches are seldom applied by few young lecturers.

II.2. Estonia

Estonia's higher education system follows the Bologna treaty. Bachelor level studies takes 3 years, master studies 2 years. This structure is justified by the rapid changes at the job market. I order to cope with fast changes in the labor changes the time spent in different school levels is limited. Bologna treaty is heavily criticized by some of the experts who argue that this devalues the quality of the higher education.

Universities have lot of freedom to coordinate their teaching practices but rectors of bigger universities have signet the quality agreement - a document that describe the general best teaching practices at the university level. The work inside of different universities has arranged differently but in most of the cases they are divided into smaller units (schools or institutes or faculties) that are semi-autonomous in decision making and mostly independent in the matters that concern teaching practices.

Unfortunately the most dominating teaching methodology is based on presentational based learning, which includes lectures and slide shows. Some university regulations and vocabulary fit best to traditional training methods. For example, attending classes can't be mandatory because study materials, such as slides, should be available for students. On the other hand, the school has to offer 3 exam periods between which a student can choose when to undertake an exam.

There is a trend to include more and more active learning approaches in the framework of higher education. For example, especially on more technically oriented programs, practice based subjects are introduced already decades ago through internship programs or design and development based learning activities. In general the society and particularly representatives from industry can see the high value of more practice oriented teaching methods. Internship programs conducting projects and designing prototypes are mostly accepted by all stakeholders while other more unconventional methods like gamification, game based learning, and flipped classroom don't generate consensus among different players.

II.3. Greece

Higher education institutions in Greece have the following mission:

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- To promote knowledge through research and teaching, to prepare students to use the acquired knowledge in their professional life, and to boost arts and culture.
- To offer higher education and to contribute to lifelong learning using modern teaching methods, including distance learning, on the basis of high quality scientific and technological research which follows international criteria.
- To develop students' critical thinking and skills, to take care of their integration into the labor market, and to create the appropriate conditions for the emergence of new researchers.
- To correspond to the labor market needs and to the country's development needs as well as to promote the knowledge dissemination, the optimization of research results, and of innovation focusing on the scientific ethics, sustainable development, and social cohesion.
- To promote cooperation with other Greek or foreign institutions and research organizations. To promote student and stuff mobility contributing this way to the construction of the European Higher Education and Research Area.
- To create responsible citizens capable of facing all human activities demands with scientific, professional, and cultural sufficiency as well as to respect values such as justice, freedom, democracy, and social solidarity.

Greece is a country whose historical heritage has had the propensity of enticing many overseas students to pursue their university education within its shores (Higher Education Greece, n.d.). All students of EU origin are not required to pay any tuition fees. According to the constitution of Greece, higher education in the country is provided by the state and should be made available to all citizens at no cost up to the undergraduate level. Beyond this level the payment of tuition fees are left to the discretion of decision makers in the upper echelons of higher education institutions. This effectively means that the universities offering the courses determine the level of fees paid.

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Greece has a high number of university graduates. Most of them attend four-year studies in University departments and in Technological University departments, as well as in the various departments of the School of Pedagogical and Technological Education, while those attending Technical University departments, which specialize in fields like architecture and engineering, graduate after five years of studies. Students who wish to enroll in the School of Fine Arts take special exams, and graduate after five years of studies. Courses in higher education institutes in Greece take the form of either lectures or workshops, and most of the courses spread over one semester. Most university departments in Greece offer one year or two year postgraduate courses as well as the opportunity to pursue a doctoral degree. Students may also enroll in the Hellenic Open University for graduate or postgraduate studies, where they pay tuition fees and where they are admitted through an annual lottery system.

Active learning is an approach to instruction that involves actively engaging students with the course material through discussions, problem solving, case studies, role plays, and other methods (What is active learning, n.d.). Active learning approaches place a greater degree of responsibility on the learner than passive approaches such as lectures, but instructor guidance is still crucial in the active learning classroom. Active learning activities may range in length from a couple of minutes to whole class sessions or may take place over multiple class sessions.

When it comes to learning a new concept or skill instruction that is essential, the belief is that practice makes perfect (What is active learning and why does it work, n.d.). Traditionally, lectures teach students new concepts and active learning helps students master them. Active learning works because it engages students in the learning process. More specifically, active learning in the classroom has distinct advantages:

- Teachers and students get more one on one interaction; students receive frequent and immediate feedback from instructors during active learning activities.
- Students learn through collaboration and interaction with other students, engaging more deeply with the course content and building invaluable social skills.
- Teaching is more inclusive. Students with different learning styles get a personalized experience.

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II.4. Cambodia

Higher Education plays a crucial role in human resource development and it is a key contributor to socio economic development of each nation, particularly in Cambodia. Realizing this value, Cambodia has deemed higher education as an important sub-sector for developing human capital which promotes the rapid development of Cambodia towards prosperity in the future. Linking to the strategies, many reforms are being carried out to improve quality of life and equitable access to higher education to produce graduates who will become both economically competitive and socially responsible. Globalization, regional integration, and proliferation of widespread understanding of science and technology have significant impacts on all sectors of Cambodian economy. Therefore, higher education development is required to adapt and conform to global and regional trends. Responding to this context, the Ministry of Education, Youth, and Sport has formulated Cambodian Higher Education Vision 2030 aiming at identifying long term direction and clear roadmap for development of this sub-sector.

In the last decade, the higher education system in Cambodia has transformed exponentially since there is a considerable increase in the number of private universities. This trend allows students to have more and more opportunities for jobs as well as further education. However, this trend also highlights the intricate challenges faced by parties involved in the overall qualities assurance of higher education as there is the rapid growth in the demand of education. Management of higher education in the country remains difficult and needs to be clarified and strengthened across several key dimensions, including the strengthening of institutional and organizational capacity. As a developing country, Cambodia faces huge challenges in coping up well with other countries in the regions in terms of economy and education and perhaps the lack of human resource is the major contributing factors to this.

In relation to the predominant method of teaching and learning in Cambodia, although there is a lack of quantitative research on classroom teaching and learning processes, qualitative research studies have found that teachers in Cambodia primarily focus on frontal teaching and rote learning, especially in primary and secondary education (Altinyelken, 2015).

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After the fall of the Khmer Rouge, the education system had to be rebuilt from scratch to become what the modern national education system is today, starting from Grade 1, at age 6, to Grade 12 for a total of 12 years of public general education. The methods of teaching adopted by each educational institution, especially at the university level, in Cambodia may differ significantly. Two noticeable approaches that are now widespread across Cambodian academic sectors are innovative and traditional methods.

In primary and secondary school and high school, especially outside of the capital Phnom Penh, the traditional approach of learning seems to dominate what teachers use to teach their students. Teachers generally adopt this long-established custom that society traditionally used in schools. Traditional, teacher-centered methods focusing on rote learning and memorization are still in use by many teachers in the rural areas as well as in the city. The adopted reforms of teaching and learning recommended by the ministry of education emphasized a shift from teacher-centered approach to child-centered pedagogy, deemed as student-centered pedagogy, active learning, or learner-centered education in different contexts. Despite its benefits, there the transition from traditional methods to more innovative ones is sluggish. Furthermore, in rural areas where knowledge of accessing technology for education is limited students may not be able to benefit from the advancement of technology. The lack of facilities and expertise in basic technology may generally be one of the main problems that limit the effectiveness of teaching in primary and secondary education. However, teaching methods in some high-class and expensive private schools in Phnom Penh are somehow different from what teachers do in public school. Thanks to the sufficient budget and conducive environment, those private schools may go one step further from public school by introducing various approaches to boost their student academic performance and social skills.

At the university level, the situation is, to certain extent, different from lower education. As science and technology keep spreading dramatically the change of the ways university teachers give lectures is a hotly debated topic that deserves ultimate attention. With the rapid rise of the digital age and innovation in teaching university students are using smart phones, tablets, and laptops as learning tools. There is a phenomenal wealth of information available online and the presence of traditional lecture should not exist anymore.

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More innovative teaching techniques are introduced to shift our perception away from traditional model of teaching and passive learning and highlight the greater focus on active learning. In active learning and PBL students actively interact with others and participate in the lectures. The majority of Cambodian universities agree that the collaborative way of learning in the university, in which students are engaged in synthesizing solution to a problem, developing high level thinking and problem solving abilities.

II.5. Malaysia

In 2007, the Malaysian National Higher Education Strategic Plan beyond 2020 (NHESP/PSPTN) (Kementerian Pengajian Tinggi, 2007) has been launched. Its main objective is to enhance the quality of human capital towards becoming a high income developed nation as par to those first class world citizens through enhancement of national higher education. The plan introduces seven strategic thrusts to improve knowledge acquisition capability, realize the nation's innovative potential, and inspire first class mentality. Thrust 2, the second of the seven thrusts is Improving Teaching and Learning Quality. This strategy sets the new transformation horizon in teaching and learning approaches for the higher learning institutions in Malaysia.

Based on the spirit of Thrust 2, it is imperative for higher learning institutions to continuously improve the teaching and learning quality so that their curriculum is always innovative, dynamic, up-to-date, and relevant to market demands as well as meeting the standards of intellectual developments. Attention is directed to supporting facilities and other ecosystem components such as teaching and learning infrastructure, teaching and learning methods, and up skilling of teaching staff to be qualified and professional to undertake effective teaching and learning processes (Kementerian Pengajian Tinggi, 2012). These three areas are strategically planned and implemented collaboratively through Critical Agenda Projects (CAP) between the Ministry of Higher Education (MOHE) and all the 20 public universities. Through the CAP for Teaching and Learning, five strategic objectives were further three of which are dedicated to active learning (AL) student-centered learning (SCL) as follows:

- To improve the quality of academic programs.

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- To ensure that the Generic Student Attributes (GSA) are achieved.
- To enhance the quality of lecturers in implementing teaching and learning activities.
- To enhance the quality of non-academic staff in supporting teaching and learning activities.
- To improve the quality of physical facilities so that they are conducive to effective teaching and learning.

Public universities were given six key performance indicators (KPIs) during the first phase of NHESP (2006-2010) to ensure that the above objectives were met. Within these six indicators, active learning and student centered learning are specifically mentioned as in the list below:

- Percentage of the final year students with a minimum average of 6 in the GSA system (My3S).
- Number of facilities at each higher education institution that are dedicated to SCL.
- Number of lecturers with the ability to conduct at least one type of SCL.
- Number of programs that adopt the SCL approach.
- Number of curricula developed based on Outcome-Based Learning.
- Number of non-academic staff attending training courses related to teaching and learning for at least 2 out of 7 training days in a year.

When the KPIs were first in place, the initial data collected showed that the practice of AL and SCL was not totally alien to the higher learning institutions community. However, it was necessary to improve and expand the practice. The preferred AL and SCL TnL at that time included PBL, project oriented problem based Learning (PoPBL), case based learning, interactive lecture, e-Learning, industrial training and practicum, and integrated design. At the end of the first implementation phase of the initiative the activities as set in the above KPIs were implemented by all the 20 public universities and the number exceeded the national targets for the Teaching and Learning CAP.

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The effort in emphasising the AL and SCL practices continued in the second phase (2011-2015) of NHESP. Public universities were expected to embed SCL in their individual strategic plans. Hence, specific KPIs related to SCL set by MOHE were reduced to one: 100% of the lecturers were expected to be competent to implement SCL in teaching and learning activities by the end of this phase. The two main action plans laid out include the following:

- Conduct training directed to strengthening lecturers' capacity in conducting SCL.
- Produce innovative methods in teaching and learning based on SCL.

Each university was required to report the outcome of these two plans to MOHE:

- Increase in the number of SCL Trainers at each institution.
- Increase in the number of publications/ instruments related to innovative SCL.

At the national level, the Malaysian Higher Education Leadership Academy (AKEPT) started (2010-2015) the master trainers (MT) training program and had published fifteen (15) master trainer TnL modules. The training modules and MT programs directly dedicated to AL and SCL include the following: PBL, POPBL, case teaching, interactive lecture, e-Learning, and industrial training. With the introduction of National Teaching Award since 2007 the culture of innovation in TnL with AL has been officially recognized.

In addition to Thrust 2 of NHESP, the emergence of AL and SCL was also driven by the need for the Malaysia academic programs to be officially accredited. The launching of NHESP was indeed the starting point of the Malaysian Qualification Framework (MQF), with the establishment of the Malaysian Qualifications Agency (MQA), to regulate and accredit the courses of all the institutions of higher learning in Malaysia. The implication MQF in TnL is this: the main emphasis of the education system is outcome-based learning and AL and SCL is no longer an option. Under Thrust 2, the MQF and Critical Agenda Project are driven and monitored closely by MOHE. These are the two critical factors behind the transformation of the classroom instructions from the transmissive model to active and student centered learning approach.

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II.6. Nepal

The history of Nepalese education has been developed from the root of Gurukul Education System (GES) where learners used to be taught certain knowledge and skills under the guidance of their gurus (teachers) with the purpose of preparing them with particular knowledge and skills to be applied in their practical life (Prakash, 2018). In traditional Nepalese educational practices, the textbooks are regarded as curriculum so teachers are more focused on teaching contents prescribed in the textbook. As a result, curricular objectives are shadowed (Devkota & Giri, 2016).

The Nepali education system can be differentiated into two types (Paudyal, 2016):

- School level education.
- Higher level education.

Higher level education consists of bachelor, masters, and PhD levels. School level education is categorized into basic/elementary level (Grade 1 to 8) and secondary level (Grades 9 to 12).

In Nepal higher education is provided by the central departments, constituent campuses, and affiliated campuses of the fully autonomous non-private universities. Except newly established universities all universities have affiliated campuses. Currently fourteen fully autonomous non-private universities and medical academies are established for providing higher education in the country. Among those thirteen autonomous institutions ten are full universities and four are medical academies.

Most teaching and learning methodologies in Nepalese universities are program dependent. Social sciences program adopt the teacher centered methodology whereby the faculties delivers the lectures to their students in assigned lecture hours and students show their understanding of subject matter by appearing in an exam with bounded time frame.

In practice, the exam-centered teaching and learning strategy is adopted throughout the private colleges of the country (Paudyal, 2016). Most of the private colleges have developed internal policies that help achieve high graduation rates in order to satisfy parents and to be covered by magazines and national newspapers. In advertisements, they equally expand research culture,

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students' involvement in governmental sector, and good physical facility as their quality feature, which normally very rarely are close to reality.

Active learning is an instructional methodology in which student (learner) and teacher (facilitator) have to be collaboratively and creatively involved to achieve concrete outputs as a result of group discussion within a classroom. Active learning classes mainly focus on small groups of 4 - 5 students where students have to be actively engaged themselves for better understanding and accurate solution to a particular problem.

In Nepal's educational context, many programs follow the traditional lecture tutorial approach, in which students from a very early school days have to be seated independently and need to work quietly on a singular task. The teacher (mentor) is the only entity to control the whole class. Beside this, Nepalese schools only use course books recommended and offered by the government. These books are supposed to be the only source of their knowledge. Students and teachers hardly get a chance to interact with each other. This trend follows till higher secondary level. As a result, when students reach the higher education level they lack self-confidence and motivation to explore their abilities in a large group. Students have to spend more time and effort than usual in order to apply their knowledge and skills to solve any problem if they really want to adapt to active learning methods. But most students never bother to put in the additional efforts as a result of being overburdened with course work.

AL being an emerging learning approach for both teachers and students, introduces a high possibility of raising social issues for the lecturer. It is common knowledge that even mentors won't be able to solve all the queries of learners during group discussions in classes. Active learning requires lectures to invest time and hard work on a particular subject. However, lack of motivation, student's overall performance, and lack of quality control may lead to sloppiness of instructors. As a result, instead of making classes interesting and interactive active learning may instead turn classes into very hectic and tiresome experiences for both the teachers and learners.

Finally, some difficulties may arise while implementing PBL classes as a result of large class sizes that may inhibit proper knowledge flow among students.

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II.7. Pakistan

The Higher Education Commission (HEC) was established in Pakistan in 2002 to comprehensively reform the higher education in the institutions of Pakistan with the mission to "facilitate institutions of higher learning to serve as Engine of socio-economic development of Pakistan (Higher Education Commission [HEC] Pakistan, 2017)." The foundation of HEC in just over a decade since its establishment led to an increase in the number of higher education institutions from 59 universities to 178 universities in 2014-15. The establishment of a number of institutions also increased the number of student enrolment from 276274 in 2002 to 1.3 million in 2014-15. This was made possible with the significant increase in the investment in human resource development by Government of Pakistan to improve the quality of faculty members, instructional facilities available at the institutes, and the research culture in the universities. HEC Pakistan has an HEC Vision 2025 for the long term sustainability of what they achieved in the HEIs of Pakistan since 2002. The vision is intended to initiate and bring both qualitative and quantitative reforms in the HEIs of Pakistan in line with the Government of Pakistan vision 2025. HEC of Pakistan is planning to implement the process of developing human capital that is not only professionally competent but also ethically committed and support Pakistan to become an emerging Asian Economic Tiger (HEC, 2017).

Pakistan is one of the developing countries and with limited resources available to the higher education institutions of the country. It is often difficult for higher education institutions to incorporate the use of new technology throughout the institute. This is also the case for the implementation of active learning.

