D2.1 Institutional Strategy

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I. INTRODUCTION

Active Learning (AL) 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 (Queens University, 2018). 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.

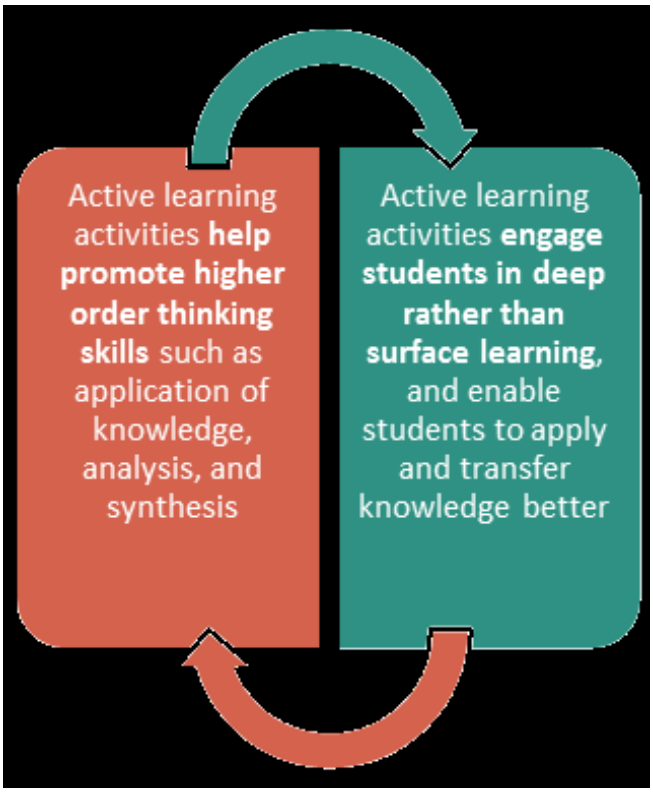

Figure 1: What is Active Learning (Queens University, 2018)

The ALIEN (Active Learning in Engineering Education) research project aims to design, implement and validate an active learning-based learning methodology based on science,

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technology, engineering and mathematics (STEM). The methodology will be supported by a virtual learning environment that includes a set of digital tools and will allow students to experiment, collaborate and communicate with an extensive and multinational learning community that includes other stakeholders such as teachers and researchers. In fact, ALIEN's expected impact includes the institutional strategic adoption of active learning as the primary pedagogical approach to education.

This document guides the definition of such strategic approach addressing three different levels:

- The institutional level with the goal of getting AL and PBL as a strategic and systematic option
- The pedagogical level with the goal of having teachers and students adopting AL and PBL
- The technological level, by demonstrating through innovative ICT tools, how to support AL and PBL

The strategic plan to be adopted / adapted by each institution on the use of Active Learning and Problem/Project Based Learning will have mostly impact on the institutional and pedagogical level. As part of the institutional strategy, the PBL laboratory impacts directly on teachers and students but depends heavily on the technological level. The validated pedagogical methodology (flexible enough to allow for several instances) that promotes AL and PBL impacts mainly at pedagogical level but depends on the technological tools. Its systematization depends on the institutional level.

Through the ALIEN approach:

- Teachers from Higher Education in Engineering/Sciences/Technical faculties will be able to apply the Active Learning methodology and the tools to be developed in the project

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- The students will benefit from a more motivating pedagogical context and will be more attracted to these subject areas
- HEIs will benefit from adopting a more active pedagogical approach and will be able to attract more students, will establish closer links with the society and the labor market

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II. ACTIVE LEARNING

Active learning is generally defined as an instructional method that requires interaction with students to do meaningful learning activities or thinking about what they are doing in the classroom. The core element of the method is students' engagement throughout the learning process (Bonwell and Eison, 1991). Unlike passive learning, this learning approach is said to be better because it involves students' interaction among themselves as well as the teacher through discussions and collaborations, critical thinking, problem solving and connecting new learning in the students' world (OpenLearning, 2018). There is a lot of methods that apply active learning techniques in the teaching such as think pair share, role playing, discovering plate boundaries, peer review and game-based learning (Gallery Walks, 2018). When it comes to learning a new concept or skill, instruction is essential but practice makes perfect (Panopto, 2018). 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

"The ultimate contribution of active learning is an innovative way of thinking, where reality and truth are not a case of black and white, where teaching and learning are an exploratory journey to the wealth of knowledge and different realities and, finally, where nothing is

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taken for granted but the provision of a fruitful learning context, full of interactions, that can reveal to everyone his or her own path to inner achievement and fulfilment." (Misseyanni, et al., 2018, p. xviii).

In other words, active and experiential learning methodologies motivate and engage learners that are technologically-savvy, rapidly absorb pieces of information and expect instant responses and feedback (Batista & Vaz de Carvalho, 2008).

Engineering is one of the fastest changing fields that can benefit from AL, once permanent innovation is mandatory and professionals should combine the more technical aspects of their knowledge with Science and Technology, providing a problem-solving posture that beneficiates society: "So, at present, engineers with technical skills must also learn how to work in interdisciplinary teams, how to develop designs rapidly, how to manufacture sustainably, how to combine art and engineering and how to address global markets." (Ciampi, et al., 2016, p. 2).

Guidelines for Engineering Education offer insight in common goals and perspectives on how to best address the challenges, suggesting the adoption of alternative learning methods, such as student-cantered learning and a strong connection between theory and practice and the reinforcement of aspects that are key to a comprehensive professional practice (Colombo, et al., 2014).

PROBLEM AND PROJECT BASED LEARNING (PBL)

Traditional learning methodologies based on passive dissemination of information fail to effectively develop the broad skills required today in industry. Emerging learning methodologies, such as Project and Problem-Based Learning, offer significant benefits by contributing to the development of sophisticated skills such as analysis, synthesis and evaluation. Problem-based learning is an active methodology focusing on the learner. Within this framework, students develop knowledge and skills following a process of

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synthesis of solutions to problems that are usually based on real situations. The method offers significant benefits including the development of critical thinking, creativity, the capacity for collaboration, communication skills, inherent motivation to engage in learning and business thinking. PBL can also be regarded as a form of active learning. It is based on the fact that in order to solve problems, the students must be able to utilize their existing body of knowledge and if they do not have it, they need to proactively searching for it, inside or outside the classroom. PBL has gained world-wide interest as an innovative technique that engage learners for deep learning and develop a multitude of crucial professional skills, especially self-directed learning and problem solving (Strobel, 2007), which are essential in graduates for the 21st Century (Duderstadt, 2010). Student-centered learning and collaborative learning are among the basic characteristics of PBL. Student-centered learning assumes the idea that student can “learn by doing” and therefore acknowledges that they can play an active role in their learning as problem-solvers and think in critical and creative ways (Barron et al., 1998). Teamwork among the students engaged in collaborative learning increases the chances of success and enables the development of communication and interpersonal relationship skills.

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:

a) 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.

b) 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.

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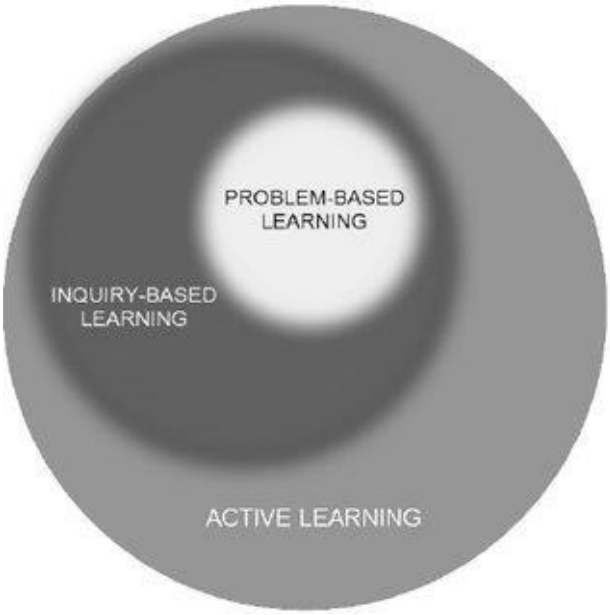

Figure 2: Active Learning Methodologies (Queens University, 2018)

c) 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 (actually 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 project-based learning 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 helping learners negotiate conflicts and enough self-confidence not to give up when a project peters out or refuses to come together.

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PBL is a teaching method where complex real-world problems are used to promote the development of critical thinking skills, problem-solving abilities and communication skills (Tsalapatas, 2018). During the past few years Problem-Based Learning had played an important role in university curricula. Teachers use technology in class in many forms, including videos, Internet, TV and other educational tools, and students learn to research the Internet, collect information and compile it into projects while working in groups.

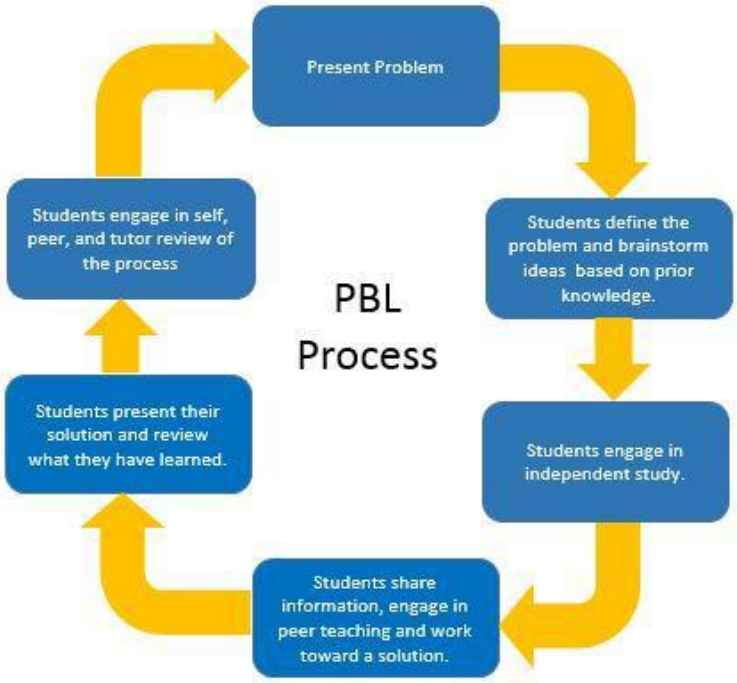

Figure 3: PBL Process (Gukeisen, 2013)

Teachers, in order to make their class attendance more attractive, need to attend continuous training programs to update cognitive backgrounds and skills against the traditional methods of teaching. Of course, an important element for all this to be efficient is the existence of material and technical facilities. The continuous combination with teaching, alternative teaching methods, knowledge of each subject and motivation are important factors for the development of professional competencies of adult educators. Laboratory personnel have formal education and therefore that tends to carry every

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stereotyped and conventional teaching trend in university teaching. This highlights the need for training support for teachers, young and old.

Undergraduate and postgraduate teachers should be encouraged by their Administration to join/participate in pedagogical nature facilities and incentives in conferences so they are informed for all alternative forms of education and integrate them into teaching. Finally, pedagogical courses should be held, with emphasis in the field of alternative teaching as it is now undeniable that they contribute to a better school performance for learners and especially adults.

WHY SHOULD WE USE PROBLEM-BASED LEARNING?

Here are 12 reasons why teachers, guides, educators, educationists, or students should go for PBL.

1. Scope of work

The first and foremost reason to go for problem-based learning is that it enables educators, teachers and students to learn and adopt structures around projects rather than having lecture-based learning and reading-writing assignments of the traditional classed room learning. Students learn to comprehend the entire scope of the project and put the execution into a structure under guidance of their teachers or supervisors.