The use of active learning in different universities of Pakistan has increased over the last decade. During the search on active learning in the higher education institutions of Pakistan it was found that active learning has been highly used in the medical education compare to other fields like engineering and business among others. This can be seen by a systematic review paper written by (Mahmud & Hyder, 2012) to review research in undergraduate medical education in Pakistan to evaluate PBL programs, examine outcomes and competencies influenced by PBL, and compare with typical classroom teaching by an instructor also known as

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lecture-based learning (LBL). The search did not reveal any specific PBL lab where the research or learning of specific subject-matter using PBL takes place. However, it did reveal a number of studies which provide an application of PBL in the learning of instructional content of different subjects including electrical engineering, mathematics, social science, and humanity. The number of studies in comparison to medical education is very limited. The scope of this document is limited to the use of PBL in engineering education. Therefore, only studies related to the engineering are discussed below.

(Sultan, 2018) has discussed the use of the flipped classroom (FCL) to promote an interactive and challenging learning environment for the student. The FCL is an active teaching and learning strategy based on a pedagogical model with easy to use technology inside and outside the classroom environment. The technology for outside classroom includes video lectures, handouts for reading, and practical problems, whereas the technology inside the classroom includes group based discussion and problem solving activities. Instead of using the whole time of the classroom to conduct a lecture the time is spent on the collaborative discussions and activities involving all the students. This makes the class more interactive and discusses real-time issues, examples, and challenging activities that allow students to think out of the box to come up with solutions. This strategy allows teachers to record videos of basic concepts that were supposed to be discussed in the actual classroom and use actual classroom time to engage students in activities based on the recorded videos. Teachers using this strategy ask students to go through the recorded videos and other shared material before coming to the classroom. FCL promotes teachers to move from the role of “sage on the stage”, i.e. teacher to transfer knowledge in the classroom based on the lecture only, to the role of “guide on the side”, i.e. to support students to explore the topic of discussion independently or in the group. FCL is based on the theory of constructivism and behaviorism. According to the behaviorism, the teacher is a focus point that uses different types of contents such as demonstrations, tutorials, and lectures among others. On the other hand, constructivism is based on the idea that students use their existing knowledge and experience to develop new concepts.

(Khan & Abid, 2017) discuss the tools to design labs and their effectiveness on the learning of students studying in the first year of an electrical engineering course. Project-based learning

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(PjBL) is one of the models in which students tend to work on a real time problem as a part of project and tend to identify the solution by having discussions with other students, asking questions and answers, discussing ideas and possible solutions, designing experiments and scenarios to validate its working, gathering data, and performing analysis on it among others. This is different from PBL where students acquire knowledge and practical experience by working on open ended problems. Both of the models have their pros and cons. The authors combined both of these models by integrating their positive aspects. The authors used the PjBL in the linear circuit analysis (LCA) lab at Riphah International University, Pakistan to support first year students of LCA lab in the spring of 2015 in design and simulation, physical implementation, analysis, and measurement of the electronic circuit. A survey study was conducted with the students to compare the use of PjBL and classical lab. The results showed improvement in the abilities of students using PjBL.

The research has shown that traditional classroom lecture constrains the learning of all students (Bonwell & Eison, 1991). It has been found that students are attentive in the starting 15-20 minutes but they tend to lose concentration afterwards (Milton, 1986), (Verner & Dickinson, 1967). This is the case for both non motivated as well as motivated students. This shows that there is a need to reconsider the lecture of a typical classroom. (Malik, 2011) has investigated the impact of using active learning strategies on the motivation and communication skills of first-semester graduate students of Masters of Education at International Islamic University, Pakistan. The author chose subject “Research Methods in Education” of three credit hours with 53 students registered to determine the impact of AL on motivation, communication skills, and academic achievement. The students were taught with traditional teaching for the first two months and then AL was incorporated in the lectures. The motivation of students was determined using a questionnaire by (Pintrich & De Groot, 1990). Academic performance was calculated based on the midterm and end term scores. A questionnaire was developed to measure communication skills and used twice during the study. The results show that students were motivated, academic performance improved, and gain in communication skills was achieved.

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During the search for studies on AL it was found that the use of AL in addition to HEIs has also increased to the high schools and colleges. (Majoka, Dad, & Mahmood, 2010) highlighted the same point in their study that there is a shift in the mode of teaching from being passive to active. Students become more responsible for their learning in AL. According to (Hung, 2006), "actively developing thinking and learning strategies and constantly formulating new ideas and refining them through their conversational exchanges with others" (p. 30). Among different AL strategies the authors used Student Team Achievement Division (STAD) which is a cooperative learning strategy where students are divided into different groups with different abilities to work together and achieve the common learning goals. The authors conducted a study to investigate the empirical use of STAD among the students of class 10 (secondary level) to teach mathematics. The students in the class were divided into groups. The control group students taught using traditional competitive situation. The experimental group was provided with STAD. The pretest of both groups was conducted and the scores showed the balance in terms of a mathematical base. The experiments were conducted for 10 weeks. During the 10th week both groups were observed for three days in terms of the level of engagement and at the end of teaching and a posttest of both groups was conducted. The observational data shows a high level of engagement among the students of the experimental group, the posttest scores of the experimental group were significantly better than the control group, and the retention rates of the experimental group were slightly better than the control group.

II.8. Portugal

An inspiring learning context provides opportunities for students to proactively seek knowledge and technical proficiency according to their capabilities of learning monitoring their own learning process: "AL undoubtedly enables an enriching learning context, where technical and transversal competences can be widely exercised and developed" (Colombo, 2014). However, adopting the traditional curricula and widely introducing this methodology is not an easy task due to pre-existing bias regarding this methodology. Usage of AL demands a change in the way subjects are taught and how contents are prepared and transmitted towards students, directly impacting teacher's attitudes towards these new methodologies. "Traditional learning is mostly

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an end-term process in which the fundamental acquired competency would be the competency to pass final exams. A more contextualized, autonomous, interdisciplinary learning and student-centered process, continuously assessed, could contribute to a more effective learning process" (Lima R. e., 2007).

All these difficulties may help explain why Portuguese universities are slowly but positively implementing and developing projects/actions that disseminate the importance of AL among their student and teacher communities.

In terms of the Engineering academic community progress there are some studies that discuss the difficulties encountered when adopting traditional curricula. Colombo, et al. (2014) state that the work developed is usually "(1) straightly patterned into the curricula; (2) loosely coupled or arbitrarily schedule amongst a number of degree courses; or (3) essentially absent" (p. ID55.1). So, it`s not just a question of adapting what already exists, but reconfigure it in a logical form, guaranteeing the quality of the knowledge and empowering the learning experience.

In spite of a slower progress, throughout the years some good examples can be highlighted and, more recently, some cases of officially adapting course curricula in Engineering are already registered and will be referenced in the section below.

One thing to have in mind is that the link between ICT and education is also crucial in this context. Education should be linked directly with technology calling upon teachers and students to help create a better and more flexible educational experience in an environment that maximizes the positive outcomes that can be achieved through active and technological methodologies. By observing the upward tendency on the application of ICT in new teaching models and methodologies it is evident the growing emphasis that is being given to the role that technology plays in education, but also the way they are helping the learning process and achievement of better results by students (Gonçalves, 2002), (Tavares, 2002).

According to a study conducted by (GEPE, 2008) technological modernization in Portugal has two main obstacles related with:

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- Insufficiency in gaining access to the necessary equipment and Internet connection.
- Qualifications and competences.

This, in turn, results in a reduced usage of ICT tools (which are significantly lower than that of the other countries in the European Union at the time of the study). Moreover, the report calls upon a crucial necessity in applying new emerging learning methodologies in contrast with traditional ones and creating applications, content and software in the Portuguese language to efficiently promote and consolidate our knowledge based society. At the time, virtual platforms of knowledge and learning were suggested as a possibility but promotion of ICT training for both teachers and students is also mentioned.

II.9. United Kingdom

For many years, Universities in the UK followed a very traditional approach to teaching and learning with the 'norm' being a lecture / tutorial structure with students being 'taught to' in large lecture theatres (often 200 - 500 students) and small, in office space tutorials, where 7 - 12 students would come to discuss some pre – set work, being standard (Gibbs, 1982). As technical subjects crept into the curriculum lab classes or "workshops" were introduced, where students would be timetabled to work through linear problems.

Pre 18+ education was quicker than HE to incorporate new models of learning. Two stand out initiatives were the Nuffield Science Program (http://www.nuffieldfoundation.org/nuffield-science-teaching-project) and the School Mathematics Project (SMP). The Nuffield Science Courses (1962) were characterized by their reliance on practical work carried out by students and the spirit of inquiry that infused the teaching. One consequence was that a great deal of effort was invested in developing new practical activities and the associated apparatus. Much of the equipment developed for the courses is still in use in schools today. The guidance about practical work in the guides for teachers was exceptionally detailed and unusually well illustrated making it easy to adopt. The School Mathematics Project (SMP) began as a research project inspired by a 1961 conference at the University of Southampton which itself was precipitated by calls to reform mathematics teaching in the wake of the launch of Sputnik and against a political backdrop which was to advance the learning of UK children, so the UK could

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'compete' with Russia in terms of science and engineering. SMP dwelt on subjects such as set theory, graph theory and logic, non-cartesian co-ordinate systems, matrix mathematics, affine transforms, vectors and non-decimal number systems. It laid the way for a new approach to Mathematics teaching, which was inquiry based and problem based.

II.10. Vietnam

Vietnam's higher education (HE) system has steadily developed thanks to the HE reform which started from 1990. The number of HE institutions has increased and the training quality has gradually improved. From the system consisting of only narrowly specialized universities with only Bachelor and PhD degrees following the former Soviet model now many of them have changed to multi-field, multi-disciplinary/comprehensive universities offering Associate/college, Bachelor/university, Master's and PhD programs.

It is stated that Vietnam's HE consists of the following 5 types (Vietnam's Law on Higher Education, 2012):

- Colleges.
- Universities.
- Academies.
- Local universities, national universities.
- Scientific research institutes eligible for PhD training.
- Foreign-invested universities.

At present, there are 498 higher education institutions out of which 93 are private.

There are two national universities: Vietnam National University, Hanoi (VNU) and Vietnam National University, Ho Chi Minh City (VNU-HCM). VNU and VNU-HCM have several member universities (7 and 5 respectively), research institutes (5 and 1 respectively), some schools, and a number of centers. The model of national universities has been stabilized by the government's decision which stated that two national universities operate according to their own Regulation on Organization and Operation promulgated by the government. Moreover, they are clearly stated in one separate article in the Vietnam's Law on Higher Education as comprehensive, high

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quality training, and R&D centers which are given priorities for development by the government.

According to Vietnam's Law on Higher Education, Vietnam's HE institutions are organized into state-owned public and private. State-owned public HE institutions are established by the government and receive budgets for their infrastructure, facilities, and operational expenditures from the government. Private HE institutions are possessed by social organizations, socio-professional organizations, private economic organizations or individuals, and invested and built by social organizations, socio-professional organizations, private economic organizations or individuals. The government supports public HE institutions to ensure that they always play a key role in the national education system.

Vietnam's higher education comprises the following levels: Associate/College, Bachelor/University, Master's and PhD.

- Associate/college is from 2 to 3 years depending on disciplines and is for students with upper secondary education certificates, 1.5 to 2 years for students with secondary vocational certificates of the same training disciplines.
- Bachelor/university is from 4 to 6 years depending on disciplines and for students with upper secondary education certificates.
- Master is 2 years for students with Bachelor degrees.
- PhD is from 2 to 4 years for students with Bachelor degrees and Master degrees respectively.

Colleges normally offer three-year programs and award Associate Diplomas to those who graduate. About two-thirds of Vietnam's colleges specialize in training teachers for lower levels of the education system. Colleges are small and the students in these colleges make up a small pan of the total enrollment of public HE institutions.

It might be right to say that HE management is characterized by a very high level of centralization. The Ministry of Education and Training (MOET) has significant power over higher education and determines the curriculum, student enrolment, academic assessment, awarding of degrees, staff appointments, budget decisions, infrastructure, and facility maintenance

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(Hayden, 2005). Universities have little experience in managing themselves or pursuing their own goals. There still exists a severe lack of close links between higher education institutions and scientific research, businesses, industries, and employers. However, it is worth noting that Vietnam's HE institutions are not only managed by the Ministry of Education and Training but also by various ministries and provincial people's committees: namely by Ministry of Education and Training (56), by other ministries such as Ministry of Public Security (11), Ministry of Defense (25) [wiki/danh sach cac truong dai hoc vien va cao dang tai Viet Nam], and by provincial people's committees. 40/63 provinces and cities have universities accounting for 63.3%, 60/63 provinces have colleges making up 95.2%. Most of Vietnam's college-level institutions are managed by provincial people's committees.

In relation to teaching and learning styles in Vietnam, the teaching style is, as indicated in a study by (Kramsch & Sullivan, 1996), authoritarian and based on Confucian moral lessons. The role of teachers in classrooms is like fathers in traditional families or the leaders of the institutions, and the students are considered as their children or subordinate members. Hence, the teacher is treated with deference and expected to transmit all the authority knowledge to students in order to help them pass their course. The teacher tends to be dominant and hold superior power over the students in classroom activities and academic matters. It means that the relationship between lecturers and students is unequal. Lecturers are used to being ranked just after the king as the proverb above indicates, so students should respect and follow what the lecturers say. In this context, teachers' duties are believed to include delivering their lectures and helping students to take notes, accept, and memorize knowledge rather than interpreting or questioning it. In addition, the practice of students asking questions during the class can be regarded as showing a lack of understanding or respect for their teacher. The teaching style is, therefore, still based on what would be considered a traditional or teacher-centered approach (Harman & Nguyen, 2010).

Correspondingly, the learning style of Vietnamese students is largely considered as passive (Harman & Nguyen, 2010). It is argued that this is a manifestation of Confucian values which place more emphasis on the importance of harmony over conflict and of collective rather than personal self-expression. The students are less likely to voluntarily express personal opinions,

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beliefs, and feelings openly or directly. Many would not consider questioning or challenging their teachers' knowledge and ideas or those of their classmates, in fear of either being seen as unknowledgeable or humiliating others. This is often related to being frightened of losing face, which inflicts extremely serious personal damage and is thus best avoided (McCornac & Chi, 2005). Additionally, limitations in curricula, programs, and teaching approaches such as excessively academic curricula, heavy teaching loads, and the teacher-directed approach have been argued to disrupt active learning (Harman & Nguyen, 2010). As a result, students seem to be quiet, passive and lacking in contributions and responsibilities for their learning (Le, 2013). They rarely initiate or engage in learning activities. Instead, they mainly listen and memorize provided information in order to reproduce the knowledge.

There are a number of recent studies that have investigated Vietnamese students' learning styles in the contexts of globalization and internationalization of education. For example, (Dang, Nguyen, & Le, 2013) studied how Vietnamese students can become active learners in the context of their training as English language teachers by English speaking teachers in Vietnam. (Dang, Nguyen, & Le, 2013) demonstrated that being taught by English-speaking teachers prompted the pre-service teacher students to adopt some characteristics of their teacher's style. (Nguyen C. T., 2012) investigated autonomous learning of Vietnamese students in Australia. This study focused on how Vietnamese international students can become more autonomous in their learning in Australia. (Nguyen C. T., 2012) study looked at one particular characteristic of active learning: Autonomous learning. The study was based on interviews of Vietnamese international students about the ways that they gradually became independent learners. The studies demonstrated that with relevant support, Vietnamese students moved towards being more independent and autonomous learners than they were at the beginning of their study in university.

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III. EXISTING NATIONAL/LOCAL/INSTITUTIONAL INITIATIVES TO PROMOTE APBL

III.1. Bulgaria

Following are some examples of initiatives that promote APBL in Bultaria:

- Erasmus+ Project "Innovative tools to improve the skills of university lecturers so as to enhance the quality of higher education in Bulgaria", 2016 -2019.

  The project is initiated by the Ministry of Education and Science. It aims to study the needs of academics in relation to improving their teaching competence. A book of good practice is going to be published.

- Seminar "How to improve teaching skills and education in Bulgarian universities", 30.05.2017, Sofia.

  The seminar was conducted by the Ministry of Education and Science where presenters from Norway and Bulgaria presented best practices.

- Strategy for Development of Higher Education in the Republic of Bulgaria for the2014-2020 period.

  One of its aims is to "improve the quality of higher education for providing opportunities for further qualification of university lecturers."

- Development of distance learning strategies and respective online materials by all universities within Operational Programs.
- Program for adapting the educational system to Net generation, 2017, Russe University.
- Scientific papers on APBL presented at national conferences.

III.2. Estonia

While higher level education is not regulated by the state laws, the activities at the primary and secondary school level is coordinated by the state learning programme - a regulation that is

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mandatory to all schools. The latest version of this regulation puts extra effort on increasing the number and quality of active learning activities. It suggests replacing traditional presentation and drill and practice based activities with techniques that support learners' creativity and collaboration. Different national and European initiatives were initiated in order to provide support to teachers who didn't know what exactly to do in the changed circumstances. For example one initiative among others was iTec project (FR7 2010 - 2014), which aimed to promote innovative teaching strategies such outdoor learning asking students to design teaching models, learning games, educational stories, etc. (http://itec.eun.org/web/guest).

At the university level the use of active learning methods is promoted by different institutions and experts. Following is just a short example of supportive materials and guidelines created for this purpose:

- Tallinn University course about Teaching at the Higher Education Institutions - including cooperative and problem based methodology. (https://ois.tlu.ee/pls/portal//!tois.ois_public.draw_page?_page=26C55172C85FAFF3D6EB1F8D2FED4A6307BA759863366D72&p_id=8892278EBBDF5D3E)
- Tartu University's tips to the students how to be actively involved in their studies - including how to use effective memory strategies: to take notes, use mind-maps, check-lists, etc. (http://www.test.tudengiveeb.ut.ee/et/esileht/tulemuslik-korgharidus2/15-oppimine-korgkoolis/106-naepunaeiteid-aktiivseks-oppimiseks)
- Mari Karm's book about Higher Education teaching methods such as: active presentation, questions based guidance, discussions, debate, group work, case study, PBL, role play, infographics, ertc (https://ec.europa.eu/epale/sites/epale/files/oppemeetodid.pdf).
- Mari Karmi, Triin Marandi, Einike Pilli, Katrin Poom-Valickise and Lehti Pilti - Active learning methods (http://www.e-ope.ee/_download/repository/juhendisse_aktiivoppemeetodid.pdf).
- Tatjana Baum-Valgma and Anastassia Šmõreitšiki "Active learning methods to teach Estonian language and culture" (https://www.digar.ee/arhiiv/et/raamatud/21618).

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- Arno Baltin - Groupwork methodologies (https://sites.google.com/site/ryhmatooe6piobjekt/tehnikad).
- Jaan Mikk and Hiie Hasser - PBL in Higher Education Institutions (http://kodu.ut.ee/~jaanm/probleemope.htm).
- Maia Lust - PBL methods in e-learning (http://aktiivopemeetodid.weebly.com/probleemipotildehine-otildepe.html).

III.3. Greece

PBL appears to be effective model for producing gains in the development of social skills. It offers a wide range of benefits to students. Some of these benefits can be listed as below:

- Grouping students of all academic levels, mixing the males and females, the athletes, the popular, and the socially awkward, breaks down the social structure of “cliques” often found within schools and leads to higher self-esteem and better communication skills.
- Students, working both individually and cooperatively, feel empowered when they apply critical thinking to solve problems. In this productive work, students learn and strengthen their work habits and throughout this process, students learn new knowledge, social skills and positive.
- Student activity revolves around a complex series of interactions between team members and draws on a range of key transferable skills such as communication, planning and team working.

Moreover, the teacher’s role is less that of an instructor who transmits information and organizes activities for practice and more that of a guide and a facilitator, which it is a critical role. Projects require that teachers know their learners’ interests. Teachers must listen when learners become excited about a topic, and start asking questions. Facilitating PBL requires the kind of leadership skills that allow teachers to help a group of learners to move in the direction that they want to go without getting defensive when students decide they like their own ideas better. It is of great importance if teachers possess a tolerance for ambiguity some skills in

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helping learners negotiate conflicts and enough self-confidence not to give up when a project peters out or refuses to come together.

III.4. Cambodia

The majority of the APBL activities implemented in Cambodia are related to primary school and secondary school. Education reform requires novel initiative with good policy and procedures. One of initiatives closely related to active learning is known as "Child Friendly Schools" defined in the official policy document of the ministry of education (Ministry of Education, 2007). Child Friendly School is defined as a school that values and nurtures what children are able to achieve with their basic rights. Child Friendly Schools collaborate closely with a series of parties such as parents of students and many other contributions that provide the right condition and conductive environment for all children to attend school. These lead to the overall effective learning quality of children by focusing on the current and future needs of each child. The Ministry of Education clearly defines that the learning environment of Child Friendly Schools are defined by equity, balance, solidarity, freedom, and the outmost care for physical, mental, and emotional health. These lead to the development of knowledge, skills, attitudes, values, and morals so that children can live together in a harmonious way. In 2009, two government Officials from MoEYS interviewed were both very delighted in their support of Child Friendly Schools and particularly its focus on active-learning and child-centered instruction. Child Friendly Schools represent the example of a very important AL initiative done by Ministry of Education, leading to the optimal outcome of study. Through Child Friendly Schools, students will also be fully engaged and they will be able to successfully reach the four pillars of learning, namely remembering, knowing, reflecting, and applying.

There is also the noticeable initiative funded and assisted by USAID in 2003 for basic education for children in grades 1 to 9 (Bunlay, Wright, Sophea, & Bredenburg, 2009). The purpose of this initiative is to promote the development of competency-based learning, AL student based approach, life skills curriculum, and to enrich teachers' capacity through training. In order to achieve this objective USAID encourages relevance and quality of basic education by introducing AL student-based approach. The program focuses on reform and positive change within the

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MoEYS, supports the recruitment and training of teachers from minority groups, and is integrated into key government education initiatives, including the five-year strategic and operational plans. This national education reform efforts towards AL yields valuable information concerning the agency's perspectives and efforts related to policies on the enrichment of AL pedagogies. While USAID does not have existing strategy AL pedagogies, USAID/Cambodia fully supports the policy of the Ministry of Education, Youth, and Sport on Child Friendly Schools and requires NGOs to include this strategy in implementing projects funded by the USAID Mission in Cambodia.

Another initiative has been undertaken by the team of researchers from the Royal University of Phnom Penh on a review of selected teaching training materials related to active learning as part of a study for UNESCO on inclusive education (Zimmerman & al., 2009). All reviewed curricula emphasized the necessity of active learning (student-centered approach) but still they have found some limitations within the methods used. The main features in this initiative are cooperative and collaborative learning as well as problem-oriented teaching and individual educational planning and support. In 2009, observations of teacher training at the Kandal Regional Teaching Training Center gave evidence that a significant amount of active-learning and student-centered instruction can be found within the observed location. However, more actions must be taken to achieve more. The director of the center reported during a formal presentation to education delegates from other countries in the region that "the practice of the learner-centered approach in learning and teaching has not been efficient enough yet" (Nuon, 2009). When asked later to elaborate, she said that there is a shortage of materials they can use to train the students in learner-centered instruction and thus is it not as emphasized as much as it should be. She said, however, that about 80% of her trainers are skilled in learner-centered instruction and use it and model it in their own classrooms.

Although the active learning and problem-based learning have been applied in the university education, concrete information such as official reports or survey results concerning AL and PBL activities from particular institutions as well as university have not been gathered. However, active learning strategies have been widely used not only in the public but also in the private institutions and in particular in language learning. Teachers select an appropriate AL strategy

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differently depending on size of the group of students. Possible strategies include but are not limited to reflection paper, debate, peer review, and case studies. Furthermore, teachers utilized PBL when the real issues require discussion among students. This generate virtually realistic experience for students by extracting ongoing issues facing Cambodian society and fictional case studies derived from official reports as well as scientific journals. Students involved in PBL are able to explore possible solution to problem, plan actual investigation, clarify controversial ideas, and propose credible and rational resolution. Further investigation to understand the comprehensive scope is required as information collected is inadequate to clarify the ongoing activities for AL and PBL in Cambodian educational sectors.

III.5. Malaysia

The need for the inclusion of PBL in the engineering classes in Malaysia has been the result of the numerous feedback and complaints received from stakeholders of the higher learning institutions, especially the job industry (Ministry of Human Resource Malaysia, 2005). Unsatisfactory remarks and complaints of poor quality and performance of a significant number of Malaysian graduates are imminent and have raised concern among the government, industry, and parents. In consequence, this has led to the gradual process of curriculum review, not only at the primary, but the tertiary level as well.

The Engineering Faculty of the University of Malaya (UM) was amongst the first to introduce PBL in Malaysia through their selected courses. The extent of PBL implementation was gradually introduced to the students at the faculty according to the academic years as shown in Figure 1. The PBL content in the first-year courses should be minimal at about 20%, because the first-year undergraduate students at the faculty came in with Higher National Education Certificate (STPM) qualification or equivalent level with knowledge on core science subjects such as mathematics and physics. Therefore, the types of PBL problems that can be given to them are limited to simple problems, which can be solved using this knowledge. Other fundamental subjects in electrical engineering and telecommunication taught in the first year, such as engineering mathematics, circuit theory, and electromagnetic theory, should still be taught

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using the conventional method in order to establish solid grounding of the theoretical and fundamental knowledge in these subjects.

In the second year, the implementation of PBL can be more extensive. Commencing 2003/04 academic session a course on thinking and communication skills was taught to all second year undergraduate students at the University of Malaya. This course is based on the premise that thinking and communication skills can be enhanced if taught in an organized approach (University of Malaya, 2003). With regard to PBL, it is hoped that these skills can be utilized in tackling PBL based assignments in the courses within the faculty. By the second year, the undergraduates' knowledge in engineering would have increased. Therefore, therefore the number of courses to be taught using the PBL approach can be increased (40%). With the same understanding, the number of courses taught using PBL can be increased even more in the third year (60%). By the time the students reach their fourth and final year of study, they would have amassed enough engineering knowledge that enables most of the fourth year courses to be taught using the PBL approach.

III.6. Nepal

PBL/Active learning has been practiced in Nepal for 30 years with some additional inputs every 10 years (B., E., MR., & H., 2012). The first institute to introduce it in Nepal was institute of medicine, Tribhuvan University.

In 2011, with the great support of faculties of Harvard University, AL and PBL were introduced to the first batch of MBBS student in KUSMS (Kathmandu University School of Medical Sciences). KUSMS has been applying PBL academic programs during pre-clinical stage (i.e., the first 2 years) of MBBS course. During this period, approximately one third of the total academic hours for about forty cases are covered only by PBL methodology.

In KUSMS, PBL may be used either as the mainstay of an entire curriculum or for the delivery of individual courses. In practice, PBL is usually part of an integrated curriculum using a systems based approach, with nonclinical material delivered in the context of clinical practice. A module or short course can be designed to include mixed teaching methods, including PBL, to achieve

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the learning outcomes in knowledge, skills, and attitudes. A small number of lectures may be desirable to introduce topics or provide an overview of difficult subject material in conjunction with the PBL scenarios. Sufficient time should be allowed each week for students to do the self-directed learning required for PBL.

The given below are the steps KUSMS applied in PBL methodology, it includes five components of perfect PBL (Mansur, Kayastha, Makaju, & Dongol, 2012):

- PBL cases.
- PBL groups.
- PBL session.
- PBL study session.
- Wrap-Up session.

Following is a discussion of each method.

PBL cases:

During the class, the faculty member / tutor will select / create cases or problems relatable to regional health problems. The format of the problem simulates professional practice or a real life situation and can involve a real or standardized patient or a paper case. It is the tutor's or facilitator's job to prepare any clinical based cases that can give basic concept on that particular problem. Before collaborating with classes, it is he faculty members' job to discuss among them and come up with concrete results to share among tutor and co-tutors. On average, 3 cases are introduced in a 4 – 5 weeks block of studies and 4 - 5 cases in a 6 – 8 weeks block. Since problems and cases cannot be concluded and solved in a very first attempt, class participants are even allowed to use other form of media such as video, the internet, and digitized computer applications. Cases are constructed in a manner that allows students to explore what they know until it becomes evident to them that they do not have enough information to decide among the hypotheses they have developed making imperative the need for researching for additional information.

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PBL groups:

PBL provides a logical approach in training students for practicing medicine in a complex environment by exposing them to simulated problems which may reflect real life. So, this is good thing that our medicals schools are also changing over to a PBL system. Generally PBL groups consist of 6 - 8 students only. However, in the case of KUSMS a PBL group once had 10 students where one student was the chairperson and another was the scriber. Also, each group includes at least one tutor, who has to be a MBBS doctor and one co-tutor.

PBL sessions:

In PBL sessions, total time of 2 hours three times in week on different dates is allocated. During this session, participants usually mark “problems” as a primary source of learning. The tutor’s first job is to form a group setting. This session focuses on learning process in which students are encouraged to learn or analyze any problems by themselves first rather than accepting any help from tutors. In PBL sessions, the tutor is projected as a process manager and not necessarily an “expert” except in the process.

In KUSMS, PBL process is based on clinical and relevant cases where each group will identify and clarify unfamiliar terms. Students have to define the problems first then they analyze them and explain the underlying causes. Their job is to summarize and discuss the analysis. Each group formulates learning objectives first and then each student is assigned self-studies on those formulated learning objectives. At the end, everyone brainstorms, contributing their understanding.

PBL study sessions:

After each PBL session, 2 hour PBL preparation (study) time is allotted. The students are supposed to use this time and also other time for the preparation related to PBL. During study sessions, students use available resources with students, available books in library, journals, internet resources, and research results.

Wrap up session:

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At the end of each block, a wrap up session takes place. It lasts 1 hour. In the wrap up session Students should select and present different topics related to the PBL cases which are made in their learning objective during PBL session. Also, the presence of all the faculty members is mandatory.

III.7. Pakistan

Following are some examples of AL and PBL in Pakistan.

Peer Teaching and Peer Assessment for Policy studies:

Peer teaching was focused for policy studies by Sarwar and Shah. It is the phenomenon that allows the student to teach their peers. It has been extensively applied in education generally to increase students' involvement and learning. Peer teaching aids students by encouraging an in-depth immersive study of the material to analyze and select key concepts into one's own words to teach their fellows at higher education level. For their learning students feel empowered, active, and responsible in peer assessment. In Pakistan, assessment is narrowed to examinations that may turn biased. In between peer assessment and teacher assessment there was strong positive correlation. This enhances the dependability of peer assessment. The researchers concluded that at university level peer assessment may be used in addition to teacher lecturing for students' learning. Students' involvement at university level in active learning through peer-teaching and peer-assessment is found active, operative, and effective. The authors found that through peer learning, learning experience becomes more autonomous, interactive, independent, and reflective.

Cognitivism and Constructivism (The pedagogical practices) for ADE/BEd (Hons.) programs:

A study was conducted to study that active learning strategies applied in lectures provide increased student engagement and improved learning outcomes. Cognitivism and constructivism delivers the foundation for active learning. Students must involve in reading, writing, discussion, or be involved in classroom and primarily, to be actively involved, they must be involved in higher-order thinking to perform tasks that involves analysis, synthesis, and evaluation. Active learning techniques emphasize on the undeviating and direct involvement of

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the student with the learning material and can comprise brainstorming, quick surveys, think-pair-share, short writes ,debate, role playing, cooperative learning, collaborative learning, formative quizzes, and simulations. A passive teaching and learning environment can be transformed to active by simply changing the traditional lectures through incorporation of active learning strategies and transforming them into active lectures.

III.8. Portugal

In order to develop and implement the Project objectives, it is essential to first analyze what the current national strategies for linking education and technology are, which, in turn, will be translated into real ongoing cases as examples. There are a series of existing national initiatives promoting AL in Portugal with a majority of Universities applying it in the Engineering, but also in Sciences and Health fields of study and research.

The Games Interaction and Learning Technologies (GILT) Research & Development Group, located at the Engineering College (ISEP) of the Porto's Polytechnic Institute (IPP), focuses on the analysis, design, and development of scientific and technical knowledge in the fields of Serious Games, Assistive Technology, Learning Technology, Interaction and Health Technology. This mission is integrated with post-graduate programs at MSc and PhD level, instigating students to learn in a proactive form, once they are part of the team that designs, develops and test the ongoing projects. Additionally, and emphasizing the relevance of collaboration, GILT is also part of leading international collaborative projects and joint initiatives with other academic and commercial institutions which promote these innovations in the Education field.

A practical example worth mentioning and provided by GILT is the case of the haptic simulator called "Forces of Physics", provided to help learners understand the relation between the theoretical physics concepts and their practical application. The simulator intended to complement the traditional educational process providing the students with hands-on experiences, therefore trying to implement an experimental learning methodology (Vaz de Carvalho & Santos, 2013).

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A second successful case is the project eCity Serious Game, which the main objective was to design, develop and validate a PBL-oriented, online, collaborative VLE platform, based on a city-development simulation engine that stimulates the integration and continuous exploitation of PBL. This was implemented, specifically, in secondary education, but demonstrates the importance of disseminating these practices in Portugal.

Still focusing in the Engineering field, there is another case integrated in the Engineering School, specifically thought for the integration of new students in Systems Engineering Course. This degree was designed following the principles and recommendations established in the CDIO (Conceive-Design-Implement-Operate) initiative. During the first 4 weeks of the first semester, the students attend a single subject, Engineering Labs I (LENG1), where a PBL methodology is implemented. The study presented refers to the 2016/17 edition, attained by 48 students, where two projects proposed, respective activities and results are described. The students' comments regarding their acquired competences and motivations are also presented (Magalhães, 2018).

"The PBL teaching and learning methodology provided a context of design and project, an active and experiential learning in a multidisciplinary environment. Thus, students obtained a set of ethical, social, and technical skills, such as teamwork, research, inter, and intra group communication and report writing, which will be useful for the rest of the course and their professional future. Projects worked out were motivating for the students to learn different areas of engineering and integrate them in the class, ISEP campus and city and established good principles of commitment in teamwork." (Magalhães, 2018).

Expanding outside the Engineering field, Algarve University makes use of a simulator in the Bachelor Degree in Enterprise Management. In the last semester of the degree students can choose the curricular unit "Entrepreneurial Games" which explores a business simulator named Cesim Global Challenge for learning purposes. It integrates the various areas of management and facilitates the development of diagnostic, analysis and decision-making skills in the context of overall management (Kikot & al., 2013).

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The Health field can be said to be one where AL and PBL are predominantly implemented. One case is from Minho University, in the scope of the Curricular Unit of Child and Adolescent Health Nursing, of the 3rd year of the Bachelor Degree in Nursing, in the academic year of 2010-2011. The PBL experience included the description of a given real-life situation by one or more observers. The case had to be discussed and analyzed in small groups of students, facilitating the proximity to the teacher as facilitator of learning and encouragement to individual study and group discussion (Silva & al., 2015).