2. Real world problem simulation

Problem-based learning focuses on enabling student to face real world situations simulated in the forms of the projects. Students learn while doing what they know and develop new learning around hobbies, passions and careers. They often develop new hobbies, passions and liking for new careers.

3. Improves the interpersonal skills of a student

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It greatly impacts the development of interpersonal skills of the students. Projects given often are more complex than in the assignments given in the traditional classroom-based learning. Students need to structure their efforts in organizing their survey required for the projects, analyze the survey results and prepare reports to reach markets and collaborates with sponsors of the projects. In the entire approach or different stages of the project they improve their communication skills to collaborate with various stakeholders.

4. Concept and creativity development

Problem-based learning develops greater depth of understanding the concepts than in traditional classroom-based learning and results in improved levels of student's creativity. Real world situations given in the project are more capable to draw students' attention and capture their interest to provoke the needed level of thinking to apply new knowledge in a problem-solving context.

5. Determines the actual knowledge

Project-based learning determines in depth knowledge and experience of the students and sometimes of teachers in comparison to the fixed length of learning experience of traditional classroom-based learning. In project-based learning student develop their skills and knowledge while classed-based learning has shorter span of memorizing based experience derived from a rote approach.

6. Choice of selecting real world problems

Another great reason to go for project-based learning is that projects are chosen by the students or assigned by the teachers according to the students' interest. Students are presented to have choice based on their interest in selecting a real-world problem presented in the project. Interest-based selection of projects gives student unique ways of solving different problems which are diverse even in the same class, where as traditional

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classroom-based learning has question/answer-based essays and exam writing, including assignments given to all students of the class.

7. New style assessment of students' skills

Teachers are able to assess students' capabilities to observe, survey and investigate, then allocate the projects determining the activities and events based on their interest. Students find themselves capable of honing their observation and analyzing skills. Teachers can directly assess the development of these skills among their students when they perform activities of the project work.

8. Visits to field-sites of real-world problems

A significant feature of problem-based learning is field-site visits by the students, teachers and other involved researchers and educationists as needed in the project executions which open new ways of learning and collaborating with stakeholders and new people.

9. Direct demonstration of the capability

Teachers get greater opportunity to assess their students' capabilities demonstrated in the performing activities and events organized in the projects than the essays and exams of the traditional classroom learning based on rote learning and memorization to write what teachers have taught as their fixed and pre-determination of the topic or subject.

10. Technology inclusion

Problem-based learning is an effective way of including technology in the learning laboratories of the education system. Projects selected by students according to their interest are now likely to involve computers and the internet, as well as interactive whiteboards, GPS devices and cameras.

11. Tracking of progress

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In problem-based learning teachers and students both can track their activities involved in the project given to the student to solve real world problems. In traditional classroom-based learning this is ever missing, as not required or non-existing mechanism in the structure.

12. End-To-End problem-solving Skills

In problem-based learning students undergo various stages of problem solving through structure of the project which include various stages like project scoping, work planning, activity performing and tracking, managing uncertainties presented during problem solving activities of the project, presentation of the project and closure. Students have opportunities to develop skills of observation, survey, research, reporting, presentation, communication and collaboration with people involved, team building and leadership in the end-to-end problem-solving approach of problem-based learning.

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III. INSTITUTIONAL APPROACH TO ACTIVE LEARNING

There is no special curriculum for Problem-Based Learning in higher education. Furthermore, there are no formal guidelines for teachers on how to apply such methods in the classroom. In addition, no training exists for teachers on hot to integrate AL and PBL, or other emerging pedagogies into educational activities for their students. As a result, teachers may sometimes be negative towards emerging educational methodologies, such as Problem-Based Learning in their instructional practices. Teachers bear the responsibility of integrating Problem-Based Learning into their classes through their own initiative if they so choose. It is not uncommon for teachers to design activities for their students or to research the internet for related educational content, however, when this takes place, it happens as a result of personal interest of the teachers to enrich learning activities for the benefit of their students.

Currently Problem-Based Learning in deployed in courses such as mathematics and natural sciences, including physics, chemistry, biology and geology. These courses traditionally apply Problem-Based Learning. Typically, students are challenged to solve exercises that are specific to the course being taught. For example, students are asked to solve math or science exercises that the teacher selects from the formal school text book. Students typically work on exercises at home, while the teacher also solves exercises on the blackboard.

The main issue with this approach is the fact that students only have the opportunity to apply Problem-Based Learning within the strict context of a specific course. They rarely get the opportunity to apply Problem-Based Learning in wider contexts that challenge them to integrate knowledge from different courses, e.g. to integrate physics, chemistry and math knowledge towards resolving broader exercises, the solution to which requires knowledge from diverse fields.

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Another challenge that teachers and students face is the limited infrastructure available in universities as well as the lack of formal teaching training in AL and PBL. Physical labs, either physics, chemistry, or computer labs, are limited and do not necessarily exist in all universities. As a result, Problem-Based Learning is limited to paper and pen exercises.

INSTITUTIONAL SUPPORT TO ACTIVE LEARNING

The following six key recommendations can be made which are considered to be essential for the successful adoption of a PBL approach in the mainstream school setting:

1. **Student support**: Students need to be effectively guided and supported; emphasis should be given on effective time management and student self-management, including making safe and productive use of technological resources.
2. **Teacher support**: Regular support needs to be offered to teachers through regular networking and professional development opportunities. The support from the school senior management is crucial.
3. **Effective group work**: High-quality group work will help ensure that students share equal levels of agency and participation.
4. **Balancing didactic instruction with independent inquiry**: This method work will ensure that students develop a certain level of knowledge and skills before being comfortably engaged in independent work.
5. **Assessment**: Emphasis on reflection, self and peer evaluation. Evidence of progress needs to be regularly monitored and recorded.
6. **An element of student choice and autonomy throughout the PBL process**: This approach will help students develop a sense of ownership and control over their learning.

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PEDAGOGICAL APPROACH TO ACTIVE LEARNING

Research shows that Problem-Based Learning, works to engage students and provide them with life-long learning skills. This teaching method leads to higher retention rates and improvements in critical thinking skills. Teachers in project-based learning classrooms are responsible for encouraging students to take charge of their own education rather than the teaching and testing model that tends to be the standard in schools today.

Project-Based Learning looks intimidating to many teachers who work within prescribed traditional curriculums. It seems like quite a stretch to get there from where their teaching methods currently stand. But it doesn't have to be as all-encompassing as you might imagine and the changes you make don't need to be drastic.

Most teachers already use projects in an effort to evaluate whether students are grasping an important concept well enough to really use them in real life. With a few adjustments, the projects currently in use can take on the hallmarks of project-based learning to help students improve critical thinking skills and empower them to take their education into their own hands. Here are a few ways you can begin to incorporate the principles of project-based learning into your traditional classroom.

- **Adjust project timelines so that students are learning material *during* the project rather than assigning projects to gauge whether material was learned**

  Make learning a part of the whole project rather than the project acting as an assessment of what was learned. Alter the way students typically carry out projects by presenting the problem first. Give students a real-world problem at the beginning of the unit that they'll work on solving throughout.

  The material used doesn't necessarily need to change that much. The lectures, resources and homework you've always associated with a unit will work just fine with a project-based learning approach. You're simply offering students a different perspective, where the problem presented at the beginning of the unit gives them a

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tangible reason to soak up the information provided in a way that they may use it their whole lives through.

- **Assign benchmarks throughout the projects to create milestones for grading and ensuring student success**

  Teaching in the traditional school model means grades and assessments are a must. Project based learning doesn't by any stretch mean that these things go out the window, simply that you'll insert grade checkpoints into projects. These checkpoints not only allow you to keep up with traditional grading requirements, they also allow you a formal space to assess student development over the course of the project.

- **Prepare in advance to offer students flexibility**

  When you put students in charge of their education, their needs will inevitably vary. Some kids will zoom ahead, grasping the concepts with ease and developing a passion for the subject. Others will flag, wondering where and how to find the information they need to succeed and generally struggle with the subject matter and the development of critical thinking required in these all-encompassing projects.

  When the goal is to empower students to learn and think critically their whole lives this flexibility is crucial. As the facilitator in Problem-Based Learning, it's the teacher's job to provide students with the tools they need to learn to the best of their ability. Likely, this will mean preparing projects so that they are adjustable, offering various pathways that lead to thought-provoking challenges for students of all levels. This provides for every child a way to succeed through hard work and perseverance.

  Allowing flexibility and assigning benchmarks that uphold the ideals of Problem-Based Learning make the acquisition of lifelong learning skills your top priority in the classroom (rather than a simply mastery of the materials). This is at the heart of why great teachers do what they do. The most important thing for teachers who want to

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adopt a more project-based strategy should be to keep in mind that small steps can lead to big changes in student learning.

IV. PBL LABORATORY

Some partners do not have a specific space or institutional support, but are implementing:

- Collaboration strategies between students in classes
- Other equipment like smart TVs
- Educational platforms like Moodle
- Video showcasing in classes

Other partners already have spaces adapted or integrated options to facilitate the movement inside the university space.

One significant aspect is to search for guidelines about how to adapt the space to PBL and partners from the United Kingdom and Estonia are going to search for that kind of information in their own universities to understand if can be used as a model or auxiliary template.

In terms of institutional support, it's important to be aware that some institutions may require authorization from their Ministry of Education in order to implement PBL projects; and the financial support towards buying the necessary equipment.

Focusing on the teachers, it is important to offer incentives as a way to motivate them like:

- Organization of workshops about PBL
- Provision of adapted start up content to the teachers - have some guidelines to show how to save time adapting what they already have;
- And instigate teachers to implement an interdisciplinary strategy

In terms of space, partners agree that it's important to have flexible rooms to adapt to space limitations (indicated as a problem for some partners, specially, from Asian countries). Tables may be something dispensable and the chairs movable to facilitate interaction. Screens should also be portable in order to adapt to space configurations, which may vary with the number of the students involved and to be used in different university locations.

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In terms of expected difficulties, 1st and 2nd year students may struggle applying PBL once they are still developing skills necessary to be active in their own learning process. Additionally, classes with a big number of students may provide challenges.

Partners revealed that the ALIEN PBL platform is something important in the development of the PBL Labs, once it may provide technical support.

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IV. PBL PLATFORM

ALIEN PBL APPROACH

STEP 0: The consortium (later, the teachers) select and formulate the topic and the learning goals and achievements. Identify/define the problem.

The consortium (and later, the teachers) must here plan how and what the students must learn and how to explain it for them. The learning goals can relate to the curriculum of a special subject, or it can be related to students getting special competences, knowledge, techniques of general or specialized character of a particular subject or theme. The learning goals and achievements are the foundation for which problems and themes, the teacher selects to inform and explain the students about their task and how they will work with the task.

If possible, the teacher identifies different learning goals and progression stages to accept that individual students not learn equally fast or have the same possibilities for learning.

PRE-STEP: Define groups, setup logistics (platform and other resources), organize platform tools

Teachers and students register at the platform. Teacher sets up groups, gather resources, etc. The students use the logbook in ALIEN to record what they use their time on and what they learn from each resource they investigate. The teacher must have access to this logbook.

The teacher is present and can overlook the work either in class or online on the platform at any time. The students can work and cooperate face-to-face or online through the platform. The teacher can measure the progress of the students by the pre-and after reflections. The teacher should assume a role of a facilitator to support the students in the right directions. Dependent on variations in groups and how well they work and how skilled the students

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are, the teacher may provide more clear directives with some groups than other groups to make sure that all groups accomplish something.

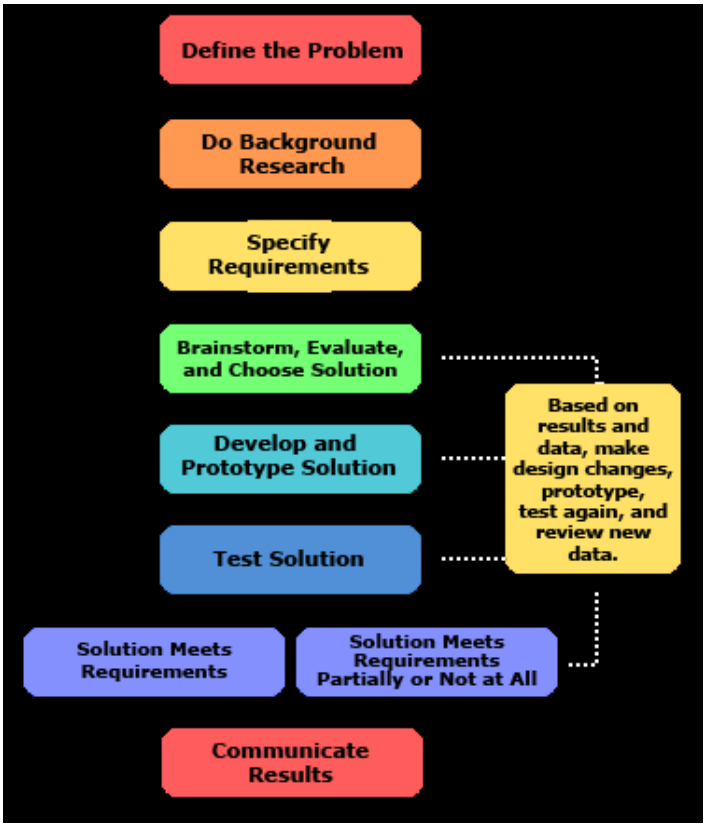

Figure 4: Steps of ALIEN PBL approach

STEP 1: Explore the problem statement and topic. Background research

The students shall work in groups to analyze the problem. This means writing questions and ideas, looking into books and other material they have at hand to understand what the problem statement is (the problem they will work with). The students ask themselves: “what do we know?”, “What do we need to know?”, “How can we find out what we need to know?”.

As part of this step, the students can identify what they need to know and do project planning and allocation of tasks. Through games, or simulation cases related to the problem and topic, the students can get a better understanding of what they need to know. The

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teacher needs to support this step by discussing the relevant need to know parts and how the students plan to gain the knowledge, as well as how to allocate the time for each task. Through the-need-to-know-list, the teacher has a clear indication of the starting point for the students as a basis for understanding and measuring the progression later.

The teacher must be aware that there is a chance that different student groups will work with different problem statements related to the topic. Furthermore, the teacher can engage in a discussion with the students about the problem statement and the way it can be answered/solved and in that way direct the students to do change in the problem statement.

Students can consult experts, read books, or read, or watch other relevant material that the teacher can support them by identifying. There is here also the possibility that the students do empirical work, surveys or interviews if that is relevant in relation to the questions, they need to have answer to.

This step takes longer time. The ALIEN platform can be used here, if teachers have placed video's, or have identified games or simulation cases that the students can use as a basis for their learning about the questions.

STEP 2: Investigate the problem. Specify Requirements

Here the students collect data to answer to the questions. They identify the requirements for the potential solutions and they can identify resources and tasks to undertake to solve the problem.

STEP 3: Identify possible solutions. Brainstorm, evaluate and choose solution

The students describe different solutions and actions to the questions they identified in Step 2. Furthermore, they should answer the overall problem statement they did in Step 1. They should try to explain why they think that is the solution and discuss if there is any problems or other ways to look at another solution. Solutions can be made in various ways – as a

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game, as a video, as a report, as a poster, with diagrams, calculations, or with relevant laboratory work as basis. The ALIEN platform can be used to upload the possible solutions and for the students to compare and share information on another groups' work. Students finally decide on the best solution.

The teacher must support the students in this process by discussing the pros and cons of the answers and making sure that the students have found that is associated with the learning goals of the exercise. At the same time, the teacher can here see the progress that the students have made both by talking with them face-to-face but also by looking at their solutions at the platform.

STEP 4: Develop and prototype solution

With the help of the teacher, students implement the selected solution (this might not always be possible, it depends on the actual problem).

STEP 5: Test solution

Test the solution and measure results. Iterate to step 4 if necessary (results do not correspond to the problem solution, are not efficient or should be improved).

STEP 6: Present the findings. communicate results

The students should present their findings to other students and the teacher. This can be done in oral presentations, through videos or others agreed by and with the teacher.
At this stage, the students should fill-out a self-reflection form including questions how well they understand the questions now and how the group work has been. This self-reflection form is something the teacher can do and share with the individual students at the ALIEN platform. In these reflection forms, the teacher can get an idea of how the students see him/herself and can use that along with the information from the other steps to understand the progression of the individual students. The self-reflection represents a sort of review of

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how the process and learning process has been and can point to how the students can become better for the next project.

ALIEN PBL PLATFORM SPECIFICATION

GENERAL REQUIREMENTS

- Should support the community and the features should be used by everybody, should be user-friendly with a great emphasis on the spirit of community and collaboration
- Should allow users to access content related to the domains chosen. That said, can`t be too generic
- The target group of the community should be clear: teachers or students (or both) and what type of engineers (from all Engineering fields or just from a specific one)
- Each domain, depending on the target, should have a specific platform (starting from a generic data base)
- Work as a meeting point that provides solutions to the community
- Include different strategies of active learning with different activities and adapt the community with that in mind (have an option to select which one)
- The platform should reflect the different stages of PBL and manage the learning process
- Include team work support and extra functions, including communication systems and sharing of information, debates, discussion groups and video reactions
- Should also include evaluation, applying digital systems (composed of multiple questions with the same level of difficulty)
    - Constant monitoring of results
    - Also, a test to evaluate the learning experience and understand how the students see the experience, providing a more active evaluation and

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including peer review. Additionally, the evaluation should include the reflection of students, written in a report

Moreover, the platform should permit:

- Organization of teams to report problems
- Students can produce evaluation content and problem creation for sharing purposes;
- Should have a list of types of PBL and find software that could help students — a template with multiple interfaces
- Problems related to software development
- Applying the same strategy with members from different areas and promote reflection — including the premise of “learning by failure”
- Multidisciplinary approach and focus on problem solving
- Explore the strategy of collective storytelling
- Inclusion of automatic complier to decide if the solution in case is correct or not. That would facilitate evaluation
- Translation system in the back end and platform translation into English. Other languages could potentiate more users

In terms of difficulties, it is advisable to be aware that:

- The platform can´t be too difficult to use — it should be user-friendly
- Having to create external platforms to accommodate the community (depending on the institution)
- Teacher training (if teachers have training in this area or are from a specific Engineering field, they might be able to do it alone, but if they don’t, it can be hard for them and training should be provided)
- Should facilitate the transition for teachers (apply some similarities of other existent systems)

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- There are different time zones when students are playing and therefore it becomes necessary to handle this issue when students are playing in teams from all over the world

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V. ADAPTED INSTITUTIONAL STRATEGIES BY PARTNER

The following sections discuss the individual institutional strategies of ALIEN project partners towards adopting AL and PBL as a strategic educational approach in engineering higher education.

P1. University of Thessaly (UTH)

Institutional mission, vision and strategy

The University of Thessaly aims to bring high quality education to students, linking education to the world of work. Taking into account the current economic and societal trends in Greece that is faced with high youth unemployment that exceeds 55%, universities face the challenge of building knowledge that promotes growth and social cohesion. The University further aims to implement European policies in education. These include the New Skills Agenda for Europe, which underscores the need in industry and society for high level skills developed in higher education and the Investing in Europe's Youth initiative, which highlights the importance of building knowledge and skills for fighting unemployment and promoting innovation, competitiveness and social fairness.

The Department of Electrical and Computer Engineering, which is the partner in this project, has as its mission to promote the science of computer and electrical engineering and to build the foundational and moral capacities of students so that they can further pursue the topic in post graduate programs while at the same time being in a good position to continuously learn to learn in order to maintain state of the art knowledge in this rapidly evolving sector. To this end, the department continuously updates its 5-year academic program in order to provide engineering, educational, managerial and entrepreneurial skills demanded by industry.

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The above goals are achieved through educational programs that are continuously updated in order to reflect the needs of society and to develop the knowledge, competencies and skills that students will need in order to fulfill their full potential as individuals, active citizens and professionals. Being the only higher education institution in the wider area of Thessaly, which spans central Greece and has 800.000 inhabitants, the University of Thessaly further pursues its mission by assuming a consulting role and by collaborating with public authorities, professional associations and industry in joint initiatives that promote regional development in the area of Thessaly. The university further has broad professional and research networks with universities at the European and international level through which it pursues research and development activities for enriching the organization's research profile and for maintaining a high quality in its educational initiatives by integrating research activities and results into educational offerings, promoting the research-innovation-education triangle.

The Engineering School includes Departments for Electrical and Computer Engineering, Mechanical Engineering, Civil Engineering, Urban Engineering, Architecture and Agricultural Engineering. These departments share the overall vision of the institution of providing quality education that develops skills needed in society and the world of work at the national and international level.

Active learning and problem-based learning are not specifically mentioned in the organization's strategical documents. However, active learning can offer significant benefits in engineering education. In engineering principles, learning by doing is one of the most effective ways for building and retaining knowledge, as it prepares individuals to apply the new knowledge in the field, thus linking education to the world of work by building skills for employment, which is one of the strategic goals of education in Europe today. In addition, by preparing young individuals to effectively tackle real world problems, engineering education helps develop highly skilled professionals that are needed in order for companies

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and SMEs to pursue emerging business opportunities. Problem based and active learning can build the critical and analytical thinking skills that are need in innovation related sectors, such as engineering, that are expected to drive growth in the coming years.

A number of steps can be put into place to promote the deployment of active and problem-based learning at the Engineering School of the University of Thessaly.

Digital educational resources

Universities in Greece, including the University of Thessaly, face several issues when applying innovative approaches such as active and problem-based learning, including limited infrastructure. A good way to overcome this limitation is to deploy open, digital educational resources in the form of simulations that allow students to experiment and to practically apply knowledge. The ALIEN PBL platform can significantly contribute to this end. ALIEN will be available for all engineering departments for publishing and accessing digital simulations and games that will be made openly available to students through the platform. The digital problems to be used will includes ones that have been developed by the university through research activities as well as external ones that can benefit students in specific educational contexts.

Instructor training

Most importantly, what is missing from engineering education is the training of instructors on a more structured implementation of problem-based learning, which they already intuitively apply. Engineering instructors are specialists and have little exposure to emerging pedagogies, such as problem-based learning. Instructors can benefit from training on how to more formally introduce into their course structured problem-based approaches. There are different ways that a problem may be structured but some of the well accepted approaches include identifying the problem and the given parameters for solving it, breaking down the

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problem into smaller tasks, solving each task separately, integrating the solutions to the subtasks to synthesize a final solution to the given problem.

The best approach to promote active and problem-based learning is through instructor training that will build both the appreciation of instructors on the benefits of active learning as well as their practical competencies on how to integrate problem-based learning into the classroom by structuring projects according to well accepted approaches described above. Training content may include:

- General principles on problem-based learning
- Benefits of problem-based learning in engineering education
- Suggested methodologies for structuring problem-based learning activities in the classroom
- Examples of problems that are relevant in engineering education and suggestions on how to integrate them into classroom activities

The above can be provided to instructors in small, limited in duration activities (“bites”) in which they will be exposed to problem-based learning good practices. This will allow engineering instructors to build knowledge in a step wise manner enriching their instructional practices for the benefit of their students.