The Integrated Master Degree in Medicine at the Beira Interior University also offers a PBL approach based on practical and multidisciplinary activities (FCSUBI, s.d.). This methodology allows the student to have personalized support, while avoiding repetitive and isolated teaching techniques.

Conclusively, Portuguese higher education institutions, particularly in medical Sciences and Engineering, are starting to apply active learning methodologies with excellent results which are the basis for a systematic adoption of these methodologies.

III.9. United Kingdom

Innovation in teaching and learning in UK universities tends to lag behind the innovation in compulsory education. There are not the same political or altruistic drivers for change. Innovation instead is primarily driven from two positions:

- The natural inquisitiveness of academics.
- An economic desire to keep the UK HE system competitive and effective.

Academics and initiatives:

In the UK HE system there is no national curriculum and so the individual lecturer typically has considerable flexibility to structure their teaching by determining the mix between lectures and workshops – by asking for certain rooms and by suggesting certain physical spaces. Within that, and given that the academic can then also structure each learning event as she thinks fit, obviously constrained, to some extent, by the rooming. Over several years enthusiastic staff in universities have explored many active learning methods especially the use of clickers on lecture

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theatres (Abdulwahed, Jaworski, & Crawford, 2012), the use of flipped classrooms (Bryson, 2016) and the use of problem-based learning (Seery, 2015). There are many papers that document these initiatives.

External influences:

External influence in UK Universities comes from two instruments that are not entirely independent. They are the National Students Survey (NSS) (https://www.officeforstudents.org.uk/news-blog-and-events/press-and-media/national-student-survey-2018-shows-high-satisfaction-levels-but-still-more-to-do/) and the Teaching Excellence Framework (TEF).

The NSS is an annual survey that was started in 2005. This survey opens between January and May each year and asks a set of questions that are then scored so that a rating can be given to each course in a University. The NSS scores directly influence the positions of Universities and courses on league tables. Given the importance of league tables on recruitment, universities are extremely anxious to maximize NSS scores and so spend a lot of money and time on trying to 'improve' their NSS scores. Questions in the NSS that might encourage Universities to think about learning spaces and learning paradigms include:

- The IT resources and facilities provided have supported my learning well.
- I have had the right opportunities to work with other students as part of my course.
- Staff has made the subject interesting.

Other questions provoke responses that could also be enriched by having better learning experiences:

- My course has provided me with opportunities to explore ideas or concepts in depth.
- My course has provided me with opportunities to bring information and ideas together from different topics.
- My course has provided me with opportunities to apply what I have learnt.

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As well as the NSS, a more recent innovation is the Teaching Excellence Framework (https://www.officeforstudents.org.uk/advice-and-guidance/teaching/what-is-the-tef/). This is another government driven initiative designed to rank and score universities on their teaching quality. The Teaching Excellence Framework (TEF) was initiated in 2017 and awarded Universities with a Bronze, Silver or Gold status. From 2020, TEF will start to score subject areas in a similar way to how research has classically been ranked using the REF exercise. TEF uses three of the results from the NSS, teaching, assessment, and academic support, together with data on student dropout rates and data on graduate destinations.

These two scoring systems initially encouraged universities to invest heavily on monitoring feedback on assessments as well as focusing on improving student support; the low hanging fruit of the NSS and TEF orchard. More recently, as all universities have "upped" their game in these areas, there has been a nationwide push towards enhancing the entire learning experience so that there are simply happier students.

III.10. Vietnam

In Vietnam, PBL has not been introduced formally but there is a trend towards AL. In Vietnam, Intel is involved in engineering education and according to their report the learning methods are mostly passive: there was little to no active or student centered teaching approaches and especially project based ones (Intel, 2013). More broadly, the Higher Engineering Education Alliance Program (HEEAP) recently audited the country's current engineering education system. Vietnamese and American Universities and several international corporations with the in fine objectives to support the systematic transformation of Vietnamese engineering education conduct this alliance jointly. It is worth highlighting two action items of the alliance in their first pilot, HEEAP 1.0 (2008-2013):

- Designing multidisciplinary and problem-based curriculum.
- Training Vietnamese academics to new active learning and teaching methodologies.

Outcomes from this phase indicate the early success and positive feedbacks where AL techniques, such as cooperative learning, were well received by students. The students were also reported to enjoy the new activities and projects as well as learn in HEEAP classes (Intel,

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2013). Following these initial outcomes, it is reasonable to say that there is a demand for active learning methods at national level.

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IV. BEST PRACTICES IN THE USE OF APBL

IV.1. Bulgaria

Following is a discussion of best practices in the country.

PBL at the Medical University Pleven:

The university uses a teaching model that is a hybrid combining traditional learning with PBL. The teaching model is a combination of PBL sessions based on clinical cases, lectures and lab classes.

Teaching deploys PBL sessions in which students work in small groups of 6, guided by a tutor. Students are given a clinical case for a discussion, where hypothesis are presented. The unanswered questions are left to be further researched at home. The students collect data and analyze the new information. When back in the classroom, the clinical case is discussed again. In case of new questions during the second sessions, the students continue to do the subject-related research at home.

The benefits were measured by 101 students and 33 lecturers against traditional teaching/learning model.

Benefits for students:

- Better presentation skills.
- Overcoming the power distance between the lecturer and the student – building trust and friendship.
- Critical thinking.
- Better communication skills.
- Team work.
- Higher requirements towards the lecturers.
- Systematic and regular preparation for classes every week.

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- Lower level of stress.
- Better group dynamics.

Benefits for teachers:

- Improved teaching competence.
- Overcoming the power distance between the lecturer and the student – building trust and friendship.
- Getting aware of the content and way of teaching of similar subjects.
- Reconsidering the way of teaching of their subject.
- Teaching becomes more rewarding.
- Lower level of stress.

PBL at the Technical University of Gabrovo:

The university uses a teaching model that is problem and project based. This model is incorporated in the Curriculum of 3rd and 4th year students following a degree course in Mechatronics. The university further uses PBL in an Apprenticeship Cluster for Industry-Ready Engineers of Tomorrow.

PBL is one of the teaching methods pinpointed in both the curriculum and its study programs. Students work on real life industrial problems in a team facilitated by the university lecturers. Project based learning is incorporated in the apprenticeships where students are supposed to work at enterprises on projects involving them in teamwork with company engineering staff, guided by academic and company mentors.

The real benefits are to be tested in 2019. However, the following benefits are expected.

Benefits for students:

- Higher motivation to learn and develop themselves.
- Successful teamwork.
- Enhanced analytical and critical thinking.

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- Better communication and presentation skills.
- Higher level of creativity.
- Regular preparation for class work; overcoming the power distance between the lecturer and the student – building trust and friendship.
- Time and priority management.

Benefits for teachers:

- Improved teaching competence.
- Overcoming the power distance between the lecturer and the student – building trust and friendship.
- Getting aware of the content and way of teaching of similar subjects.
- Reconsidering the way of teaching of their subjects.
- Teaching becomes more rewarding.

IV.2. Estonia

Garage 48 is a startup hackaton series for turning ideas into prototypes (garage48.org/en). They organize series of events focusing on different problems and objectives (e.g. how to support elderly people with the help of innovation and technology). In the beginning of the event participants present their ideas. Small teams will be formed around most promising ideas. Teams work intensively 48 hours for developing the first prototype. In the end of the event prototypes will be presented and winners will be selected. Meanwhile teams will get support from mentors and experts. Hackatons have proven to be efficient method for creating new products and services and also for starting new companies and building networks.

Hackatons are active learning events similar to Garage 48 events. Main difference is that they are coordinated by different organization (Garage 48 is one specific institution) and in different formats (Garage 48 is a registered trademark). The common aspect of every hackaton is that people who donät know each other gather together, form teams, and design prototypes or

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solutions to specific problems during the limited time of period. Every hackaton can be different depending on the duration, ranging from half a day to one week, price list or follow-up activities. Hackatons are coordinated by different organizations and institutions like universities, research institutions, non-profit organizations (e.g. IGDA Estonia www.igdaestonia.org) etc.

Game Founders is a global game accelerator, established in Estonia (www.gamefounders.com). It's an incubator for game startups and indi studios. From one side it is a business initiative that invests to the promising game startups. It is a unique arrangement of game related learning activities. Teams and studios selected for this program have to change physically their location and work next to each other for 3 months. They also provide a mentoring program and organize regular design and development sessions. Team members can learn from each other, through practice and from different game industry experts. Attendees have provided feedback that 15 min discussion to find answers to current development, design, or marketing needs with an expert is worth one year study at the university.

Mektory is a Tallinn University of Technology innovation and business centre (www.ttu.ee/mektory-eng). Its objective is to bring together scientists, students, and entrepreneurs to solve practical problems and generate new ideas. It contains several laboratories for testing and demonstration such:

- Wood lab.
- Metal lab Welding lab.
- Paint lab, Automaticum.
- Electronics lab.
- Mechatronics lab.
- Cool Tool studio.
- 3D Printing Innovation Lab.
- App lab.
- LEGO lab „Playful learning".
- Smart Lab.
- Virtual reality lab „Re:Creation".

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- eHealth lab.
- eRiik.
- Space Centre.
- And more.

Moctori offers trainings consultations and support for students, startups and other targethroups interested in R&D and Innovation.

Bank of ideas is one example among several others how industry partners are making collaboration with Mektory (www.ttu.ee/projects/mektory-eng/mektory-center/reservable-rooms/bankofideas). This is a seminar room sponsored by the Swedbank, a leading finance institution in the Baltic and Scandinavian area. On the other hand, this is an example of collaboration between the universities and private companies. In current case Swedbank is interested in developing innovative solutions for supporting the financial literacy among youngsters and young adults. They offer meaningful problem statements and financial support for university students who are interested in developing innovative solutions.

Game Lab is a community of game development enthusiasts who coordinate game design and development events in different Tallinn universities and game industry institutions (game-lab.ee). All activities are based on the effort of volunteers and the main learning strategy is community based learning. They learn from each other and from industry experts. GameLab target group is not limited by any of the age groups and they are the main source for different game development events, including hackatons.

IV.3. Greece

Following are examples of PBL practices in engineering courses in the Department of Electrical and Computer Engineering of the University of Thessaly.

PBL in programming (ECE115 Programming I, n.d.):

The programming course exposes 1st year students to the main concepts of programming and problem solving with computers. It introduces C, a classic, powerful procedural programming language. The course includes a mandatory lab in which participants apply in practice – in a

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series of exercises – the material taught in class in order to familiarize themselves with the concepts and techniques. After successfully fulfilling the requirements of the course, the student is capable of:

- Analyzing the requirements of problems which are to be solved with a computer and synthesizing a solution.
- Producing solutions which strictly comply with given specifications.
- Knowing the main characteristics and structures of the C programming language and applying the most appropriate on a case-by-case basis to implement his/her algorithmic solutions.
- Applying the basic principles of software engineering in order to organize his/her code efficiently (structure, readability, design).
- Verifying the correctness of programs and identifying errors.
- Using program development and debugging tools.
- Working both individually and synergistically in small groups, with specific time limitations.

PBL in numerical analysis (ECE220 Numerical Analysis, n.d.):

The course aims to give students the necessary knowledge and tools to solve known mathematical problems arising directly problems from hardware and telecommunications (including solution of systems of linear and nonlinear equations, solution of differential equations, data approximation, etc.). MATLAB software, which is well known and used by engineers and computer scientists, makes it possible to implement and study the methods presented in theory. Upon successful completion of this course the student will:

- Have a great understanding on how to solve linear systems by direct and iterative methods and will be able to choose the proper method per problem.
- Have knowledge of basic methods of solving systems of nonlinear equations.

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- Have knowledge of data approximation and interpolation methods using polynomials, splines, and trigonometric functions (Fourier).
- Have knowledge in basic numerical methods of finite differences differentiation and integration, which will be extremely useful for the numerical solution of differential equations.
- Be able to understand the effect of finite arithmetic errors and errors of methods in numerical results.
- Have basic knowledge of MATLAB software and its toolboxes.

IV.4. Cambodia

According to (Ginsburg, 2010), initiative has done by USAID in organizing activities and workshops in Cambodia in order to promote AL pedagogies. Moreover, the Cambodian government is seeking with foreign aids to revise some of primary and secondary curriculum to stimulate AL. The research into this activity shows that instructors do not routinely practice AL pedagogies and the quality and intensity of programs varies widely depending on the international assistance. Despite unpromising response, teachers participating in USAID-supported initiatives reported that they can significantly improve their knowledge and understanding of AL and the cooperative learning approach. As the students are directly involved in PBL and AL, they are likely to be very friendly and confident to express themselves and participate in discussion. What is unclear in this initiative is that teachers probably do not apply sufficient problem-based learning and critical thinking skills.

IV.5. Malaysia

While the use of PBL method in courses such as medicine and management are quite common in Malaysia its adoption in engineering courses is quite limited. An exhaustive literature search performed found a total of only 6 published works that described about the PBL implementation in engineering and related courses. The search was focusing on the journal articles and conference proceedings on the implementation of PBL in the Malaysian institution

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of higher learning (IHL), which can be found from the bibliographic databases that specialize on education and social science research. The 3 works that describe case studies on the use of PBL in engineering related courses at the institution of higher learning in Malaysia are explained below:

The first study was performed at the Faculty of Civil and Environmental Engineering, Universiti Tun Hussein Onn (UTHM), one of the public IHLs in Malaysia (Hashim et al, 2006). In the first semester of 2005/2006 session, the Faculty of Civil and Environmental Engineering introduced PBL in the Solid and Hazardous Waste Management subject. Two topics were chosen for the purpose:

- Proper Management in Hazardous Waste Handling.
- Treatment and Clinical Waste Disposal: Comparing the Technology.

Each topic was covered for 2 weeks. The students were divided into three groups of 6 students each during the PBL sessions. The assessments were based on their workload, nature of problem solving project, individual and group participation as well as aspects of creativity in their presentation.

Evaluation was performed at the end of the semester. It was found that the students had achieved better grades in the related topics of the subject and they showed improvements in both tests and the final examination compared to the previous semester when PBL was not implemented yet. The students also enjoyed the experience of working as a team member compared to learning conventionally trough lectures. The PBL sessions also gave them the opportunity to better familiarize themselves with inquiry learning and searching for materials via the Internet, books and journals within the limited time given. The findings reveal that the benefits gained by the students are not limited to only the content of the subject, but they also the equally crucial aspect of human resource development, which are the generic skills like leadership, analytical thinking, conflict management, decision making and et cetera.

The second case study was also performed at the same university, UTHM, but by different faculty. It was done at the Faculty of Electronics and Electrical Engineering. In the Faculty of Electronics and Electrical Engineering, PBL method was first implemented in the

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Microelectronics subject. The objective of the PBL session was to enable the students to design a 4-bit carry lookahead adder (CLA) using both top-down and bottom-up approaches. Ten undergraduates were involved working as a team to accomplish the task. Each of the team members were given specific tasks towards achieving the common goal of coming up with the required CLA design. Throughout the 2 month duration, the students were expected to learn new computer-aided design (CAD) and electronic design automation (EDA) tools, determine the most suitable methodology flow, and prepare the presentation and the documentation of the project.

Throughout the project, a majority of the students confessed that they gained a lot both in terms of theory and the practical aspects. The given problem excites the students' curiosity to know more and this resulted in the exploration for new ideas and finding solutions to the given problem with the help of newly introduced software and techniques that they have just learned. In brainstorming and discussion sessions students were able to exchange useful information and ideas which were helpful for the completion of the project. The students also improved on their study skills like conducting library research, making references, doing simulations. At the end of the session, 4-bit CLA codes and a 4-bit CLA layout are made available. Simulations on both end products were presented and validated against initial specifications, minimum area used, fastest speed and least amount of transistors. In general, the PBL project has resulted in the students becoming more proactive, creative, innovative and more responsible towards their academic development. Besides, it has also better enhanced the students' problem solving skills, management and communication skills, leadership skills, effective teamwork, and various other generic skills required of competent engineers.

The third study involves the Universiti Teknologi Malaysia (UTM), another public IHL in Malaysia applied PBL and cooperative PBL (CPBL) in the teaching of Process Control and Dynamics subject at the Faculty of Chemical and Natural Resources Engineering (Mohd-Yusof, Hassan, Jamaludin, & Harun, 2011; Yusof, Hassan, Jamaludin, & Harun, 2012; Yusof, Tasir, Harun, & Helmi, n.d.). It was regarded as the pilot implementation that led to more applications in the campus by other faculties such as Faculty of Mechanical Engineering, Electrical Engineering and Civil Engineering. Combining cooperative learning with PBL in UTM was believed to be able to emphasize the

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learning and problems solving in small teams consisting of between three and five students. The opportunity to learn in small groups is expected to greatly improve students' focus and understanding. Otherwise, in a medium size class there can be up to 60 students for one floating academic staff or facilitator (Yusof et al., 2012). Eventually appreciate and actually gained and enjoyed the experience after undergoing one semester of CPBL.

IV.6. Nepal

AL modality for teaching learning was initiated by Professor Dr. James M Widmann from California Polytechnic State University and Fulbright Scholar in association with Mr. Binay KC on Fall Semester of 2012.