Special interest groups

A special interest group will be created on the topic of active and problem-based learning. Any instructor in the engineering school will be able to join. Through the group, instructors will be able to explore emerging pedagogical design, share experiences, review good practices and collectively develop their capacity to integrate problem-based learning into their activities.

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Where will active and problem-based learning be used

Active learning will be integrated into engineering principles in phases.

Pilot phase:

Initially, the proposed solution will be deployed within the Electrical and Computer Engineering Department in diverse courses that are part of the formal program, either as obligatory courses in the first 2 academic years or electives in years 3 to 5.

Examples of courses include:

- Technology in education
- Software Engineering
- Databases
- Machine learning
- Game design

The total number of students to be engaged in this phase will be 140.

Deployment phase

In the deployment phase, the approach will be deployed more widely in the Electrical and Computer Engineering Department, including additional courses such as:

Game design, data extraction, machine learning for data sciences, logic, arithmetic analysis, parallel and networked computations, advanced machine learning, problem-based learning environments in data science.

Furthermore, it will be promoted to additional departments of the Engineering school, including:

- Architecture

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- Mechanical Engineering
- Civil Engineering
- Mariculture

In addition, the proposed solution will be deployed in recently introduced 2-year professional education programs that target vocational secondary education graduates and aim to build skills. The total number of students to be engaged in this phase will be at least 400.

Finally, the ALIEN solution will be promoted to additional universities in Greece, such as the Hellenic Open University, the Demokriteio University of Thrace and University of Macedonia and more.

Faculty support

The Creative Technologies Learning Lab at the Department of Electrical and Computer Engineering (http://ctll.e-ce.uth.gr) offers experience in the area of integrating emerging pedagogies, such as PBL and active learning and ICT, including digital games, simulations, communities, web platform, analytics and more, towards enriching learning experiences of diverse groups of learners, ranging from primary to higher and professional education and contributing to better reaching specific educational objectives. The group will support instructors in the structuring of educational activities through PBL and active learning methods, it will coordinate special interest group activities and will provide instructor training towards understanding the benefits of PBL and active learning and towards building instructor capacity on integrating these methodologies into their existing instructional practices.

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Scenario of ALIEN AL/PBL lab use in a course

Course title: Game design and implementation (HY516)

Engineering curriculum where it belongs

The course is a 4th year elective in the curriculum of the Department of Electrical and Computer Engineering.

Course description

The course analyses the theory and practices necessary for the understanding, analysis, design, development and evaluation of digital games and serious digital games.

Upon completion of the course the participants will be able to:

- Understand concepts and methods of designing and implementing digital and learning digital games
- Implement methods and procedures relevant to its conception, design, implementation and evaluation of a digital or learning digital game
- To make digital game development environments useful
- Understand research topics on the design and implementation of digital games and learning digital games

Keywords: Mechanics, aesthetics, technology, story, narrative, character development, world development, level development, puzzle development, skill and chance, serious games, online game aspects, research topics.

Number of students to be engaged

140 students are typically enrolled in the course each year.

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PBL activities that will be integrated in the course

The students will be asked to design and implement through software coding a serious game, namely a game that is designed for educational purposes. The students will be asked to:

- Identify the target group of the game
- Build a "game concept", namely a concise, short document that presents the game idea, audience, role of the player, game genre, targeted hardware platform, compelling features of the game, game cycle, core game mechanics, story, game world, competition/collaboration elements and marketing strategy
- Develop a game design document, which, in addition to the above, includes more technical information on the gameplay, game world, the game characters, the hierarchy of challenges, user interface and technical implementation parameters
- Develop the game using the Unity software development platform
- Present the game to their peers

Equipment, software and educational material to be deployed

Hardware

- 30 workstations
- Internet connectivity
- Projector

Software

- Unity software development environment

Educational material (books, scenarios, etc. and sources)

- Unity tutorials on how to build basic game functionality, available on the internet
- Fundamentals of game design, Ernest Adams, available in the library

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- Challenges for game designers, Brenda Brathwaite, Ian Schreiber, available in the library
- The art of game design, Jesse Schell, available in the library
- Games that educate train and inform, Michael Chen, available in the library

How the ALIEN equipment will be used

Students will be working in teams of 4-6 individuals on the design and implementation serious game.

In the beginning of the course the students will use the workstations and lab connectivity in order to be build experience on game development by executing selected tutorials on how to use the Unity platform. The students will download the tutorials over the internet and run them on their workstation.

Subsequently, the students will use the workstations of the lab to develop the software code for their serious game collaboratively in groups. Finally, students will deploy the projector to present their game to the rest of the class.

P2. Instituto Politécnico do Porto (IPP)

Institutional mission, vision and strategy

In Portugal, the legal definition of the strategic aspects of a Higher Education Institution is done in the institutional statutes, a legal document that is approved by the Ministry of Education and is published in the official legal journal. The institutional statues define the vision, mission and objectives of the institution amidst other aspects like the government entities, their responsibilities and duties, the integrated units and other special units, etc.

The Porto Polytechnic statutes do not mention specifically active learning but include references to the objective of:

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- “Promover a aprendizagem através de experiências formativas diversificadas;
- Promover a formação académica, sempre que possível, em contexto de investigação aplicada, ou em ambiente de simulação ou em situações reais de inserção no mundo do trabalho;”

which means:

- “Promote learning through diversified learning experiences;
- Promote academic training whenever possible through applied research, simulated or real professional situations.”

These aspects clearly are related with active learning and specifically with experiential learning but also the use of methodologies used in the context of professional work, namely Lean and Agile practices.

The Polytechnic´s statutes also include a reference to the need to implement strategies that lead to improvement of teaching practices by the teachers:

- “Implementar estratégias que estimulem a participação dos docentes em actividades conducentes à melhoria da sua formação pedagógica, profissional, académica, técnica e científica;”

All these aspects are defined and passed on to the schools and special units that form the Polytechnic. The two special units that are more directly related to the active learning practices are the following:

- e-ipp: unit for distance learning and pedagogical support for teachers
- Porto design factory: unit for non-academic degrees (mostly pos-grads) through active learning (PBL, Design Thinking) from which we can pinpoint:
    - ME310, Product Development, Heads, bea Maker! Innovation 101, and more

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In what regards, the Engineering School of the Porto Polytechnic, besides the specific statutes which to a certain extent replicate what is defined in the mother-entity statutes, there is a Development Plan for 2019-2022 which was delivered (final version) just two weeks ago. This document has been somehow impacted by ALIEN as it identifies as school weaknesses the remaining antiquated teaching practices in some programs:

- “Práticas pedagógicas antiquadas em alguns cursos (abordagens expositivas em detrimento de ativas);“

And as a consequence, the document proposes to implement actions meant to:

- “Promover a adoção, sistemática, de novas metodologias de aprendizagem ativa”

that is, to promote the systematic adoption of active learning methodologies that will allow students to acquire transversal competences needed for their professional future:

- “Promover ações que confiram [aos alunos] competências transversais às diversas áreas de conhecimento.”

In relation to the teachers, it is proposed to create the conditions to allow their qualification in terms of their pedagogical abilities:

- “Criar condições para a qualificação dos docentes em áreas transversais de grande utilidade para o exercício das suas funções, e em particular na componente pedagógica e línguas estrangeiras”

It is therefore clear the connection between the development plan of the school of engineering and the objectives of the ALIEN project.

At the school the implementation of active learning methodologies is the responsibility of the programme director that is helped by a group of professors he/she nominates. They are helped by:

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- The presidency of the school through a specifically nominated assessor
- GILT R&D group focused on educational technologies and its application in innovative pedagogical methodologies

GILT (Games, Interaction and Learning Technologies (GILT) 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 programmes 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 emphasising 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 (Carvalho & Santos, 2013).

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.

Several programmes have adopted PBL as a secondary delivery model. A special case is the department of computer engineering that has defined PBL as the main delivery model. That includes:

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- Specific PBL courses (project lab) in each semester in the graduation programme
- The MSc in Computer Engineering program that is predominantly delivered through PBL methodologies

It is important to stress that the situation of the Engineering school is not the same of the other school which lag in terms of the adoption of active learning methodologies.

PBL Lab

The current and future practice of PBL will be assessed with a focus, on the computer engineering department in a first stance that will later be extended to other departments and finally to other schools.

The department currently has about 1200 students in total and the adopted pedagogical methodology implies that the existing labs can be reorganized in island-format for active learning practices. It is up to each responsible teacher to adopt that specific learning classroom format.

Figure 5: ALIEN PBL lab in IPP

For ALIEN, one special lab will receive an upgrade in equipment, furniture and layout and will be used mainly for the MSc Computer Engineering program.

This means that about 250 students will benefit from this LAB, which will also be available for 8 different courses per year and the 12 teachers involved in those courses.

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In the meantime, the involvement of other programs (mathematics, mechanical engineering) which also have quite interesting experiences with Active Learning will also be sought. The next image shows the implementation of the DRIVE-MATH project, an active learning proposal, in the Mathematical Department.

Figure 6: ALIEN PBL lab in IPP

Faculty support

As mentioned before, the pedagogical qualification of the teachers has been included as fundamental in the statues of the Polytechnic and School (in the last case, also in the current Development Plan)

The special unit e-IPP provides teacher support at the university level while GILT provides support at the faculty level, together with the presidency's assessor for teacher support.

This support is mostly provided in the form of teacher training courses and workshops.

These can be:

- External to project with the specific thematic
    - Online and blended learning concepts
    - Pedagogical strategies and innovation
- Internal to project
    - Implementing Problem-Based Learning with 3 editions in October 2019, January 2020, May 2020 addressing 24 teachers in each session

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P3. University of Lancashire (UCLan)

Institutional mission, vision and strategy

Active Learning and Problem based learning is being facilitated at UCLan through an institutional strategy to provide creative learning spaces.

Creative Learning Spaces

UCLAN is investing £5 million on upgrading learning spaces across the main campus in Preston. The aim is to modernize and digitalize the current teaching environments, whilst equipping academic staff with the best digital tools to assist them in developing and integrating modern teaching methods across campus.

These spaces will allow for diverse and innovative teaching, moving away from traditional lecturing, towards involving students in their learning and giving them the opportunity to be an active participant in learning activities.

The project, will see the majority of general teaching spaces across campus transformed into creative learning spaces. The project follows on from the Classrooms of the Future project, which was delivered in Summer 2016.

Teaching and Learning Environments

The upgrades will begin at the beginning of June, when most teaching modules are finished, in order to minimize disruption. The majority of rooms will see aesthetic changes as well as technology and equipment upgrades, alongside new furniture suitable for group work.

Rooms will be changed on a case by case basis; they will be redecorated to incorporate one feature wall and re-carpeted. They will be fitted with additional power trucking around the perimeter including double power sockets and USB sockets. Additional whiteboards will be installed to support group work and ceilings will be enhanced where necessary.

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Semi-circular tables will be provided in around 100 rooms to support group work and new chairs will be provided to tie-in with overall color schemes.

IT Provision

The aim is to modernize and digitalize the current learning environments,

To support the delivery of Digital UCLan and the adoption of appropriate digital technologies in teaching, a further investment will be made in the form of Surface Pros for full-time academic staff, together with associated training. The Surface Pros are intended to be used in the classroom environment, but docking stations will also be provided to enable staff to use the Surface Pro in their offices.