The Strength of Materials course offered by Department of Mechanical Engineering to second year undergraduate was taught in AL modality. The class consists of 60 students. The department curriculum plan for the class was to meet for 3 hours lecture and 1 hour tutorial each week. The organization of class period was divided into two instructors with approximately half of the instructions in Active Learning modality and other half in traditional lecture format and example problem format. The traditional lecture formats uses a deductive approach to the material. General theory and concepts were presented through formal lectures and then followed by application examples. The course instructor used the Socratic Method to encourage student attention and thinking during class.

In AL approach, changes were made in lecture mode, first PowerPoint example problems were placed online prior to the class period through the class group-mail email account and students were requested to go through the slides prior to the class. In class the instructor used three AL techniques:

- Think pair share activities.
- In-class group problem solving.
- Ranking task.
- Liberal use of the Socratic Method.

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A survey was conducted to assess the student's attitude towards the AL methods. 49 students completed the survey. The survey result shows that students found course conducted in AL modality were interesting, motivating and helped them to learn the material. Out of the four different techniques of AL student found ranking task and multiple-choice concept questions were most interesting and motivating (Widmann & K. C., 2013). The students also reported that these two activities helped them in learning the course matter. The survey also showed that traditional lecturing was ranked the second lowest by the students in helping them to learn the material.

Additional engaged Learning in Department of Computer Science and Engineering. In 2016, The Department of Computer Science and Engineering (DoCSE) has initiated the concept Student centric learning known as Engaged Learning (EL) in collaboration with United Nations Asian and Pacific Training Centre for Information and Communication Technology for Development (UN-APCICT/ESCAP). The objectives of incorporating EL were as follows (Shrestha, Gupta, & Colle, 2016):

- To evaluate the effectiveness of implementing EL on students learning.
- To identify the faculty's perception regarding the effectiveness of EL.
- To identify the community's perception towards the developed system.
- To demonstrate how university's credit based course can be carried out by incorporating community service.

The activities carried out during the Engaged Learning were differentiated into three parts.

Pre-engagement:

- Selecting the undergraduate students of third year from DoCSE.
- Studying the EL toolkits by students and faculty members provided by APCICT/ESCAP.
- Providing the initial training/awareness to the students regarding the community to be visited and the methodology of the content to be delivered.
- Identifying the sources for getting information related to foreign employment.

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- Collecting the information and having discussion with group members.
- Developing the SMS based query response system and Android based Mobile Application “Saarthi”.
- Performing the testing in simulated environment.
- Developing an operating Manual for SMS based query response system and Android based Mobile Application “Saarthi”.
- Evaluation by Project supervisor and Mid- term Examination.

Engagement:

- Field testing the developed system by reaching to the community people to identify its effectiveness and drawback.
- Preparation of Video while undergoing field test.
- Writing the reflection by students and involved faculty members to share their experience during the field test.
- Evaluation by project supervisor.

Post-engagement:

- Writing a report by student to share their experience and understanding about the EL
- Writing a report by faculty to share their experience and understanding about the EL.
- Develop a final video of 15 minutes.
- Evaluation by external examiner.

After the completion of the teaching learning in EL modality following outcomes were received which are reported in terms of reflections of different stakeholders.

Faculty’s reflection:

- Provided an opportunity to work for social cause.

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- Allowed to take a closer look to students learning and was able to identify their caliber in problem solving.
- Established a Strong bond with the students as both were working closely for achieving common goal.
- Identified the importance and impact an effective use of ICT can bring to the community members.
- Enhanced communication skills while dealing with community members.
- Identified the community problems that can be carried out in Engaged Learning modality.

Student reflection:

- Taught how to interact with public, which they used to avoid in the past but after this involvement they now feel relatively comfortable around masses and they are determined to improve themselves as they found this skill equally important as their technical skills.
- Explored new grounds and learned what it actually feels like to be working in the field
- Helped to get in touch with their skills they hadn't yet discovered and got to sharpen the ones they were familiar with.
- Learned how to implement their knowledge for providing ICT based solutions for community problems.

Community reflection:

- Developed system is very effective and very useful for getting the information regarding foreign employment.
- Gained the knowledge on effective use of mobile devices for retrieving the information of their need.

The EL teaching learning modality was piloted in Department of Computer Science and Engineering. The group of 12 students was chosen for undertaking the course in EL modality.

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The students used to have weekly meeting with supervisor to discuss about the progress. The course contents were delivered to students from faculty through group mail account. The students used Github for sharing the program code among the team members and supervisors and used Google doc for sharing the documents among the team members.

IV.7. Pakistan

Following are examples of AL and PBL in Pakistan.

The first involves the deployment of flipped classroom principles in medical education. A study was conducted to explore on the role of flipped classrooms in medical education. The teachers reversed the role of school work and homework. They attained this by either recording their lectures or consuming previously available video lectures from the internet. Before coming to class students watched the lectures and discussed the topic in the classroom in their favored social learning style with the help of the facilitator. The results revealed that the visionary students were inclined to use technology and favored this mode for teaching and learning. The students were content and relaxed while learning in the experimental social situations. Therefore, the study suggests that it is vital to seek ideas that apply e-learning technologies as effective promoters for active, self-directed, deeper learning in our teaching systems. The findings of the study recommend that flipped classroom teaching and learning pedagogy is an effective way to enhance student involvement and learning.

The next study involves the deployment of visual Aids in the Education Department at District Dera Ghazi Khan. A study proposed the use of visual aids for stronger, clearer, and easier understanding of the lesson. There are many visual aids in use these days such as:

- Models.
- Actual objects.
- Charts.
- Pictures.
- Maps.
- Flannel board.

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- Flash cards.
- Bulletin board.
- Chalkboard.
- Slides.
- Overhead projector.
- And more.

Out of these, black board and chalk are the common ones in traditional teaching environments. The authors used a joint approach to incorporate textbooks with audio visual aids as additional or supplementary resources that are used in classroom course for learning activities. The results revealed that that students and teachers possess positive perceptions of the use of visual aids.

Another study involves experiential learning in business schools in Karachi. The study was conducted to explore the use of experiential learning in Marketing, Human Resources Management, and Finance courses of five leading business schools in Karachi (Higher Education Commission Vision-2025, 2017). The researchers used the Experiential Learning Scale (UELS) developed to extract the findings to indicate that experiential learning, though comparatively a new concept in business education in Pakistan has found its way in to business education.

A forth example involves using models for investigating the learning style preferences of medical students. The study was conducted that used VARK model for the learning styles determination. It is an acronym for the Visual, Auditory, Read/Write and the kinesthetic sensory modalities. It delivers learners the insight of their favored sensory modalities in receiving and understanding the information. For the best processing of information the visual learners favor to see, the auditory learners choose to listen, the read-write learners like to read while the kinesthetic learners prefer to get information by practice. The “learning style” of a person is the selected method to gather, process, and deducing, consolidating, and examining information. Some of these inventories include Honey and Mumford, VARK by Fleming and Kolb’s learning style inventory. These inventories are founded on different principles of learning, learning theories, and psychological constructs.

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Another study involves using AL practices at the Suleman Dawood Business School (SDBS). The primary teaching methodology used at SDBS, Lahore School of Management Sciences (LUMS) is the case method. The case method encourages active learning and student participation. It develops a remarkable ability to analyze theoretical frameworks, to debate and develop arguments, and to make quick decisions in challenging, uncertain situations. The SDSB is the pioneer of case method based education in Pakistan. This avant-garde method of studying aids the students in discovering solutions to real-life business issues in a classroom setting by placing them in decision making roles. The students are involved into real life managerial situations where they debate the odds and evens of the businesses and create innovative solutions through exchange of perspectives. Once a case is presented in class, the students become the decision maker in various business management scenarios. They are divided into study groups who work in a discussion room prior to joining their peers in the classroom.

Discussion groups take place before the class session. They deploy collective learning and interaction to augment individual preparation. Intensive interaction with the members of the group enhances team spirit. These groups meet between sessions to prepare for the next class. Each member contributes individual analysis and personal point of view for the issues in the case. Through sharing of diverse views and insights the overall understanding of the case is enhanced, validity of arguments is determined, and new dimensions are added to the problems and prescribed solutions. For mandatory discussion groups students must ensure punctuality, attendance, and active participation. Failure to do so will result in disciplinary action. For optional discussion groups, students are strongly encouraged to use the time for group discussions, but they are allowed individual discretion regarding attendance.

The discussion group preparation leads to a class session, a collective classroom discussion under the guidance of an instructor. Contribution to classroom discussion is extremely important and constitutes a significant portion of the course grade. Effective class contribution requires active listening by a student in the classroom.

An important component of the MBA program is the weekend assignment, which involves a written analysis of a case (WAC). Students receive the WAC assignment in their mailboxes

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usually on the last working day of the week. The WAC assignment must meet the requirements specified in the weekly schedule. Both content and style are important in grading of a WAC. In addition to case analysis, students should also pay attention to elements of style such as grammar, spellings, structure and presentation of the report. A late WAC is not accepted.

IV.8. Portugal

In this section we intend to focus examples that present a more specific context and objective in terms of implementing and promoting AL and/or PBL.

One case is the informal network Active Learning in Engineering Education (ALE), a community of students, engineers, educators and people dedicated to improving engineering education through AL techniques, since 2001, in which the University of Minho is actively involved. “ALE creates opportunity for practitioners and researchers of engineering education to collaboratively learn how to foster learning of engineering students” (Lima & al., 2017).

IV.9. United Kingdom

With over 100 HE institutions in the UK there are many examples of effective active learning promoted in the literature and on university websites. Some of the initiatives focused on the lab spaces and technological solutions, others on curriculum design.

Learning spaces is a concept used across the sector. Universities have been investing heavily in spaces. As examples, City University in London and the University of Central Lancashire have invested in modernizing teaching spaces introducing furniture that can be moved around and arranged to suit different classroom configurations. City University in London advertises its labs as a special attraction to students – see https://www.youtube.com/watch?v=sAVtiuHCfCM#action=share.

Liverpool University has an Active Learning Lab that is illuminated with LED lights and is a landmark building in the City. The University changes the colour of the lab to suit local events.

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The Liverpool Lab is the showpiece of the Engineering Department. It contains two large, flexible spaces allowing full-size models to be exhibited and tested. This is considered to be the best such lab in the UK.

Active learning spaces have the flexibility to foster active learning within groups and are a move away from the traditional lecture format. Lectures are widely criticised for their ineffectiveness in a teaching context and even main stream media have queried their educational value (https://www.bbc.co.uk/news/business-38058477) in today's society. More recently an article by the Times Higher https://www.timeshighereducation.com/blog/evidence-active-learning-more-effective-lecturing-overwhelming provoked that active learning is more effective than lecturing.

The University of Glasgow has created technology enhanced active learning (TEAL) spaces, that are classrooms that have been adapted to encourage interactive learning in small groups supported by technology.

Some of the key features of this classroom are:

- 60-seat interactive teaching room, ideal for group work.
- Clusters of 6 or 8 swivel base chairs grouped around media tables, each with two screens, allowing collaborative teaching methods.
- Centrally positioned lectern allows lecturer to have close interaction with all groups.
- Additional projection screens positioned around the perimeter.

Edinburgh Napier shows images of its own active learning classrooms at (https://staff.napier.ac.uk/services/information-services/KeyProjects/Pages/Active-Learning-Classrooms.aspx).

This apace is augmented with an 85" Samsung interactive display which allows finger-touch annotations to the on-screen content, and device mirroring to display the contents from laptop and tablet devices. There are four 55" Samsung displays which are inter-spaced with traditional white boards to support group working activities.

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Despite the introduction of these facilities staff still needs support to make the transition to active learning. Using a phased approach and providing staff support appears to be a key for successfully integrating active learning into the classroom (White et al. 2016), as after a pilot project in active learning, only three out of nine staff agreed that they understood what makes for an effective active learning exercise. Without this support it is likely that the labs and technology being integrated into them will not necessarily promote an increase in the adoption of active learning.

Building spaces is not sufficient. It is important to get staff involved. Staff needs to understand what to do with the new spaces and the new technology. This being understood, attempts to change the way University education is done have needed some initiatives and projects. SCALE-UP is one such project that was funded by the Higher Education Funding Council of England to address barriers to student success and is based on a belief that active learning can be a core component of this. Nottingham Trent University (NTU) claims to be a world leader in active learning with its 12 SCALE-UP (Student-Centered Active Learning Environment with Upside-down Pedagogies) rooms.

The SCALE-UP approach (that the NTU staff adapted from (Beichner, et al., 2007)) offers an engaging, inclusive alternative to traditional lectures through the following components:

- Room design and equipment to promote collaboration, including circular tables, shared laptops and mirroring technology.
- “Upside-down” teaching in which content is encountered outside class and sessions are devoted to applying ideas.
- Collaborative learning via problem-solving tasks in tutor-assigned groups with roles.

When used with physics students in the USA, results of applying the SCALE-UP approach were convincing. A 50+ page handbook has been designed for tutors aiming to introduce them to active learning. It includes detail on redesign of modules, on redesign of individual classes, and on the management of groups and the promotion of collaboration. It is a fantastic document for anyone looking to initiate AL. This document describes how in SCALE-UP lectures are replaced by problem solving and inquiry-based activities carried out in strategically assigned

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groups. To foster collaborative learning, the re-designed classroom environment incorporates bespoke circular tables, shared laptops, and mirroring technology for students to share their work with the class. Flipcharts and whiteboards function as additional Public Thinking Spaces (Beichner, History and evolution of active learning spaces, 2014) . These physical aspects are supported by a threefold "upside-down pedagogy" comprising "backwards design" in which the curriculum is designed "backwards" from the learning outcomes; "students as teachers"; and flipped learning, where "content" may be encountered outside class and sessions are devoted to applying ideas.

Other universities have taken a more ad-hoc approach to initiating active learning, encouraging staff in competitions and small projects. The University of Bristol, for example, describes a series of case studies on active learning including one using clickers in Math (http://www.bristol.ac.uk/digital-education/ideas/all/ex028.html) and one using the flipped classroom idea in aeronautical engineering (http://www.bristol.ac.uk/digital-education/ideas/all/ex039.html) . Flipped classrooms are a common strategy for active learning and classically introduce students to a problem that they work on before the tutor then lectures and brings together the knowledge. A flipped classroom is defined as one in which '"students gain first exposure to new material outside of class, usually via reading or lecture videos, and then use class time to do the harder work of assimilating that knowledge, perhaps through problem solving, discussion, or debates."

Imperial College London had a summer active learning challenge where staff were asked to revisit lectures they had done the year previous and see where they could bring more 'activeness' into their work. (http://www.imperial.ac.uk/natural-sciences/education-and-teaching/the-fons-active-learning-summer-challenge-2018/active-learning-showcase-/).

Solutions that were suggested included the use of class polling in a probability class as well as research inspired problems in a physics class.

In relation to studying and promoting active learning in the UK, whilst active learning clearly features in many educational conferences, there was a specialist UK based Active Learning Conference in 2017 held at the Anglia Ruskin University (https://www.anglia.ac.uk/anglia-

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learning-and-teaching/cpd-opportunities/events/active-learning-conference-2017). This was a showcase of projects from HEFCE's Catalyst fund which was the fund that paid for the Active learning work (SCALE-UP) at Nottingham Trent University. This fund, which topped £7.5 million, was set up to initiate innovations that tackled barriers to student success. Mike Sharples keynote (https://www.slideshare.net/sharplem/designs-for-active-learning-cambridge-2017-79690448/1) for this conference, as well as the paper on the use of spaces (https://myplayer.anglia.ac.uk/Player/8426), are both stand out contributions.

The active learning conference has been followed by a 2018 conference in June in Brighton and a 2019 conference is planned for Tuesday 11th June at University of Sussex. The conference series is now managed by the 'Active Learning Network' (https://activelearningnetwork.com/) a network set up by the group of participating universities. This was initiated by Wendy Garnham and Tab Betts from the Technology Enhanced Learning group at the University of Sussex.

Other academic contributions from the UK include the innovations series from the Open University (http://www.open.ac.uk/blogs/innovating/), the Sage Journal of 'Active Learning in Higher Education', which is edited by a UK scholar and the engineering resources at (http://www.materials.ac.uk/guides/casestudies.asp) which outline many ways to make engineering education more active.

IV.10. Vietnam

This section presents three examples of applying AL/PBL training models in universities in Vietnam.

Best practices at Duy Tan University, Vietnam:

The number of universities and colleges that offer IT training programs in Vietnam has increased from 192 in 2002 to 277 in 2010. The enrollment quota for IT training programs also continues to increase: about 30.000 in 2006 to over 60.000 in 2010. However, the quality of IT engineers is another critical and crucial subject. According to recent forecasts by the year of 2020 the IT labor market of Vietnam will need about 600.000 new workers while the training system can only provide approximately 400.000. In addition, the percentage of graduates who can meet the

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real-world requirements of the IT industry without any retraining is expected to be low (Nguyen, Truong, & Le, 2013).

Based on reports from many IT businesses the current IT labor of Vietnam has many limitations, including:

- Lack of expert knowledge on project deployment or systems implementation.
- Lack of experience with large-scale and/or complex IT projects.
- Lack of professional work practices, poor language ability.
- Weak soft-skills, insufficient knowledgeable about customers and their cultural values.
- Inadequate management and project-management capability.