New IT/AV housing units with Surface Pro docking points will replace Moby-go's and event capture technology will be installed in a further 61 classrooms, bringing the total number of teaching spaces with this capability to 185.

Social Spaces and Lecture Theatres

The team will also be creating small social spaces across campus with new furniture, charging points and water fountains. Examples of these spaces can already be seen across campus including those in Greenbank, C&T and Harrington buildings.

A pilot scheme is also being developed for Greenbank Lecture Theatre, which will test how creative learning practices translate into a larger environment and will help to inform future changes to other lecture theatres.

Creative Learning Spaces in Numbers

- £5million investment
- 600 Surface Pro's and monitors
- 163 rooms with new IT/AV units
- 61 additional rooms with event capture technology

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- 81 rooms with additional power trucking
- 104 rooms re-carpeted
- 108 rooms repainted
- 98 rooms with additional whiteboards
- 100 rooms with new tables
- 95 rooms with new chairs
- 5 rooms with new ceilings

PBL Lab

Figure 7: ALIEN PBL lab in UCLan

Activities

- Workshop at the university in September for staff to discuss problem-based learning and integration into courses
- Need to highlight project to https://activelearningnetwork.com/)
- Need to find strategy to engage with teachers in September / October
- UCLan has its own educational journal – special issue on problem-based learning!

Students are using PBL in final year undergraduate / PG.

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- 150 UG students
- 80 PG Students
- 24 staff involved

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P4. University of Malaya (UM)

Institutional mission, vision and strategy

University of Malaya is a research university with strong emphasis on research initiatives and innovation; the university's high-quality teaching and learning activities are a testament to the mission and vision of the university. This is also in line with the Malaysian government's national higher education policies, which emphasize active learning according to the National Higher Education Strategic Plan (NHESP) 2006-2020 Thrust 2 and the Malaysia Education Blueprint for Higher Education (MEB-HE 2015-2025). Guided by the national policies and UM's aspiration UM dedicates considerable resources to AL activities through its institutional strategic plan under Thrust 1. The overarching goal for UM's current Strategic Plan 2016-2020 Thrust 1 - Academic is to be the preferred university for staff and students. One of the main sub-goals is to create an outstanding teaching and learning experience through high-quality, technologically enhanced academic programs. Among the main strategies in the pipeline for achieving this goal are to incorporate the use of ICT in teaching and learning and to employ effective pedagogy in course delivery as well as aiming for curriculum internalization. ALIEN Active Learning Project is aligned with UM's current main strategies, which is timely and will bring positive impact to UM's overall institutional strategic plan achievement.

Active learning implementation as specified in UM's strategic plan is driven and led by the Quality Assurance Unit (QMEC), Academic Development Centre (ADeC) and the Curriculum Design Centre. ADeC offers plenty of in-house training related to AL/SCL to the UM academic staff while QMEC and Curriculum Design Centre (CDC) monitor the implementation of Active Learning of the academic programs.

UM has realized the need to support AL through the appropriate infrastructure. As a result, the introduction of learning space enculturation has been specifically included in the

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strategies. As such UM Learning Space Policy 2012 was introduced. The university management has agreed that all faculties/centers/academies must comply with the learning space (student-centered active learning) criteria for any renovation work (excerpts of Minit Mesyuarat JK. Pengurusan: 4.7.2012; Perkara: 17; MP75/2012, meeting minutes). The university AL management committee further reinforced the implementation related to this matter in the renovation of a classroom into The CUBE (Figure 8) 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 spaces throughout the campus.

Figure 8: The Cube at Engineering Faculty at the University of Malaya

To ensure the sustainability of this initiative 10 Learning Spaces grants have been approved by the university. This learning spaces grant project produced another 10 additional learning spaces, designed and executed by faculty members and the end users. These new learning spaces provide an exciting learning environment that supports and promotes collaborative and active student-centered learning as specifically intended by the faculty staff. The overall impact of this learning spaces initiative has led to UM being the country's role model in learning spaces for Malaysian higher learning institutions in enhancing students' learning experiences and attributes.

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The increasing number of learning spaces in UM was coupled with upskilling programs for academic staff in using the AL spaces. The staff training strategy has been transformed into AL/SCL experiential-learning training mode. In this manner, the lecturers learn AL/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 (Figure 9).

Figure 9: UM academic staff training program utilizing AL in learning space environment

UM has been recognized by the Ministry of Education Malaysia as the role model in relation to active learning spaces for higher learning institutions. ADeC being the central key player for UM in this initiative organized a National Learning Space Seminar in 2016, which was attended by academics from both public and private universities. They also organized the recent UM Learning Innovation and Teaching Enhancement Conference (LiTEC) 2019 with the theme of active learning space. University of Malaya realizes that active learning in cyberspace plays an important role in this era. UM has also introduced and executed the E-learning Week during which no face-to-face lecture was carried out in a normal classroom. In this manner, lecturers and students actively communicate via the e-learning platform or other digital means.

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PBL Lab

Technology-Enabled Active Learning Space (TEALS)

Aim of TEALS

Technology-Enabled Active Learning Space (TEALS) is a learning space designed under the ALIEN Erasmus+ project for conducting active learning classes in the Software Engineering Department, Faculty of Computer Science and Information Technology, University of Malaya. The aim of creating the learning space is to equip software engineering students for the workplace to solve future problems and to improve the psychomotor, cognitive and affective skills in teaching and learning software engineering courses (Timothy L.J. Ferris 2020). To achieve this aim, hardware and software are used in the active learning process to strike a good balance between emphasizing knowledge and application of the knowledge.

Designing Process of TEALS

The design process is described in two sections, the learning space and the equipment.

The Learning Space

The learning space was designed to take into consideration active learning pedagogical methodologies towards achieving the aim of equipping Software Engineering students to solve future problems and to improve the application of knowledge in the learning process as described in the aims section above. We concluded that important elements that should be included in the design of the learning space are as follows:

- Tables and chairs are movable and can be arranged to suit multiple pedagogical approaches in active learning
- Movable workstation should be provided to assist the active learning session (as part of the equipment provided)

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- Equipment (devices and software) for supporting the development of cognitive, psychomotor and effective skills in the teaching and learning process of the software engineering courses
- Storage and space for keeping the devices

Equipment

TEALS is designed to consist of seven islands with 7- 8 students per island. This totals up to a capacity of 49-56 students. Figure 10 shows the layout of TEALS. Each island is equipped with movable workstations, monitors, casters, writable surface, drones, Arduino and Raspberry.




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Figure 10: The TEALS showing the 7 islands, movable workstations & monitor and the writable surface used by students in collaborating on ideas/solutions

TEALS is also equipped with one unit of Autonomous Car, 3D printer, as part of the equipment used in the active learning process; there is also one Samsung Galaxy Tab for the lecturer to use.

The purchasing of equipment was done in four phases to allow for sufficient time to research on the suitability of the equipment, which would cater for various methods of active learning. The equipment bought consisted of mainly programmable hardware which could be related to software engineering and current industrial usages such as the Internet of Things (IOT), Machine Learning and Cloud Computing.

The monitor and 7 movable workstations were bought in the first phase, followed by the equipment (i.e. the devices/hardware) in the second and third phases. We needed more time to research the practicability of Raspberry PI and Drones and hence they were bought in the third phase of purchasing. The writable surface was bought in the fourth phase as we needed to ensure there was sufficient budget for all the key equipment before we purchased the writable surface.

How the equipment will be used for active/problem-based learning

Technology-Enabled Active Learning Space (TEALS) is a learning space designed under the ALIEN Erasmus+ project for conducting active learning classes in the Software Engineering Department, Faculty of Computer Science and Information Technology, University of Malaya. The use of TEALS in implementing active learning is divided into three phases as shown in Table 1.

The pilot phase started from February till July 2019 which coincides with semester 2 session 2018-2019. Three lecturers have been coached to carry out the first implementation of active learning in the three courses they thought for that semester. During this phase, the

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lab has also been used for mobility program between UM and University of Cardiff, United Kingdom. The data and experiences collected during the pilot phase will be used to inform the implementation phase which will take place during semester 1 session 2019-2020 (July 2019 till January 2020) and will involve 3 courses thought by lecturers. For the sharing phase, 2 more UM courses will be using the lab for their active learning activities. We will be extending the use of the lab to 2 external institutions (partners) during this phase as well. Below is a summary of the total number of lecturers and students involved for the whole three phases of the training schedule.

Phases	**Institution**	**Courses/Lecturers**	**No. of students/course**	**Total no. of students**
Pilot (Semester 2 Session 2018-2019)	UM UM-UK (Mobility Program)	3/3 1/1	50/courses 15/programs	150 15
Implementation (Semester 1 Session 2019-2020)	UM	3/3	50/courses	150
Sharing (Semester 2 Session 2019-2020)	UM External (partner)	2/2 2/2	50/courses 50/courses	100 100

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(Half of Semester 1 Session 2020-2021)				
Total	**4 Institutions**	**11 courses/lecturers**		**515**

Table 1: Summary of training schedule for implementing active learning

Table 2 shows the three courses that were executed in the pilot phase, Feb 2019 – July 2019. They were Human Computer Interaction, Algorithm Design and Analysis and Software Testing.

Course	**No. of Students**	**No. of Teachers Involved**	**Pedagogical Methodology Used**
Human Computer Interaction http://alien.fsktm.um.edu.my/	159	2	Project-based learning
Algorithm Design and Analysis	60	1	Project-based learning
Software Testing	52	1	Collaborative Flipped Classroom

Table 2: The pilot phase of using TEALS in Software Engineering courses

TEALS is designed to consist of seven islands with 7- 8 students per island. This totals up to the capacity of 49-56 students. Each island is equipped with a movable workstation and a monitor; it is supported with a writable surface to facilitate brainstorming and discussion sessions with sketches and diagrams to promote active learning. Each island is equipped

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with a set of programmable hardware development kit - the drones, Arduino and Raspberry. TEALS is also equipped with one unit of 3D printer and one unit of Autonomous car.

Workstation and monitor are attached to each island at one of the rectangle's points via the stand and they are movable and multi-controlled. Drones, Raspberry Pi, Arduino, Autonomous car are used to support for programmable hardware projects which can relate to software engineering and current industrial demands such as the Internet of Things (IOT), Machine Learning and Cloud Computing.

3D printer is used to facilitate analysis, design, development and evaluation stages of software development. Samsung Galaxy Tab is the only equipment purchased for the lecturer's use and it is used to control lecture materials in an active learning environment.

Buying the equipment

The purchasing of equipment was done in four phases because we need time to research on the suitability of the equipment that will cater for various methods of active learning. The equipment bought focused on programmable hardware type of projects, which are relevant to software engineering and current industrial demands such as the Internet of Things (IOT), Machine Learning and Cloud Computing.

Six collaborative workstations were bought in the first phase, followed by the Ardruino programmable development kit in the second phase. We needed more time to research on the practicability of Raspberry PI and Drones to support the programmable hardware project and they were therefore purchased in the third phase, together with one unit of a collaborative workstation which function as a server (i.e. the 7th collaborative workstation), Drones, 3D printer and Samsung galaxy tab. The writable surface was bought in the fourth phase as we had to ensure there was sufficient budget for all the key equipment before we purchased the writable surface.

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Vendors were selected based on the lowest price offered and met the required specifications. We also considered the vendor's track record of speedy service and after-sales service.

Faculty support

At the university level, Active Learning (AL) is driven, monitored and supported by the Quality Assurance Unit (QMEC), Academic Development Centre (ADeC) and the Curriculum Design Centre. ADeC is in charge of professional development training programs in teaching and learning. Workshops on problem-based, project-based and active learning are offered almost every year. AL teaching and learning strategies are also included in the New Lecturer Training Program, which is compulsory for all new lecturers appointed by UM.