Meanwhile, the majority of new graduates in IT in Vietnam are not able to quickly adapt to the work environment because of the big gap between their training and the real world. Most Vietnamese college students also do not have adequate soft skills, project-management skills, teamwork skills, negotiation and communication skills, etc. As a result, many IT businesses in Vietnam complain that they can hardly recruit the right personnel, and most of the time, they have to spend a couple of months or more to train new recruits.

Being an institution specializing in IT training in Central Vietnam, Duy Tan University recognizes that there should be immediate change to the IT education in Vietnam. In particular, they need to change and reinvent how they assess learning outcomes, how to evaluate IT curricula, how to utilize different technologies for teaching and learning as well as how to raise the public awareness about quality standards in IT training. The purpose is to bridge the gap of IT practices of the academia versus those of industry and of developing countries versus those of developed countries so as to produce a new generation of IT workers in Vietnam, who have the knowledge, skills, and professionalism that stakeholders demand. There are a number of solutions to this problem including restructuring IT curricula toward "on-the-job" training approach, integrating and building interdisciplinary knowledge base, utilizing new technologies for teaching and studying, etc. However, the major solution here will be to set up comprehensive Capstone projects which help link up different knowledge as well as different real-world stakeholders together, using the PBL approach. In fact, according to the ACM curricula for Computer Science

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and Software Engineering of 2001 and 2004, respectively, the Capstone project is always emphasized as a very important component for students to bring together the skills and knowledge learned in order to resolve some problem.

Best practices at RMIT University, Vietnam:

PBL enables industry authentic projects and increasing students' exposure to real-world working environment. Although PBL approach was introduced in education in early 70's, when used different disciplines challenges arise in designing collaborative interdisciplinary activities and, most importantly, aligning the learning outcomes and assessments for groups of students in different majors. An endeavor was conducted at RMIT University Vietnam in 2015 in PBL courses for the Bachelor of Information Technology (BIT) and the Bachelor of Electrical and Electronic Engineering (BEEE). The goals of these two courses were to provide students with knowledge and skills in working with the two closely related parts of a technological project including hardware and software as well as project management. The affinity in the learning outcomes (CLOs) of two courses as stipulated by the school program and no requirement of prerequisites for these two courses allowed their integration into one class.

Best practices at Thai Nguyen University, Vietnam:

PBL teaching model has already been used in many countries around the world, including Vietnam. Thai Nguyen University proposes the process of organizing PBL teaching model in the training of math teachers in Vietnam include 4 stages:

- Preparation.
- Planning the way to perform teaching projects.
- Performance of the project.
- Reporting the products and assessing the projects (TRAN, 2017).

V. PARTNERS' ACTIVE LEARNING STATUS

V.1. TECHNICAL UNIVERSITY OF GABROVO

In order to identify how APBL is applied at the Technical University of Gabrovo two focus groups were organized in September 2018.

The first group involved 10 university lecturers, of whom 5 are aged over 50 and 5 are aged 30 - 49. Six are male and 4 female. Four teach in the Faculty of Mechanical and Precision Engineering. Four teach in the Faculty of Electrical Engineering and Electronics and 2 teach in the Faculty of Economics.

The second group included 10 university students aged 19 - 23, of whom 7 male and 3 female. Four follow bachelor degree courses in Mechanical Engineering. Four follow bachelor degree courses in Electrical Engineering, Electronics and IT and 2 follow bachelor degree courses in business, administration, and management.

Findings show that AL is known as a concept only by academics from the Faculty of Economics and those teaching IT. In addition, only 5 students, and specifically 2 in IT, 2 in business, administration and management, and 1 in electronics, had heard that term but they were not able to give any definition. The other lecturers and students turned out to be completely unaware of what stands behind "active learning". However, all 20 participants were aware of the concept of problem based and project based learning but only two thirds of academics and half of the students were able to clearly define it.

As far as the application of APBL, it was identified that the two lecturers teaching business and management subjects and the two IT lecturers used problem-based learning on a regular basis in their classes yet in an unstructured way and on their own. Project based learning was rarely applied in its proper form as a team work since they gave more individual projects to their students. Both types of learning were partially involved in the assessment process.

Unfortunately, the 8 academics teaching Mechanical Engineering and Electrical Engineering and Electronics said that they preferred to give individual problems and projects to their students.

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Therefore, APBL as a form of teamwork, discussion and active participation is not used in their classes. When asked about their willingness to introduce APBL, only the younger lecturers expressed positive attitude.

The above data was confirmed by the students' responses as well. Eighty percent of the students were very positive about introducing APBL into the classroom and the other 20% did not give any definitive answer.

In relation to the lack of structured APBL at the university, the following reasons were given:

In relation to academics:

- Limited class time and density of curriculum.
- Size of students' groups. University lecturers of oversized classes tend to adopt lecturing as a main teaching strategy because they think they would not have enough time to monitor and guide all students if they are engaged in learner-centered teaching/learning methods.
- Inflexibility of classes. Stationary desks and tables resulting in inappropriate physical conditions.
- Lack of adequate materials and equipment or resources.
- Fear of losing control over the class.
- Research activities are considered more important than teaching strategies due to national attestation criteria. Therefore, their time is mostly devoted to writing scientific articles and manuscripts and they don't have time to invest in enhancing their teaching qualification and expertise.
- Lack of knowledge and experience in APBL.
- Students' passive learning culture to which they have become accustomed. Listening to a lecture is not only a more familiar role for students but it is also a considerably easier one.
- Lack of motivation and initiative in students –some students lack the motivation to develop themselves, don't take responsibility for their own learning or don't want to

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move away from their comfort zone because they have got used to sitting passively in class.

- Lack of enough self-confidence. Students are used to the traditional teacher-centered model used in secondary school and it is easier to follow this behavior at the university: they feel fear of speaking in front of a group because they might be criticized.
- Assessment methodology mainly based on standardized exams, which generally requires memorized information.

In relation to students:

- Most university lecturers, especially those over 55, fear of losing control over the class.
- Lack of sufficient teaching skills.
- Some students do not feel comfortable to have closer relations with their teachers and freely express their views.
- Limited class time and density of curriculum.
- Misperception of class management.
- Passivity of lecturers.
- Lack of enough self-confidence. Students are used to the traditional teacher-centered model used in secondary school and it is easier to follow this behavior at the university: they feel fear of speaking in front of a group because they might be criticized.
- Students' passive learning culture to which they have become accustomed. Listening to a lecture is not only a more familiar role for students but it is also a considerably easier one.
- Assessment methodology mainly based on standardized exams, which generally requires memorized information.
- Inflexibility of classes. Stationary desks and tables resulting in inappropriate physical conditions.
- Lack of motivation and initiative in students. Some students lack the motivation to develop themselves, don't take responsibility for their own learning or don't want to

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move away from their comfort zone because they have got used to sitting passively in class.

- To sum up, the University APBL pattern does not differ from that of other Technical Universities in Bulgaria regarding engineering degree courses – it is still teacher-centered and theory-oriented where most academics, especially those over 50, show resistance to change and focus only on students' academic success. However, young academic staff demonstrates willingness to further develop their teaching and methodological skills so as to apply APBL at their classes.

V.2. TALLIN UNIVERSITY

LIFE (Learning in an Interdisciplinary Focused Environment), is an initiative at Tallinn University which provides an alternative to subject-based education by inviting students to collaborate on interdisciplinary projects (Sillaots & Fiadotau, 2018). LIFE or ELU in Estonian, is a semester-long project-based course which invites students to solve real life problems in interdisciplinary teams (Jõgi, et al., 2018). The teams generally comprise six to eight members with expertise in least three different areas. The purpose of LIFE is twofold: on the one hand, students can deepen their knowledge and apply it to a practical problem; on the other hand, they learn how to plan and run a project. Ideas for LIFE projects can be provided by both students and teaching staff and are advertised through LIFE Portal (http://elu.tlu.ee), which serves as a platform for team member recruitment. LIFE is mandatory to all TLU bachelor and master's level students.

DLG is a Digital Learning Games master's program at Tallinn University (www.tlu.ee/en/DLG) which main objective is to bring together people with different backgrounds, form heterogeneous teams, learn from experts and from each other, and learning make games. Making games requires an effort from different experts, including developers, artists, designers, and others, and is usually based on real life needs or problems such as how to make teaching engaging. DLG program is focusing on teaching game conceptual design but students have possibility to focus on more technical or pedagogical approach. All subjects at the DLG program are more or less based on AL and PBL. For example, in the beginning of their studies students are asked to work individually and generate game ideas that provide solutions to some school

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related problems. This is a final outcome of the course of Basics of Game design and research. Students are asked to develop this idea further in during the next course, Design of Gameplay and Mechanics, but this time working in pairs. In this course they design and test the game challenges and rules. In the next subject, Game Assets, the team grows to 3 - 4 members. Students they design the sound and graphics for the game. In the Learning Game Design course the team grows to the size of 4 - 5 members. They add pedagogical aspects and they test the game in the educational conditions. For the LIFE project the team grows to the size of 6 - 8 members. The second iteration of a bigger learning game is conducted.

TLU Labs Tallinn University has several labs equipped with the cutting edge technology in order to support students' creativity and teamwork. Some of the labs are as follows (www.tlu.ee/en/dti-labs and https://dtilabs.tlu.ee/):

- IDLAB - Interaction Design Lab is a research, design and innovation unit contributing towards the knowledge and skills of the Institute in the field of Interaction Design (http://idlab.tlu.ee/). This lab is equipped with the endless list of hardware devices (http://idlab.tlu.ee/hardware/) and software (http://idlab.tlu.ee/software/).
- SDLAB: Software Development Lab aims to support the exploration of current and state of the art software development approaches. SDLAB offers access to both expertise and resources necessary for implementing existing designs as functional prototypes or exploring new algorithms and enabling technologies for existing applications and services. SDLAB can support students working on their ongoing studies projects or thesis-related topics, as well as teams engaged in current research projects and industry partners wanting to explore specific software development related challenges (https://dtilabs.tlu.ee/software-lab/).
- TECLAB: Technology Lab Technology supports teaching processes in TLU DTI by providing necessary know-how and technical equipment for projects in the field of robotics, Internet of Things and automation. The lab also provides instructors and working and study space for organizations and individuals who are interested in developing prototype solutions in above mentioned fields. DTI Technology Lab supports teachers and students

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with their projects and is ready to play supportive roll in research project that might need resources available (https://dtilabs.tlu.ee/technology-lab/).

- GLAB: Game Lab is a meeting place for students who are interested in making games. It offers facilities for meeting and workshops and some high end gaming technology - Oculus Rift VR set (https://dtilabs.tlu.ee/game-lab/).
- MEDIT: The Tallinn University Centre of Excellence in Media Innovation and Digital culture (http://medit.tlu.ee/en). Among other activities MEDIT coordinates a Creative Lab that focus on developing innovative audiovisual applications in cooperation (http://medit.tlu.ee/creative-lab). The current technical focus of the Creative Lab is on the Virtual Reality and Augmented Reality solutions. The Lab offers an opportunity to test VR and AR gear and development platforms. List of equipment: Oculus Rift, HTC Vive, Playstation VR, Microsoft Hololens, GoPro 360, Ricoh theta 360, Leap Motion, and Samsung Gear VR.

V.3. UNIVERSITY OF THESSALY

In the Department of Electrical and Computer Engineering (ECE) of University of Thessaly (UTH), there are courses available that implement the idea and principles of active learning and problem-based learning. These are:

Education Technologies undergraduate course (ECE329 Education Technologies, n.d.):

The course focuses on the deployment of technology as an educational tool in lifelong learning contexts that target specific groups including pre-school learners, school learners, adult learners, professionals, and others. The course analyses traditional and emerging learning methodologies including collaborative learning, explorative learning, active learning, mobile learning, problem-based learning, project-based learning, and more. Subsequently the course focuses on how technology, and most importantly information technology, can be combined with emerging pedagogies towards the enhancement of learning processes and experiences in formal, informal, and non-formal learning. Specifically, the course analyses the deployment of technology as a tool that can be integrated into blended learning practices that involve

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instruction, practical applications that use technology and other activities in and out of the classroom.

Technologies in focus include knowledge and information management systems, synchronous communication technologies in learning, simulations, digital experiments, serious games, communities, mobile learning, touch screen technology, digital narration, and more. The course further analyses how technology can be applied towards addressing challenges faced by individuals at risk of exclusion, such as individuals facing learning difficulties, and others. The course furthermore focuses on how technology can contribute, in combination with pedagogical models, towards the development of basic, transversal skills including analytical thinking, critical thinking, entrepreneurial thinking, problem solving, ability to work in a team, ability to work autonomously, ability to work in an international environment, etc. Finally the course focuses on emerging research areas including gamification, learning analytics, and others. Specific research activities and good practices are presented in the context of the course. Upon completion of the course the learner should be able to:

- Be able to analyze learning needs of specific target groups in specific learning contexts
- Know and understand concepts related to basic competencies such as analytical thinking, critical thinking, entrepreneurial thinking, problem solving, ability to work in a team, ability to work autonomously, ability to work in an international environment, etc.
- Know and understand emerging learning methodologies including collaborative learning, explorative learning, active learning, game-based learning, mobile learning, problem-based learning, narrative learning, project-based learning, and more as well as learning theories such as constructivism and constructionism.
- Know, understand, and be able to apply learning evaluation processes based on specific learning objectives
- Know, understand, and be able to apply emerging information technologies in blended learning settings; technologies in focus include knowledge and information management systems, synchronous communication technologies in learning, simulations, digital experiments, serious games, communities, mobile learning, touch screen technology, digital narration, etc.

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- Be aware of and understand the context of emerging research in learning including gamification, learning analytics, big data in education, etc.
- Be able to develop and present to a live audience end-to-end solutions on learning interventions that deploy technology towards addressing specific learning needs and towards meeting specific learning goals.

Software Design and Development/Software Engineering (undergraduate/postgraduate course) (PGS602 Advanced Software Engineering, n.d.):

The students participate in a software development project in large groups. In the context of the project students have to opportunity to attain hands-on experience on the technical and administrative issues related to software systems development, as well as to use modern tools used in this context. The main goal of the course is to provide students with the technical and administrative skills necessary to develop large-scale software projects by large groups. After successfully fulfilling the requirements of the course, students are capable of:

- Knowing the main stages of the software life cycle.
- Knowing the main software development process models (traditional and agile) and applying them on real projects.
- Knowing UML notation and using the appropriate diagrams according to the phase of the software life cycle.
- Producing the respective deliverables (documents, code) at each phase of the software life cycle.
- Evaluating the quality, correctness and complexity of software projects, producing a development schedule and estimating the cost.
- Exploiting computer aided software engineering tools, as well as technologies taught in other courses, in order to develop large-scale software projects.
- Managing and / or participating in large software development groups, under specific time constraints.

V.4. INSTITUTE OF TECHNOLOGY OF CAMBODIA

Active learning and problem-based learning are new approach for universities and the initiatives for promoting active learning and problem-based throughout Cambodia universities are insufficient. ITC, in collaboration with the U.S. Agency for International Development Connecting the Mekong through Education and Training (USAID COMET) have been proactively involved in the 5 year project to boost the workforce orientation and deployment programs that allow students to acquire highly demanding skills necessary for current market need. This collaboration also seeks to promote gender balanced employment and increase technology-based learning in the classroom. More importantly, AL and PBL are one of the core values of the whole project and a number of lecturers are invited to be part of this project.

ITC is not the only institution to participate in this collaboration. The project supports universities across USAID COMET's targeted areas, including Lower Mekong countries of Burma (Myanmar), Cambodia, Laos, Thailand and Vietnam, to modify their curriculum and teaching approach to take education to the next level. By 2019, this collaboration is predicted to equip students with skills including adaptability to new technologies, working as a team, and communication and interpersonal skills. The skills taught in the training supported by USAID COMET include participatory learning, work readiness skill, learner-centered assessment, facilitation skills, instructional design, blended learning and project-oriented learning. The ultimate goal of this project is to educate instructors in ITC to understand the innovative teaching methodologies so that they are able to utilize the acquired teaching skills in the real classroom. The past 4 years, according to our observation, we noticed that some lecturers have used some of the techniques in their classroom and the outcomes are quite promising as students are more engaged in learning and they tend to work confidently and independently.

V.5. MEAN CHEY UNIVERSITY

The university efforts to get more teachers to use more routinely such instructional methods and provide fund and material to support their teaching and learning have faced many challenges. In part, this reflects the reality of any change in any patterns of human behavior in that teachers are not blank slates on whom reformers can inscribe the new pedagogical

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approaches. Since Cambodia is in serious shortage of well-trained lecturers and professors it is essential that the universities must use its scarce human resources to their full capacities through ICT as well as connecting learners to virtual learning resources worldwide. The Ministry promotes the use of ICT in teaching and learning process, research, and administration by creating a cyber campus consortium and linking this to other virtual universities in other countries. It also promotes the digitizing of the Khmer language books and translating of foreign core books into Khmer. Cambodia is in need of professional development initiatives, mainly in-service, that can promote and reform among teachers' not only different ways of talking but also different ways of behaving and interacting in classrooms. While it would be an overstatement to say that teachers involved in projects radically transformed their instructional practices it seems appropriate to conclude that real changes occurred as a result of sustained training and supervisory support. The projects facilitate teacher and student training, introduce workshops, promote modern student centered pedagogy, and make available funds for supporting and installing labs for practicing AL.