Specifically, for the ALIEN project, the training schedule for faculty support program is divided into three phases as shown in Figure 11 below.

The pilot phase started from February till July 2019, which coincides with Semester 2, Session 2018-2019. Three lecturers have been trained to carry out the first implementation of active learning in the three courses they taught for that semester employing the active learning lab set up using the Erasmus funding under the ALIEN project. During this phase, the lab has also been used for mobility programs between UM and University of Cardiff, United Kingdom. The data and experiences collected during the pilot phase will be used as the basis for the implementation phase which will take place during Semester 1, Session 2019-2020 (July 2019 till January 2020) and will involve 3 courses taught by lecturers. For the sharing phase, 2 more UM courses will use the lab for their active learning activities. We will extend the use of the lab to 2 external institutions (partners) during this phase as well.

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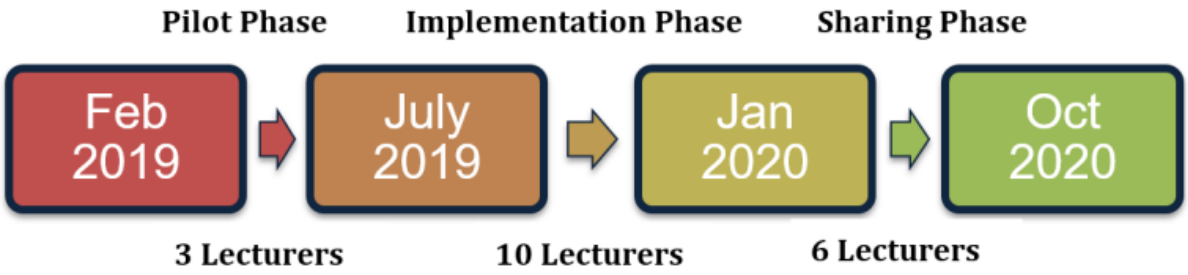

Figure 11: Training schedule timeline

Lecturers involved in implementing AL in their subjects have been trained on how they can redesign their courses to ensure that appropriate pedagogical approaches are used. Several control forms for AL activities have been established which include assessment rubrics and criteria, apart from the data collected to measure the impact of AL implemented in several courses. Technicians and other support staff have also been trained by vendors who supplied the equipment for the lab. Training workshops on 3D printer, Arduino and RaspberryPi have been attended by lecturers involved in teaching courses using the lab.

Beyond the Faculty of Computer Science and Information Technology, the active learning lab setup in this project is planned to be used collaboratively for the multidisciplinary Integrated Design Course currently being introduced by the Engineering faculty. The course will explore the CDIO - Conceive, Design, Implement and Operate framework where the active learning lab is much needed as the learning space. We also anticipate further collaboration with the UM Academic Development Centre (ADeC) for the use of the lab to train lecturers from the various faculties on active learning and PBL. We hope to model best practices in the design of the collaborative AL learning spaces and to demonstrate how teaching and learning sessions can be redesigned for a meaningful learning experience in an active mode.

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This project also aims at training and support lecturers from other institutions in Malaysia on active learning using the active learning lab. We expect 6 lecturers from International Islamic University of Malaysia and University Malaysia Pahang to be involved in this project.

Scenario of ALIEN AL/PBL lab use in a course

Course title: WIF2001 Human Computer Interaction, University of Malaya Mobility Program

Engineering curriculum where it belongs

Software Engineering.

Course description

This course covers both human factors and the technical methods for the design and evaluation of interactive systems, where it is structured within four main topics: overview of HCI, essential interaction design principles, UI Development process and interface design and programming. Overview of HCI introduces human, computer and interactions; User Interfaces (UI); usability and user experience (UX). Essential interaction design principles include topics on Psychopathology of everyday things, Psychology of everyday actions, Knowledge in the head and in the world, knowing what to do, understanding and designing for error. UI Development process includes topics on iterative design, user-centered design, design discovery, design exploration and evaluation of user interfaces. Interface design and programming include topics on visual information design, forms design, interface design patterns, prototyping and construction tools and responsiveness issue. Three types of applications are covered: Graphical User Interfaces, The Web and Mobile Devices.

Number of students to be engaged

159.

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PBL activities that will be integrated in the course

Project Based Learning will be deployed through student projects that will be implemented using the Technology Enabled Active Learning Space (TEALS) lab and will encourage students to develop software applications and services that address the specific needs of users taking into account interests, usage of the services, human computer interaction, and other aspects.

Equipment, software and educational material to be used

Equipment

Equipment	Features			Brief Description
Workstation	8th Generation Intel® Core™ i5-8400 Processor Windows 10 Home 64bit	8GB DDR4 2666MHz 16GB Intel® Optane™ memory accelerated 1TB 7200 RPM HDD	Premier Wireless Keyboard and Mouse	One workstation per island

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32" LED Monitor Display	with HDMI Cable Portable Stand for LED TV Display Moveable stand with Adjustable shelf height for storage space	Integrated cable management system Heavy gauge columns constructed Resolution 1366 x 768	HDMI/USB /Component In (Y/Pb/Pr)/ Composite In (AV) Connectivity Slim Type LED Type Wide Color Enhance Slim edge Mold Design	One monitor per island
Heavy-duty casters	Max load capacity: 46 kg Power Extension Socket Tower Type-2-Tier	With reinforced design support the equipment weight while allowing for swift maneuverability		
Computer	Professional HDMI Cable 2M			

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Peripherals	Asus RT-AC58U AC1300 Dual-Band Gigabit Wireless Router	
Drones	Programmable Drones with accessories	To support programmable hardware projects which can relate to software engineering and the Internet of Things (IOT), Machine Learning and Cloud Computing.
Raspberry Pi	Raspberry Pi Learning Kit come with user module training/manual	
Arduino	Arduino Learning & Development Kit (complete sensors/modules)	
Autonomous car	Smart Video Car Kit for Raspberry Pi Compatible with RPi 3, 2 and RPi 1 Model B+	
3D Printer	With extra filaments	To facilitate analysis, design, development and evaluation stages of software development
Samsung Galaxy Tab A	A with S-Pen come with Miracast device	For teachers to control lecture materials in an active learning environment

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11. Writable surface	Materials: Acrylic Glass -Background: Avery White	-Size & Thickness: 90 cm x 60 cm x 5 mm	To support brainstorming and discussion sessions with sketches and diagrams to facilitate active learning

Table 3: Equipment at UM

Software

The following software are being used and they are downloadable from the Internet

- Arduino IDE
- Raspberry Pi OS with all peripherals
  - Python editor
- Software for wireless connection to wireless projector
- 3D Studio to print 3D object

Educational material (books, scenarios, etc. and sources)

The following materials are being used and they are downloadable from the Internet.

- Active Learning - Project-Based

  Two examples of research paper that we refer to is by Sedelmaier & Landes (2015) and Sibona, Pourreza, & Hill (2018). The full bibliography information is as follows:

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Sedelmaier, Y., & Landes, D. (2015). Active and Inductive Learning in Software Engineering Education. 2015 IEEE/ACM 37th IEEE International Conference on Software Engineering. 5, pp. 418-427. IEEE. doi:10.1109/ICSE.2015.174

Sibona, C., Pourreza, S., & Hill, S. (2018). Origami: An Active Learning Exercise for Scrum Project Management.: EBSCOhost. Journal of Information Systems Education, 29(2), 105-116.

- HCI Project Description https://drive.google.com/file/d/1DqoscHXtWMtpN4qN5BPnPyWafu9eX4OV/view?usp=sharing
- Raspberry Pi Reference

  What is inside the starter kit

  https://www.dexterindustries.com/product/grovepi-starter-kit-2/

  Port Description https://www.youtube.com/watch?v=gbJB3387xUw

  https://www.dexterindustries.com/GrovePi/engineering/port-description/

  Some Projects:

  https://projects.raspberrypi.org/en/

- Arduino Reference

  Getting Started:

  https://www.youtube.com/watch?v=64oEr1zTlOg

  Downloads (Arduino IDE) and resources:

  https://www.arduino.cc/

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https://create.arduino.cc/

How the ALIEN equipment will be used

Technology-Enabled Active Learning Space (TEALS) is a learning space designed under the ALIEN Erasmus+ project for conducting active learning classes in the Software Engineering Department, Faculty of Computer Science and Information Technology, University of Malaya.

This scenario describes the active learning conducted in Human Computer Interaction course and Mobility program.

Human Computer Interaction

The HCI Project given to the students was conducted through active learning, specifically Project-Based Learning with the intention to cover the following topics: design principles, conceptual design method, storyboarding, personas and usability testing. The context of application of these topics is embedded in the following objectives of the project:

- To design, prototype and evaluate an interactive game
- To apply the knowledge and content of the HCI course in real-life situations using Arduino/Raspberry Pi, 3D Printer, Writable Surface

The HCI project website is available at http://alien.fsktm.um.edu.my, which illustrates the uses of TEALS, the equipment, the outcomes of the project

- The conceptual design
- The game prototypes
- The persona
- The usability evaluation

University of Malaya Mobility Program

On 25th of July 2019, 30 students from Lanzhou University, China as part of the mobility program attended a session on Programmable Drones and Autonomous car. The session is

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conducted as an active learning approach using TEALS. Programmable Drones are the main equipment used.

Programmable drones are drones that are not only controlled by remote (using apps), but can move according to program codes. The drones used for this session is Tello, an education-friendly drone suitable for learning Drone Programming.

Figure 12: Flying the drone session at the lower height

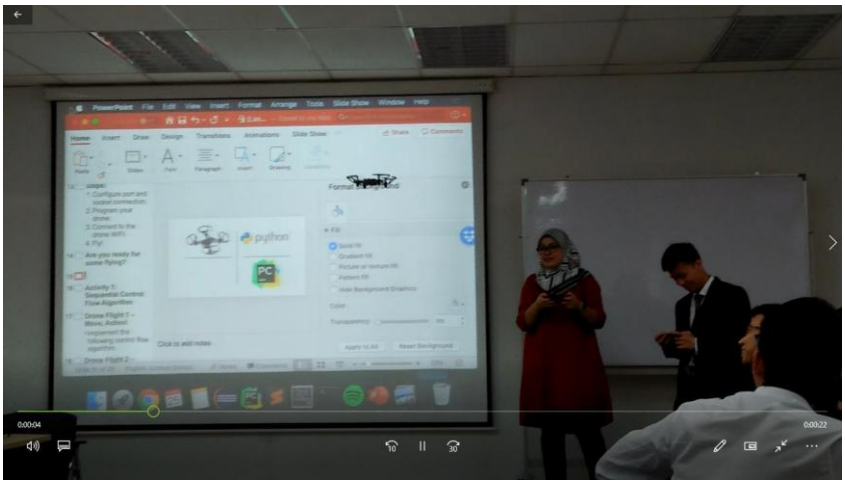

Figure 13: Flying the drone

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P5. Universiti Tenaga Nasional (UNITEN)

Institutional mission, vision and strategy

University Tenaga Nasional (UNITEN) is a private university in Malaysia offering three main undergraduate programs covering the engineering, computer science and business areas. Any strategies and activities implemented root from the university's vision and mission as stated below.

Vision

To be a leading global energy university that shapes a sustainable future.

Mission

To advance knowledge and learning experience through research and innovation that will best serve human society.

Among others, the mission emphasizes on the innovation in the teaching and learning process. This includes moving away from the traditional method of teaching delivery and going into the methods that will be able to allow the students to be more actively involved in the process, which will improve their understanding on the subjects taught.