V.6. UNIVERSITY OF MALAYA

The University of Malaya is a research university with strong emphasis on research initiatives and innovation. The mission and vision of the university have always been associated with high quality teaching and learning activities. All these educational priorities are can be seen from its quality statement pertaining to teaching and learning (TnL): aspects of research and innovation are the cornerstone of training, which is in line with the Malaysian government's aspiration for its higher education system. As one of the public universities under the Ministry of Higher Education (MOHE) Malaysia (now known as Ministry of Education (MOE) Malaysia), UM's strategic planning as well as the teaching and learning approaches are governed by the national policies laid down by MOHE and other relevant ministries.

Accordingly, University of Malaya has incorporated the above mentioned policies in its own internal governing machinery and administered by various agencies of UM:

- Strategic Planning Unit.
- Quality Assurance Unit (QMEC).

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- Academic Development Centre (ADeC).

While ADeC offers plenty of training related to AL/SCL internally to the UM academic staff UM's top management realizes that the AL practices need to be supported by appropriate infrastructure. It is recognised that the learning experiences of students must be similar to those of the real-world scenarios they will encounter in the workplace. UM, as a research university, is committed to produce positive and forward-thinking graduates with the skills ready for the future work environment. In this instance, collaborative learning is and will always be the hallmark of the university education.

The founder of ADeC is Professor Raja Maznah, an instructional designer, who set up the experimental Interactive Learning Room in 2008. This concept is in line with the national agenda and was later adopted by the University Management in the form of a Learning Space Policy in 2012. The Management committee agreed that all faculties, centres, and academy must comply with learning space (student-centered) criteria for any renovation work (experts of Minit Mesyuarat JK. Pengurusan: 4.7.2012; Perkara: 17; MP75/2012). The management committee further reinforced the implementation related to this matter in the renovation of a classroom into TheCUBE's project in 2012 in several faculties. Since then, budget was allocated at the central level to upgrade more than 35 existing spaces into learning development space throughout the campus.

The increasing number of learning spaces, however, did not result in the effective use of the space for AL/SCL. Realizing the shortcoming, the management committee opined that there was a need to empower the academic staff to embrace new ways of teaching. This was done by changing the training strategy into AL/SCL experiential learning training mode. In this manner, the lecturers learn ASL/SCL by experiencing and doing AL/SCL in the actual learning spaces themselves. Since 2016, ADeC has insisted that its training program must be held in learning spaces in various parts of the campus, and the trainers are expected to use the AL methods in delivering the training programs. Whenever possible, most of the learning spaces facilities should be utilized.

UM lecturers were further empowered to effectively use the learning spaces for active learning by appointing them as an active partner in the process of designing and using the new spaces.

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The Learning Space project in 2016 was launched for UM faculty members to design their own learning spaces that suit their disciplines. The main objective of the project was to improve students' learning, upgrade lecturers' quality of teaching, and explore the potential usage of learning space in improving students' active learning.

ADeC has organized a National Learning Space Seminar in 2016, which was attended by academics from both public and private universities. University of Malaya realizes that active learning in the cyberspace plays an important role in this era. UM has introduced and executed a program called the E-learning Week during which no face-to-face lecture is carried out in a normal classroom. In this manner, the lecturers and students actively teach and learn via the e-learning platform or other digital means.

V.7. UNIVERSITI TENAGA NASIONAL

Similar effort to enhance the teaching and learning experience by moving away from the traditional and monotonous delivery of learning materials through one-way lecture can also be seen. However, the approach is more generic without focusing on any specific method of active learning. The term used is "blended learning", which refers to "an education program that combines online digital media with traditional classroom methods". It requires the physical presence of both lecturers and students, with some elements of student control over the time, place, path, or pace. The aim is to diversify the teaching and learning methods by "blending" the traditional methods with the online methods using tools such as the learning management system (LMS), but without significant reduction to the allocated face to face time with the students. From one perspective, blended learning can also be regarded as a form of active learning with the students having more control on the learning pace. Furthermore, it specifically involves the use of ICT through the use of online digital media, which is currently lacking in most PBL implementations in Malaysia as presented earlier.

The university's commitment on this matter is manifested through the implementation of the blended learning initiative, which is set to be one of its core initiatives under BOLD 2025. BOLD 2025 is a 10 year program that aims at uplifting the university status and rank internationally. There are three main strategic goals under the program, which are teaching and learning

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excellence, research excellence and financial sustainability. Eleven strategic objectives and 29 initiatives are defined to achieve the goals, and the adoption of blended learning falls under the third strategic objective (SO3) to attain globalised online learning with the following sub initiatives.

- The use of LMS and web-based technology Upgrading of Moodle.
- Purchase of audio-visual equipment.
- Training and workshop for academic staff and The setting up of the education technology unit.

Under this initiative, lecturers are encouraged to adopt the blended learning approach in the classrooms and the implementation is closely monitored by UNITEN teaching and learning centre (TLC). A group of pilot subjects have also been identified for this purpose. TLC is responsible to promote the adoption of blended learning among the lecturers by disseminating the information and organizing trainings to provide the lecturers with the necessary knowledge and skills to use blended learning in their classes. Furthermore, the TLC is also responsible to monitor the progress and achievement of blended learning in the university. In this regard, TLC is assisted by the teaching and learning unit at each college. There are four colleges in the university that are involved in the blended learning initiative. These are College of Engineering (COE), College of Computer Science and Information Technology (CSIT), College of Business Management and Accounting (COBA) and College of Foundation and Diploma Studies (CFDS).

V.8. KATHMANDU UNIVERSITY

Kathmandu University comprises of 7 Schools:

- School of Engineering.
- School of Science.
- School of Management.
- School of Law.
- School of Medical Sciences.
- School of Arts.
- School of Education.

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All schools have developed their own way of teaching Learning suitable for their field of study in our institution which is School of Engineering, the teaching methodology is more focused on lecture and project based learning methodology where students are required to attend lecture hours and exhibit their understanding of subject matter through projects. In every semester students enroll in project, with the exception of the final semester, where students have to join the an industry internship program through which they work full time for 3 months in selected company.

In School of Engineering, they have practiced the concept of Community based learning in collaboration with Himal Partner which is named “community education project” whereby students visit the community to identify problems and come up with solutions. Some groups of students even carry out this community related problem as their project problem. In this type of learning, students and faculties get an opportunity to understand the problems faced by the community and how their education and be utilized for solving social problems.

Kathmandu University has not completely implemented the concept of AL but has indirectly associated this concept by introducing the project courses which deploy more student centered methodologies.

Regarding university facilities related to project based learning, students are allowed to access the university resources for completing their projects whenever the lab resources are free and hold required weekly meetings with their project supervisor to share their ideas and discuss project progress. These meetings are conducted in rooms with access to the internet.

The university also provides the video recording studio to faculties who are interested in recording their video lecture and disseminating it to students through the university e-learning platform. The School of Engineering uses Moodle as an e-learning platform.

The Kathmandu University School of Medical Sciences (KUSMS) uses PBL as the main teaching learning methodology. Students use the knowledge gained in lectures to solve problems. There are five components of perfect PBL (Mansur, Kayastha, Makaju, & Dongol, 2012).

- PBL cases.
- PBL group.
- PBL session.

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- PBL study session.
- Wrap- up session.

All these practices in different schools of university show the preparedness towards the adoption of student centered learning.

V.9. NATIONAL UNIVERSITY OF COMPUTER AND EMERGING SCIENCES

In Software Engineering (SE), literature shows only a handful of examples where PBL is used for teaching and learning SE. SE is taught as a series of lectures in most of the educational institutes and includes a semester project through which students get hands on experience on practical software development. However, the present system somehow fails to adequately teach the software process to the learners.

Lack of knowledge on software process among graduates results in major software failures and delivery of faulty software. The underlying issue is that the graduates are unprepared for tackling industry challenges due to their lack of practical comprehension of the concepts. Therefore, there is a need to provide the learners with an opportunity to practice the concepts as close to practical environment as possible.

Researchers introduced simulations and game based designs in PBL contexts to let the students practically experience the concepts they learn in books or through lectures. Simulations prove to be a successful way of gaining practical experience in many fields ranging from flying jets to driving cars. However, in case of SE little attention has been paid on developing simulations and games for learning purposes. Only a few examples are available e.g. Calico and SimSE.

An example of deploying PBL, and specifically using learning games in SE, involves a 3D game for learning OOAD and investigating its effectiveness in learning OOAD concepts. The game aimed to equip learners to practically picture themselves in a working environment. The aim was to provide practical experience to the students within the timeframe of the course.

An experimental research design was followed in order to gain insight on how learners utilize the proposed game in learning OOAD course. Researchers recruited 36 undergraduate students of SE for conducting a learning experiment. The students were divided into two groups of 18 members each:

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- The control group (CG).
- The experimental group (EG).

The distribution of students in both of the groups was kept random to avoid bias in the study. The experiment was designed to fit in the class standard duration of the semester (16 weeks), class (45 minutes), and lab (60 minutes).

Both groups attended classes to gain the basic knowledge of software engineering and lab sessions were conducted separately. In the start of the semester, EG was shown the game and its usage followed by an interactive 50 minutes session in which the EG members clarified their confusions about the game. The other group carried on with their projects in the conventional way. Both groups were divided in 6 teams of 6 members each, 3 in each group to carry out their projects. Three projects were assigned to both of the groups, one for each team. Similar projects were chosen for both groups to make the assessment justified. The work demonstrated a significant advantage of PBL approaches, which in this case were implemented through game-based learning, towards building knowledge and practical experience among learners.

V.10. ISRA UNIVERSITY

There is no AL lab at any of the campuses of Isra University. However, most of the labs conducted which have laboratory sessions as a part of the coursework make use of the different AL strategies from retrieval practice/one-minute papers, demonstrations, group discussions, sequence reconstruction, error identification, concept maps, brainstorming, icebreakers, case studies, and self-assessment.

The instructors teaching labs prepare a lab manual for the whole course to guide students on what to do during each lab. Each course including lab based course runs for sixteen weeks with a midterm exam at the end of the eighth week and a final exam at the end of the sixteenth week. One 3 hour long lab is conducted each week. Therefore, altogether 16 labs are conducted throughout the lab-based course. Based on the topics to be covered in the lab, for one or more related topics, the instructor creates one detailed step by step solution of the task to be performed to facilitate student in learning the concept linked with the topics and how to solve the problem associated with it. The students are asked to solve multiple questions related to

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each concept. This is to evaluate the understanding of concepts among the students. The questions can vary from the objective, multiple choice questions, and descriptive questions to write answers, code or drawing maps/circuits, finding errors in the code or diagrams among others. The solutions are checked by the instructors and returned back to the students in the next lab for the discussion. This provides them with an opportunity to identify the mistakes they made, discuss the correct approach or solution with the instructor for better understanding. Typically, the students are paired into small groups of 2 or 3 at max to support teamwork, discussion, and peer learning for students to remain active throughout the lab.

V.11. PORTO POLYTECHNIC

A characteristic case of PBL is the LEAP Project, developed ate GILT R&D Group, already mentioned above, which aims at building knowledge through experience among higher education students on emerging lean and agile industry practices empowering their skills for the transition into the professional world, focusing on Engineering disciplines. To achieve that purpose, the project included an output focused on a learning game developed in the form of 3 learning applications that promote the development of agile and lean skills. The following games have been created:

- The Technical Debt Game, which exposes learners to the concept of “Technical Debt”, namely the fact that an implementation team must invest early on a good implementation plan.
- The “5S” implementation model that is often applied in lean processes for reducing production costs by streamlining and standardizing production. The model refers to the actions sort, set in order, shine, standardize, and sustain. An educational scenario encouraged students to deploy the 5S model in context that go beyond the automotive sector for which it was initially designed to reap its benefits in sectors as diverse as pharmacy organization, office space organization, and scrap yard organization.
- The “SCRUM” model that is deployed in the context of agile design and aims at the design and implementation of solutions that closer address the needs of users. The model is useful in situations in which user requirements are not well known in advance

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or they evolve. The scenario demonstrated how SCRUM can be deployed beyond the Software Engineering sector for which it was designed to benefit broad engineering sectors, such as urban and agricultural design.

V.12. UNIVERSITY OF CENTRAL LANCASHIRE

Resources in the UK come from many areas. The Royal Academy for Engineering (RAEng) funds much of the research in engineering education. This body produces reports, like the one on experience led engineering, that directly speaks to AL in engineering (https://hefocus.raeng.org.uk/reports/) The RAEng has a fantastic set of resources, mainly from external sites, on engineering teaching (https://hefocus.raeng.org.uk/online-resources/). The Royal Society (https://royalsociety.org/) innovates on Science teaching and touches ICT and Technology. This organisation directly speaks to government on ways to improve science and technology education.

V.13. HANOI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Hanoi University of Science and Technology (HUST) is one of the best universities in Vietnam. The vision of HUST is “to become a leading research university rooted in the technical and technological fields; to make significant contributions that develop a knowledge-based economy and maintain national peace and security; and to be a pioneer in growing and sustaining Vietnam’s higher-education system”.

In order to achieve above vision, one of the important tasks is to set up a training model in which students not only learn professional knowledge but also practice soft skills such as communication skills, teamwork skills, problem solving skills, organizational, and leadership skills. Specifically, the curriculum of all majors includes "project" subjects. In the project courses, the class is divided into groups of 1 - 3 students. Each group of students is guided by a mentor. At the beginning of the semester, the mentor gives a list of problems for the student to choose. These problems may be case studies or real problems from the companies. Students choose the problem to solve based on their ability or interest. During the course students find the way to solve the problem. Weekly, students meet their mentor to report their progress or if they need

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guidance. The mentor gives suggestions or directions to solve the problem. At the end of the course, the mentor organizes a final presentation day to assess the student's performance. Mentors can also invite experts from the companies participating in the presentation. These experts advise students to add both the professional knowledge and soft skills necessary for the job after graduation.

The following paragraphs present more details on the application of PBL teaching model in the School of Mechanical Engineering and the School of ICT, HUST.

Global PBL course in the School of Mechanical Engineering (SME):

In the framework of cooperative activities between Hanoi University of Technology and Shibaura Institute of Technology (SIT), Japan, the School of Mechanical Engineering held a Global PBL program. The goals of this program were:

- To acquire the problem solving capability to be internationally attractive.
- To acquire basic technologies on "design" and "production".
- To acquire a capability of work as an international and/or interdisciplinary team.

20 students from Shibaura, along with students from Hanoi University of Technology in Mechanical Engineering, Mechatronics, participated in the PBL course. Students were assigned a specific problem and self motivated creativity to solve within 9 days. The challenge of the project was to design and create a vehicle that was able to store and use its own energy and was capable of running a distance of exactly five meters.

There was no official class time. Instead, students received brief instructions from the HUST professors and professors from the SIT to solve a given problem. Students from HUST took part in collaborative activities that were sponsored by both schools. Together with the students from SIT, 10 teams of 4 students were formed to take on the challenge. Each team included two students from HUST and two students from SIT. Students were given access to use the facilities at HUST and had just 11 days to turn out their ideas into fully functional energy self-storage vehicles.

In the final competition, the students were ready just in time to showcase their inventions. In one case, all of the teams managed to create vehicles that actually ran but the first place prize

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certificate went to the only team whose vehicle ran the required exact distance of five meters. Another certificate was awarded to the team with the best vehicle design.

Students built experience on how to collaborate in a global team, how to manage a project, and how the engineering design process is completed from idea conception to product delivery.

The project was a huge success. Both schools are planning to sponsor the collaboration again. Students were impressed with their participation in the event, in which they were able to engage in and learn from even more hands-on design engineering projects and programs.

PBL courses in the School of ICT (SoICT):

The um of SoICT has been reviewed by experts from European universities and is considered to equivalent to the European university's ICT training program. In the curriculum framework, there are four subjects that are in form of PBL models: Project 1, Project 2, Project 3, and Final Project. In these courses, students can work alone or in a team, and are guided by a mentor:

- Project 1 helps students develop programming skills. Students will be assigned to write programs that solve a number of specific problems, using languages such as C, Python, Java, Javascript, html, and more.
- Project 2 helps students to learn how to analyze and design the system. Normally, the mentor will give a specific real problem and require students to analyze and design the system. The final result of the course is a report which analyses and designs system of the given problem.
- Project 3 requires students to build a complete software product, using a given technology, to solve a specific problem. Students must self-study the problem given by the mentor, propose functional requirements of the product, analyze and design the software system, learn the necessary technologies, implement the program, run the test, and complete the software.
- In the Final Project, students have to build a complete application product, which can be used in real world. Students must find out the actual needs, give product ideas, analyze the requirements of the product, then design the system, implement the program, test, and deploy.