In line with the UNITEN's vision and mission, UNITEN's strategic plan that spans from 2010 to 2030, called Building Opportunities, Living Dreams 2025 (BOLD 2025), which is inspired from the parent company, Tenaga Nasional Berhad (TNB) comprises three main strategic goals, which are teaching excellence, research excellence and financial sustainability as shown in Figure 14 below. The three strategic goals are supported by ten strategic objectives and 30 strategic initiatives. From the ten strategic objectives, six fall under the teaching excellence; they are: building future leaders, industrial engagement, globalized online learning, entrepreneurship growth, image branding and smart campus. Ten strategic

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initiatives are enlisted under each strategic goal. The ten strategic initiatives under teaching excellence are as follows.

1. Blended learning
2. Industrial engagement
3. Entrepreneurship
4. Career services
5. Upgraded student facilities
6. Digital environment
7. Smart UniverCity
8. Global exchange and mobility
9. Premier engineering program
10. Synergy: Teaching and learning

Figure 14: BOLD 2025 (UNITEN Strategic Plan) 10 Strategic Objectives

In the ALIEN project, a serious game is developed to teach the students the requirements elicitation and analysis processes, which is in the final stage. Two subjects have been

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identified where the game can be used, Fundamentals of Software Engineering and Requirements Engineering. The game was developed following an appropriate game development framework. This project is in line with one of the strategic initiatives, which is Synergy: Teaching and Learning. The strategic initiative will contribute to the attainment of the strategic objective: Global Online Learning.

	2019								2020					
	May	**June**	**July**	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mac**	**Apr**	**May**	**June**
Uniten	Sem. 1 19/20					Sem. 2 19/20								
MMU			Trimester 1 19/20					Trimester 2 19/20						
UNIKL			Sem. 2 2019							Sem. 1 2020				
UTP					Sem. 3 2019				Sem. 1 2020					

Table 4: Planning for implementation of the ALIEN project in UNITEN and GLUs

	Total no. of exposure		
	Teacher	**Student**	
		1st Sem.	**2nd Sem.**
Uniten	4	50	50
MMU	4	50	50
UNIKL	4	50	50
UTP	4	50	50
	16	200	200

Table 5: The target exposure at each university

The implementation of ALIEN project takes place at UNITEN and three other government linked universities (GLU) in Malaysia and the implementation will cover at least two semesters under this project.

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Teaching and learning matters at UNITEN is under the purview of the Deputy Dean (Academic and Research) and the implementation is centralized and managed by the UNITEN Teaching and Learning Centre (TLC).

Equipment

- 1 AMD RYZEN 7 2700X 3,7 GHz
- 1 X470 Ultimate Mainboard System
- 1 Corsaid 2x16GB 3200MHz
- 1 550W True Power Suppy 240V
- 1 All in one cooler system
- 1 Samsung 860EVO 500GB
- 1 Seagate 4TB SATA 3HDD
- 1 29'' IPS display full HD monitor
- 1 R6 solid panel tower case
- 1 keyboard and mouse set
- 1 2.5'' My Passport 4TB
- 1 thermal paste
- 1 Windows 10 64bit with license
- 1 EPSON EB-X05
- 10 Tower desktop gaming PC

How the equipment will be used for active/problem-based learning

The types of courses that will be using the PBL lab can be broadly divided into two, those that are using computers and those that are not. Thus, the PBL lab will have two separate

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areas, one with computers and the other without. Below is a list of courses in which project outcomes will be deployed.

Course code/name	Using computers?	Method	Number of students
CSEB233 Software Engineering	Yes	Serious game	50
CSEB274 Requirements Engineering	Yes	Serious game	50
MEMB2014 Mechanics II: Dynamics	Yes	Demonstration and simulation of kinematic motion	50
EEED283 Power System	Yes	Demonstration and simulation of symmetrical components and power flow	30

Table 6: Courses of UNITEN involved in ALIEN project

Following is a description of how each type of equipment will be used in learning:

- The workstations and the VR equipment will be used to install the serious game that have been developed for this project, as well as other existing software that will be used for the PBL.

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- The Smart TVs will be used to display the screen content from a specific workstation for the purpose of discussion/example to be shared with others.
- The projectors will be used for students' presentation and sharing of their PBL activities with other students.

Scenario of ALIEN AL/PBL lab use in a course

Course title: Engineering Mechanics II: Dynamics

Engineering curriculum where it belongs

Mechanical Engineering.

Course description

This course is developed to help students to understand the concept of dynamics in engineering systems. Students will be able to analyze and solve the problems of kinematics and kinetics of particles and rigid body in the engineering system. The course covers the analysis of motion of particles and rigid body in rectilinear and curvilinear motion. The course is delivered through lectures and tutorials. Students are also engaged in active problem-solving activity during demonstration session and group debates. Figure 15 shows the demonstration session using conventional demonstration apparatus.

Figure 15: Demonstration session

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Number of students to be engaged

30 (Semester 2 2019/2020).

PBL activities that will be integrated in the course

Students will be given a problem regarding planar kinematics of rigid body. The objective of the activity is to investigate rigid body translation and show how to analyze motion about a fixed axis. Students will also study planar motion using absolute motion analysis. At the end of the learning session, students are expected to provide a relative motion analysis of velocity and acceleration using a rotating frame of reference. In order to attain the objectives, the PBL activity will be conducted in a virtual environment to first help the students visualize the scenarios. The students will then solve the problem in correct steps and well-structured manner. To conclude the session, students will share their findings and will debate the results among them.

Equipment, software and educational material to be used

Equipment

- Projector
- Personal computers
  - Intel ® Core i7-8700K (3.7 GHz, up to 7 GHz with Intel ® Turbo Boost Technology (2g), 12 MB cache, 6 cores)
  - 32 GB DDR4-2400 (2x8GB) UDIMM
    - 512GB PCIe SSD (Boot) + 2TB 7200RPM SATA 6Gb/s (Storage)
    - 2TB 7200 RPM SATA 6G 3.5 HDD

Software

- Digital software to analyze rigid body planar motion
- Information on the software:

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- Chen, K. L. & Sidhu, M. S. (2016). The Potential of Technology Assisted Engineering Problem Solving Tool for Engineering Education. Advanced Science Letter 22(10), pp. 3092–3095, doi:10.1166/asl.2016.7998

Educational material (books, scenarios, etc. and sources)

- Lecture notes on planar kinematics of rigid body
- Textbook R. C. Hibbeler, Engineering Mechanics: Dynamics, 12th Edition (SI), Prentice-Hall, 2010
- Ferdinand P. Beer, Jr., E. Russell Johnston, William E. Clausen and Phillip J. Cornwell, Vector Mechanics for Engineers: Dynamics, 8th Edition, McGraw Hill, 2006
- J. L. Meriam and L.G. Kraige, Engineering Mechanics: Dynamics, 5th Edition (SI), Wiley, 2003

How the ALIEN equipment will be used

The projector will be used to broadcast the virtual demonstration. It will also be used to showcase the findings from the activity.

The personal computers will be used by the students to solve the problems. A specific engineering mechanics software will be installed to allow the students to visualize the motion and to solve the given problem.

Course title: Power Electronics

Engineering curriculum where it belongs

Electrical Power Engineering.

Course description

This course introduces the different types of switching devices including diodes, bipolar junction transistor (BJT), thyristor and insulated-gate bipolar transistor (IGBT). The course

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reviews fundamental concepts of power converter circuits which include rectifiers, DC-DC and inverter circuits. The course assignments analyze the power converter circuits theoretically and by using MATLAB simulation software.

Number of students to be engaged

30 in semester 2 of 2019-2020.

PBL activities that will be integrated in the course

Objective:

The objective of the PBL activities is to enhance the students' understanding on the different type of converters in the Power Electronics course. In the assignment, the students are required to design a power circuitry to power up a number of Power Electronics applications. Based upon the output requirements, the students will select suitable topologies, determine the input/output voltage and design the controllers.

Before the PBL lab session:

The students will be grouped to four or five students in a group. Prior to the session in the PBL lab, the students will be given the problem to be solved. The students will discuss among themselves and formulate on possible ways to solve the problems. To assist the learning process, the students will be given the software manual prior to the class session and also a list of online videos on how to use the MATLAB software.

During the PBL session:

In the PBL lab, the students will construct the models based on the basic knowledge gained from the manual, the online video and theoretical calculations done.

At the end of the PBL session:

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The students defend their designs in formal report and oral presentations. Evaluations will be done based on standard rubrics developed by the university's outcome-based education (OBE) committee.

Equipment, software and educational material to be used

Equipment

- Projector
- Personal computers

Software

- MATLAB software licensed to Universiti Tenaga Nasional

Educational material (books, scenarios, etc. and sources)

- MATLAB Manual. Available at https://www.mathworks.com/help/matlab/
- Text books
    - Daniel W. Hart, Power Electronics McGraw-Hill Education – Europe, 2010.
    - Power Electronics: Circuits, Devices and Applications, Muhammad H. Rashid, Pearson, 4th Edition, 2013.
    - Power Electronics: Converters, Applications and Design, Ned Mohan, Tore M. Undeland, William P. Robbins, 3rd edition, John Wiley & Sons Inc, 2002.

How the ALIEN equipment will be used

Projector

- To deliver briefing about the activities to the students
- For oral presentation

Personal computers

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- To simulate the software

Course title: Principles of Programming

Engineering curriculum where it belongs

Mechanical Engineering and Civil Engineering.

Course description

This course introduces the structured programming approach towards preparing computing solutions in solving problems. Students are introduced to the software development methodology, designing algorithms and programming principles to solve problems. Input and output operations, data types, variables, arithmetic operators, comparison operators, logic operators, selection structures, repetition structures, functions, arrays and strings are the topics covered in this course. The course assignment includes developing algorithms and programs for the given problems.

Number of students to be engaged

60 (Semester 2 2019/2020 - Oct 2019).

PBL activities that will be integrated in the course

Objective:

The objective of the PBL activities is to satisfy two Course Outcomes (CO) of this course i.e. CO4 - design algorithms for computing solutions and CO5: develop structured computer programs for computing solutions. In the assignment, students are required to design an algorithm – using flowchart and/or pseudocode, to solve a problem. Next, they are required to implement the designed algorithm into computer program using structured programming approach. Based upon the solution requirements, the students will determine and apply the

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suitable data types and structures, input/output operations, computational processes, program control structures and/or modularity of programs.

Mechanics:

Prior to the session in the PBL lab, the lecturer introduces the concepts of problem solving and programming in the lecture class and the students are also taught to use the integrated development environment (IDE) software in separate lab sessions. Students then will be grouped into 3 to 4 students per group and they will be given problem to be solved. The PBL lab is designed to be held in two sessions – one for the students to design the algorithm to solve the given problem using flowchart and/or pseudocode and another PBL lab session to write, debug and test the programs. At the end of the PBL sessions, students submit their solutions – the algorithm and the computer programs in formal report and oral presentations. Evaluation will be done based on the rubrics developed by the lecturer.

Equipment, software and educational material to be used

Equipment

- Projector
- PC

Software

- Visual Studio or Xcode or any IDE software licensed to Universiti Tenaga Nasional
- Online flowchart drawing tool

Educational material (books, scenarios, etc. and sources)

- Lecture notes in Universiti Tenaga Nasional's LMS (Moodle)
- Textbook: Problem Solving and Program Design In C, International Edition, 2012, Jeri R. Hanly and Elliot B. Koffman, Pearson

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How the ALIEN equipment will be used

Projector

- To deliver briefing about the activities

Personal computers

- To draw flowchart and/or type pseudocode
- To write, debug and test programs

Course title: Software Quality

Engineering curriculum where it belongs

Software Engineering

Course description

This course is designed to prepare the students to work in software industry; dealing with software quality assurance process, activities and challenges. The course project assignment emphasizes on quality assurance activities, challenges, processes and quality assurance standard.