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Project courses are not organized in traditional classes, instead, students and mentors meet and discuss directly. Students can do their projects in labs. SoICT has 5 labs:

- The Modeling, Simulation and Optimization Laboratory (MSOLab): MSO Lab was founded in 2013 and is a community of theoretical computer scientists with interests in algorithms, complexity, simulation, high-performance computing, modeling, machine learning, semantics, security, logic, and databases. The mainspring of research in MSO Lab is the study of theories which underline, or should in future underline, the analysis and design of computing systems. The work has a core of theoretical research and a practical component which explores application and implementation of the theory. Several research groups exist within MSO Lab: Algorithms and Optimization, High-Performance Computing, Data Science, AI.
- Software Engineering and Distributed Computing Lab (SEDIC LAB): The SEDIC Lab undertakes research in a variety of areas related to Software Engineering, Distributed Computing and Internet Technologies. Such areas include: formal methods, massive content processing, network modeling and simulation, semantic computing, signal analysis and natural language processing, security technologies, data mining and knowledge discovery, component-based systems, cloud computing, service integration, telemedicine, wireless sensor networks, P2P, social networking, etc. There are 4 main research groups associated with the SEDIC Lab: i) Software Engineering and Cloud Computing; ii) Distributed Computing and Network Modeling; iii) Semantic Computing; iv) Service Integration Technologies.
- Data science Lab (DS Lab): The main objective of DS Lab is: i) Promote high-quality research (international level) in the field of data science; ii) Actively collaborate with businesses to create smart products or services; iii) Training engineers and data scientists, meeting the market in Vietnam and internationally. Currently, DS Lab has more than 10 major researchers, and more than 60 excellent students participate. Members work in specialized groups, including: Big Data; Deep Learning; Machine Learning; Data Mining; Internet of Things; Computer Vision; Information Retrieval; Natural Language Processing. DS Lab is a place to support ICT institutes, students, and

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partners to carry out basic research and application. DS Lab research has been funded by a variety of sources, such as AFOSR (USA), ONRG (USA), NAFOSTED, SAMSUNG, businesses, etc.

- Computer Systems Laboratory (CS Lab): CS Lab focuses on intensive research and technology transfer on Computer Engineering. The main research directions of CS Lab are: Embedded computer design; Design, development of embedded systems; Signal processing and Speech processing; Supercomputer design and application; Mobile application development; Development of services on the navigation platform; Development of information systems industrial education. The research directions set forth correspond to the research capacity of the laboratory (and the coordinating units) and the policies of Vietnam.
- Network and Communication Technology Laboratory (NCT Lab): The task of NCT Lab is to conduct basic research and application around the issues of national and international interest in the field of data transmission and computer networks. The lab is based on several small research groups, focusing on the following key topics: Advanced Network Technologies; Network and Information Security; Multimedia Communication Technologies; Mobile and Distributed Computing; The second task of the laboratory is to carry out the transfer of technology, exchange of science and technology between scientists and enterprises, contributing to bridge the gap between research and practical application in the field of computer network in Vietnam as well as in the world. In addition, the laboratory has a very important role to carry out the activities supporting the training of university and postgraduate, creating a favorable research environment for engineering students and fellows, attracting students to study science right from the start of their studies.

V.14. HANOI UNIVERSITY

Since 2006, HANU established an interdisciplinary study program of Information Technology including software engineering, computer network and information system. Approximately two

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hundred students are enrolled in the program every year. To succeed in the program, a student needs to have knowledge of and to master a variety of skills such as:

- Mathematics.
- Logic.
- Problem solving.
- Algorithmic thinking.
- Programming.

Unfortunately, many students struggle to develop these skills, especially when the subject is related to programming, discrete mathematics, data structures, and analysis of algorithms. This happens because of the way in which teaching is approached in undergraduate courses, since what can be seen is a lack of practice after being exposed to the theory. Research shows that PBL meets three important criteria that promote ideal learning:

- It provides an environment where students are immersed in a practical activity.
- It allows students to receive guidance and support both from other students and a responsible teacher/ tutor.
- It fosters learning that is based on solving a real problem.

Since 2014 PBL has been applied to the teaching of programming courses in HANU aiming to promote collaborative and motivating learning based on problem solving.

In relation to the implementation of the initiative due to the large number of students per year the university organizes only a class of 30 students to experiment that follows the PBL teaching and learning method. The PBL implementation is designed to achieve the following purposes in teaching and learning:

- Connecting the learning to specific problem situations that may be encountered in practice.
- Activating prior knowledge of students about the topic to learn.
- Making the students to elaborate the material that they have learned.

The course organization is described in the following: The students are divided into groups of 4 - 6 members. Each group is supervised by a tutor who is a faculty member. The primary role of a

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tutor is to act as a domain expert who can answer questions in the domain or correct the direction of the discussion that has taken a wrong path. The secondary role of a tutor is a facilitator of the group process. If the discussion is unbalanced or unproductive, the tutor can try various approaches to improve the behavior of the group. For example, the tutor may require that the students sit in different places in each meeting, do not bring books to the meetings, or that each student writes at least five notes during the brainstorming.

Since programming is a skill it needs to be rehearsed. We asked the students to do programming assignments and a programming project. Solving the programming assignments is supported by weekly meetings with the tutor assistants. In addition, students write sort report and present concept maps about key mechanisms of the programming language. Based on the material the students have produced in these tasks they finally prepare a portfolio in which they summarize and reflect their learning. The students are evaluated based on the programming assignments, the programming project, and the portfolio.

Each group meets once a week in a PBL session lasting for three hours. A group needs a meeting room equipped with a white board and a projector. The meeting starts with the closing session of the previous case, if any. Then a new case is opened. The processing of the case goes through the sequence of sessions shown below.

Opening session:

- Activity 1. Introduction of the case.
- Activity 2. Identification of the problem. Specifying key issues of the case with some keywords.
- Activity 3. Brainstorming. The students present their associations and ideas about the problem to activate their previous knowledge about the topic. The ideas are written on a white board.
- Activity 4. Sketching of an explanatory model for the case using concept map or mind map.
- Activity 5. Establishing the learning goals for the Self-Study session based on the explanatory model.

Self-study session:

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- Students working independently to accomplish all learning goals. Student's work includes information gathering from internet or by reading materials.

Closing session:

- Activity 6. Discussion and presentation: Equipped with the newly acquired knowledge, the group reconvenes to discuss the case. The discussion/ presentation includes explanation of central concepts and mechanisms, analysis of the material, and evaluation of its validity and importance.

V.15. JOHN VON NEUMANN INSTITUTE

John von Neumann Institute (JVN) is an institute directly belonging to Viet Nam National University of Ho Chi Minh City (abbreviated as VNUHCM). JVN Institute operates as an Excellence Center in the domains of Information Technology, Data Science and Quantitative Computational Finance. The main mission of JVN Institute is to build a high-quality and sustainable model that links post-graduate education, scientific research, and data centric initiatives application into enterprise innovation. This model is expected to create many breakthrough values in bringing new knowledge about IT, data analytics, and computational finance to businesses to improve their operational performance creating a momentum for the increase of social investment in research and development. The key point of this model relates to the ability of students in solving practical problems because the outputs are likely to be directly assessed and used by enterprises. This is a difficult task in considering the constraint of reserved resources and the maturity level of post-graduate education in Vietnam, which consequently affects and forms the passive behavior of students in the process of receiving knowledge in the educational environment.

Therefore, to overcome this challenge, JVN Institute has created a fundamentally different point of post graduate education by equipping new skills and methods that encourage students more active in their learning. The active of students comes from their ability to select actively the subjects in their learning program, develop their own adaptable learning plan, and a highly interactive environment built around the students and subjects strictly following the solving problems approach. However, in order to achieve this goal in addition to human factors JVN

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Institute should focus on developing not only facilities, including basic equipment and studying space, but also methods and advanced tools for increasing the effectiveness of active learning of the students.

Implementation:

In fact, right from the establishment project, JVN Institute has shaped professional activities to be deployed around laboratories, where lecturers, researchers and students work together out of class time. The students will learn through projects, topics and subjects in the curriculum under the supervision of the lecturers and researchers.

Currently, JVN Institute has 2 types of laboratories:

- A lab for the courses in the master degree program.
- A lab for scientific or industrial research projects.

The space of the laboratories is designed openly facilitating the collaboration and group work.

In the laboratories for practice and group courses students can use the wall during their work. It is very useful for their discussion because they are not limited by the normal whiteboards. Obviously, those boards occupy a lot of space.

With laboratories for research projects, JVN Institute designed to create creative inspiration for groups working with green trees and light tones. However, in these spaces, people still work with their personal computers and interact primarily through whiteboards and projectors. If equipped with a flexible and comprehensive connectivity solution to support an active learning and working environment, the efficiency will greatly increase.

The academic activities take place on the basis of collaborating and promoting the proactive of students. The time spent on these activities is significant because differently from other post-graduate programs in Vietnam following to the model of part-time studying during working, the educational programs at JVN Institute are designed full-time. Therefore, out of the class time and in the remaining of week time the students continue to study together with the guidance of teachers, the support of researchers, and co-working with their classmates. In addition, to further facilitate the students, JVN Institute has implemented the registration and management process to allow students to work 24/7 in the laboratories. This policy helps maximize students' efforts for accomplishing the exercises and participating in projects.

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Regarding the master programs, JVN Institute has many subjects related to equipping, enhancing learning and working methods for students such as research methods, individual research projects, thesis development, and new working skills. These subjects are conducted in the form of direct work between teachers and students so the interaction is very high. The context of these subjects revolves around problems to be solved. Through these subjects, students not only complete the course requirements but also achieve some specific products for the real application, attend conferences and publish scientific papers.

Besides, JVN Institute also regularly organizes seminars on academic, professional, and methods to help students study more efficiently. These seminars are held every Friday afternoon with the participation of lecturers, researchers, students and especially industrial experts. This activity helps students not only expand their knowledge and ability to solve practical problems, but also sharpen interactive skills, team work, career orientation and work motivation.

Another factor contributing to the effectiveness of the AL model at JVN Institute is using English in training and the participation of foreign teachers and students from Europe in international cooperation. These lecturers and students not only bring freshness, higher quality, and efficiency in training activities but also create higher demands from students for modern, proactive and problem-based learning methods. These help them achieve high results and are not limited by culture even when foreign teachers and students only work at the Institute in a short time (weeks to months).

V.16. UNIVERSITY OF BATTAMBANG

Established in 2007, the University of Battambang (UBB) is one of the biggest public universities in Cambodia and the largest in the North-Western region of the country under the supervision of the Ministry of Education, Youth and Sport, Cambodia. UBB has over 3000 local students, from Associate degree to PhD degree programs, who are currently studying in its five faculties (Business Administration and Tourism, Science and Technology, Agriculture and Food Processing, Sociology and Community Development, Arts, Humanities and Education, Institute of Foreign Languages and School of Graduate Studies.

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UBB has introduced AL and PBL approaches in the university's mission, curriculums and course syllabuses. The organization's mission and strategies have been revised to modernize the teaching and learning environment. For instance, UBB educates and trains students in science, technology, arts, culture and languages at all levels through AL pedagogies, PBL and digitalized technologies in accordance with the needs of the country, especially in the northwestern part of Cambodia. Currently, three selected faculties are continuing to implement three main aspects including:

- To introduce AL and PBL teaching and learning pedagogy in faculty's strategic and financial plan, curriculum, and course syllabus to align with Cambodian government policy and strategy.
- To equip all lecturers with professional trainings on AL and PBL and modernized some equipment to support their teaching and learning activities.
- To provide students educational quality and high labor skills to match with social needs and current labor markets in Cambodia and regions.

To sum up, the ALIEN project methodologies contributes to upgrade lecturers' qualification and educational quality that are inconformity with the Royal Government of Cambodia's Rectangular Strategy for Growth, Employment, Equity and Efficiency and the Education Strategic Plan 2019-2023. The AL and PBL approaches are very significant for integrating them into the curriculum and replace traditional methods that can produce qualified graduates for industry 4.0 in the era of global advanced technologies and knowledge based economy.

V.17. TRIBHUVAN UNIVERSITY

In the case of the Institute of Engineering (IOE), Tribhuvan University (TU), PBL and AL have been introduced recently at Pulchowk Campus for Masters and Bachelors level courses. PBL/AL was first initiated in selected courses offered under the Department of Electronics and Computer Engineering. However, initiative has been taken to use the methodologies in other disciplines too, such as operation research and management science, multi-criteria design analysis, and more in the Department of Mechanical Engineering.

PBL methods were also applied in the Robotics Club at Pulchowk Campus, IOE. The club involves multidisciplinary teams of students and faculty from departments of Mechanical Engineering, Electronics and Computer Engineering and Electrical Engineering. PBL methods and AL is used for design and development of robots and automation in the club. The club annually participates in the ROBOCON International competition and National Competitions for robotics.

A Centralized Visualization System (CVS) Lab for PBL / AL has been developed and implemented at IOE, TU. Implementation of the CVS lab started with pilot testing in the Master's program in Computer Systems and Knowledge Engineering offered at the Department of Electronics and Computer Engineering. The CVS lab is used in project works of the course "Knowledge Engineering" offered in the first semester of the program. 20 students are typically enrolled in the course each year. The objectives of this course are:

- To familiarize the students with the basic concepts of knowledge engineering.
- To teach the basics of knowledge acquisition methods, IR, NLP and machine learning techniques.
- To teach students about knowledge representation, logic and reasoning.
- To introduce the students into the field of Semantic Web and ontology engineering.

Implementation involves:

- The students are divided in five groups of 4 students each.
- Each group of students is assigned a mini-project to do a case study and develop a simple knowledge-based system that would be useful for our institute.
- Each group collects and reviews material on the web and campus intranet. They have meetings/interactions with experts and contact persons of the concerned knowledge domain. They also collect necessary data and documents from the person and/or the internet.
- They explore existing solutions from the web and propose a knowledge-based system for the project.
- Each group delivers a group presentation followed by feedback provided by other groups and the instructor and domain experts.

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- Each group develops a solution prototype and demonstrates it in the final presentation to all other groups, instructor and the concerned domain experts.
- The groups are evaluated based on these presentations and the solution prototypes developed.

Few selected project titles demonstrated and presented at the CVS lab are given below:

- Online Form Photo Validation System.
- Exam Results and Entrance Score Analytics.
- Online Assessment Marks Entry System.
- Exam Papers Package Handling System.

Implementation of the CVS lab was also started with pilot testing in the elective course Big-Data Application and Analytics offered in the Master's program at the Department of Electronics and Computer Engineering. Minimum of 6 students are enrolled in the course when offered. The objectives of this course are:

- To give overview of Big data and latest Trend in Big Data Analytics.
- To introduce the technologies for Handling Big Data.
- To perform basic exploration of large, complex datasets and understand scalable big data analysis.
- To apply big data tool for advanced analytics disciplines such as predictive analytics, data mining, text analytics and statistical analysis.

The CVS lab is being used in laboratory work of this course.

In the beginning of the course, the lab is used to demonstrate the installation procedure of the different big data tools. The students use the workstations and lab connectivity to collect required documents for the tools setup and they tried to follow the installation procedures and shared the issues encountered during installation to the entire class. Either one of the students or instructor shows the way to solve the issues. Once the installation is complete, in the next lab session, the students are asked to work in a group to:

- Define a real world problem to be solved using big data stack.

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- Specify along with the sources from where the data will be collected. What are the important features that will be taken into consideration while designing the system?
- How you will store that data? Which of components of big data ecosystem can be chosen to design the system? Illustrate in detail with a block diagram.
- What are the algorithms that will be used to process the collected data? How the results will be visualized?

The students research articles and explore existing solutions from the web to identify the problems that can be solved through big data. They propose a big-data project with the appropriate use of big data tools to solve the identified problem. Students deliver group presentations and feedback is provided to each group by other groups and the instructor. In the last session, each group develops a solution prototype and demonstrated in the final presentation to all other groups and the instructor. The students are evaluated through the final presentation of the complete system that has been developed.

Implementation of the CVS lab is also planned for Bachelor level Course Computer Graphics, offered at the Department of Electronics and Computer Engineering. The CVS lab can be used for laboratory work and project works of the course Computer Graphics. 96 students are typically enrolled in the course each year.

The objectives of this course is to familiarize with graphics hardware, line and curve drawing techniques, techniques for representing and manipulating geometric objects, illumination and lighting models.

The students can be taken to lab to demonstrate the techniques for representing and manipulating geometric objects, illumination and lighting models in groups and in different sessions. They can be asked to implement the techniques demonstrated and the solutions and issues they encountered can be shared to the others in the big screens.

The students can also use this lab to demonstrate the computer graphics project to other students and faculties.

Similarly, implementation takes place on ongoing for courses on computer graphics, image processing, operations research and management science.

TU works on integrating the CVS lab application in more existing and new courses in undergraduate and graduate programs. The organization evaluates feedback and suggestions of students and teachers on the effective use of the CVS in preparation of designing and delivering capacity building activities for faculty and staff.

Conclusions

This document presented the current status quo in countries participating in the ALIEN consortium in relation to the deployment of PBL and AL in higher education engineering practices. The report includes a review of practices at the national level and at the institutional level for project partners. The work was conducted at the University of Thessaly (Greece), Porto Polytechnic (Portugal), Tallinn University (Estonia), University of Central Lancashire (UK), University of Gabrovo (Bulgaria), University of Malaya (Malaysia), University Tenaga Nasional (Malaysia), Kathmandu University (Nepal), Tribhuvan University (Nepal), Isra University (Pakistan), National University of Computer and Emerging Sciences (Pakistan), Hanoi University (Vietnam), Hanoi University of Science and Technology (Vietnam), Von Neumann Institute (Vietnam), University of Battambang (Cambodia), Institute of Technology Cambodia (Cambodia) and Meanchey University (Cambodia). The review demonstrated that while PBL and AL are to some degree deployed at partner universities and beyond in the corresponding countries obstacles do exist for the broad deployment of the methodologies in engineering HE. These include the lack of physical infrastructures, the lack of digital learning services and the need for instructor training. The ALIEN project introduces a learning intervention that aims to promote PBL and AL as strategic educational approaches in engineering HE by addressing all of the identified obstacles through the development of physical PBL labs at Asian universities, the development of a PBL collaborative digital platform, instructor training and the creation of a community of good practices for the promotion of AL and PBL.

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