Number of students to be engaged

41 (Semester 1 2019/2020).

PBL activities that will be integrated in the course

The objective of the activities to be performed is to understand the roles of the people/personnel involved in the software testing process. At the start of the session, lecture will be delivered followed by online video to be watched by the students. Selected students will play the roles of software quality managers looking for candidates to fill up the positions. The other students will hold a card each describing a specific skill needed. Based

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on the basic knowledge gained from the lecture and online video, the students holding the skill will go to the respective station where they think the skill belongs to. The manager will then decide if the skill is correct for the position that they are looking for. If the manager agrees, the student will join the station. In case of dispute, the student will either find another station or negotiate to convince the manager.

Equipment, software and educational material to be used

Equipment

- Projector
- Personal computers

Software

- Web browser

Educational material (books, scenarios, etc. and sources)

- Lecture notes on software testing topic

How the ALIEN equipment will be used

At the beginning of the session, students will be taught the basic knowledge about software testing, the processes, the objectives and the expectations. Projector will be used for this purpose. The personal computers will be used for the students to watch the identified video online to gain understanding of the responsibilities and expectations of the roles involved in the testing process.

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Figure 16: ALIEN PBL lab in UNITEN

Figure 17: ALIEN PBL lab in UNITEN

Course title: Requirements Engineering

Engineering curriculum where it belongs

Software Engineering.

Course description

This course is designed to provide a fundamental knowledge base and practical skills for students in implementing software requirements development and management techniques and practices in projects or organizations. This course is taught through lecture and interactive discussion. Throughout this course, learned skills are practiced using team exercise, case studies and projects.

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Number of students to be engaged

40 (semester 1 2019/2020).

PBL activities that will be integrated in the course

The objective of the activities to be performed is to equip the students with the required skills of requirements elicitation and analysis, which is to be able to determine the requirements with respect to their completeness, relevance, consistency and practicality. Students will play the game during the first half of the class. In the game, students are required to gather as many requirements as possible that are deemed as fulfilling the four characteristics of requirements above, within the time limit. Students can move to the higher level if time permits and if they are qualified. When the game is over, the results will be shown. Students will then continue to work in groups to deliberate on the and negotiate on the results. The outcome is their understanding of complete, relevant, consistent and practical requirements, which they have to present in class.

Equipment, software and educational material to be used

Equipment

- Projector
- Personal computers
- Development computer

Software

- Digital serious game developed for performing RE activities

Educational material (books, scenarios, etc. and sources)

- Lecture notes on requirements elicitation and analysis topic

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How the ALIEN equipment will be used

The projector is used to deliver the briefing about the activities to the students. The personal computers are used for the students to play the game and the development computer is used to monitor the student's progress, record their achievements and update the game.

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P6. Isra University (IU)

Institutional mission, vision and strategy

Isra University (IU) which started offering its first-degree program in Fall 1997 to 30 students at Hyderabad campus (main campus) has now more than 4.000 students at present across three campuses each located in different city. The main campus is in Hyderabad, whereas the other campuses are in Karachi and Islamabad. The main campus offers various degree programs at undergraduate and postgraduate levels in Faculty of Medicine & Allied Medical Sciences, Faculty of Dentistry and Allied Sciences, Faculty of Commerce Economics & Management Sciences (FCEMS) and Faculty of Engineering Science and Technology (FEST). Department of Computer Science (DCS) being one of the oldest departments of the university was initially part of the Faculty of Computer and Management Science but later university planned to start more degree programs in the electrical engineering, civil engineering and mechanical engineering. Therefore, Department of Electrical Engineering, Department of Civil Engineering and Department of Mechanical Engineering were created. These departments together with DCS were merged into a new faculty name FEST. The degree program related to management sciences were moved to FCEMS. The ongoing ALIEN project include faculty members are the DCS, therefore, the discussion in this document related to the faculty member, students and courses would be more focused on the DCS in the first or pilot phase.

As per the university policy, if the same course is being offered to both sections (male and female students) assuming there are students in each section to take course then that course is separately offered to both sections. Typically, both sections are taught by the same instructor, however, if the number of credit hours or contact hours is higher than the threshold value set by the department then a different instructor would be allocated to each section.

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Department of Computer Science Vision statement:

Fostering excellence in computing education and inspiring innovation for industrial growth and development

Department of Computer Science Mission statement:

To provide students of computing sciences with sound technical knowledge and practical skills of relevance to the contemporary industry, together with the spirit of teamwork, ability to communicate effectively and inculcating professional ethics leading to a successful career with lifelong learning

Bachelor of Science (Computer Science) Mission statement

The mission of BS(CS) program is to provide quality education in both theory and application of Computer Science and to produce graduates who can leverage constant development of Computer Science and make valuable contributions to design and development of algorithms, software systems and related areas, particularly in problem solution and programming.

Bachelor of Science (Computer Science) Objectives

1. To provide graduates with a thorough understanding of the key principles and practices of computing
2. To provide graduates with firm foundations in the scientific, mathematical and engineering principles that support the computing disciplines
3. To develop intellectual curiosity, mature judgment and a commitment to the betterment of society in students
4. To prepare students to contribute to the computing profession

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PBL Lab

A dedicated lab has been allocated for AL and PBL where the purchased equipment will be installed. The furniture is being ordered that can be used in the lab. Meanwhile, the VR has been installed in a separate room where two faculty members and one technical staff are exploring on using this equipment. The first hands-on workshop to the faculty members of DCS would be provided based on this exploration.

The furniture would be movable and allow teachers and lab instructors to use them as per their need. The following figure shows some placement of furniture and students in the group to support AL environment.

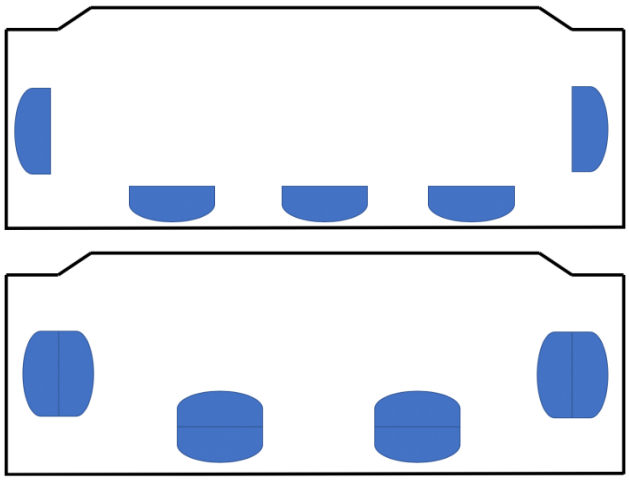

Figure 18: Blueprint of ALIEN PBL lab in IU

Based on the initial experience, the training of ALIEN platform and the equipment purchased and installed in the lab for the PBL will be exposed to other departments of FEST in the second stage. In the third phase, the training will be provided to other faculties of Hyderabad campus. In the fourth phase, the faculties in other campuses of Isra University will be trained. In the last phase, the training will be provided to other universities in the Hyderabad city.

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Equipment

- 2 HTC VIVE virtual reality systems HTC
- 3 Oculus rift and touch virtual reality system
- 2 LEAP motion VR DEV bundle
- 2 NVIDIA 3D vision 2 wireless glasses only model
- 3 G910 wireless Bluetooth game controller gamepad joysticks for Android / iOS cell phone
- 1 PIPO X9s, Box Android TV 8.9-inch Tablet Mini PC
- 3 workstations with INTEL core i7, 8700K, 8th Gen, ASUS motherboard ROG Strix B360, 32GB RAM, DVD writer, Corsair 200R casing, Corsair power supply, GIGABYTE GeForce graphing card, Logitech keyboard and mouse
- 3 HP Monitors 27 Inches - 27F
- 1 Apple MacBook Pro 15

How the equipment will be used for active/problem-based learning

Two pilot courses will initially be transformed into an ALIEN platform. The details of these courses are as follow:

Subject	Number of students	Number of teachers	Equipment	Semester
Computer graphics	Expected students: 10-15	1 teacher and 1 lab instructor	Virtual reality	August 2019
DLD/Basic electronics	Expected students: 20-30	1 teacher and 1 lab instructor	Augmented reality	August 2019

Table 7: Pilot courses in IU

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Faculty support

Higher education commission (HEC), Pakistan has established a quality assurance agency (QAA) with a vision "to promote, enhance and assure the quality of higher education across higher education institutes (HEIs) in Pakistan." QAA goals include:

1. Policy making and development of practical guidelines of quality assurance related to the degree programs offered at HEIs
2. Guidelines to develop, monitor and evaluate quality enhancement cells (QEC) at each HEI
3. Capacity building to enhance the quality assurance in higher education at national level
4. Monitor and regulate HEIs for implementation of policies to improve quality and standard of higher education in Pakistan

Based on HEC's QAA, a QEC has been established at each HEI of Pakistan. QEC timely organizes workshops for the faculty members to improve their teaching skills and provide quality education to their students. Therefore, to support teachers in using AL and PBL a number of workshops would be conducted in collaboration with QEC at the Isra University where teachers would be trained in using both AL and PBL in their courses. Three different types of workshops would be conducted as described below:

- Equipment demonstration: A number of virtual reality and augmented reality-based equipment have been purchased and set up in the AL lab for the teachers to have hands-on practice and develop simulations, serious games or game-based learning solutions that can be used in the classroom environment. The first workshop will be based on the VR equipment; the equipment purchased includes HTC Vive and Oculus Rift. This workshop will provide an opportunity to explore both equipment and also provide them a step-by-step guide on the installation, usage and creating applications or problem-based learning. Both of the above-mentioned equipment

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also supports the AR as well. Additionally, leap Motion VR DEV BUNDLE has also been purchased to support AR. The workshops on VR and AR would be conducted in consultation with QEC at Isra University are as follows.

  - VR (tentative: 1 day in 3rd week of July)
  - AR (tentative: 1 day in 4th week of July)

- AL and PBL in general (tentative: 1 day in 1st week of August): This workshop will provide an overview and hands-on of how systematically they can use AL and PBL in their courses. This workshop will be provided to the faculty of DCS.
- ALIEN Specific (tentative: 2 days in 1st / 2nd week of August): This workshop will be an extension of the first (AL+PBL in general) workshop. This workshop will introduce the ALIEN platform and how they can use this platform in their courses. The template to generate problems will be discussed in details and faculty members would be asked to created questions from their courses based on the template discussed. This would allow them to become comfortable in using platform and how to transform their courses using AL+PBL on ALIEN platform and in general. Based on this workshop, two pilot courses would be integrated into ALIEN platform.

The details of these courses are as follows:

Subject	**Number of students**	**Number of teachers**	**Equipment**	**Semester**
Computer graphics	Expected students: 10-15	1 teacher and 1 lab instructor	Virtual reality	August 2019
DLD/Basic electronics	Expected students: 20-30	1 teacher and 1 lab instructor	Augmented reality	August 2019

Table 8: Details of the courses of IU that are integrated in ALIEN platform

- The DCS holds a bi-weekly meeting to discuss different matters. A follow-on meeting would be schedule on the same as of DCS bi-weekly meeting to discuss issues related

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to the ALIEN platform and any issues that are facing in terms of using AL+PBL in their courses.

- A dedicated discussion forum on in-house MOODLE would be created if the faculty members want to discuss matters before or after the meeting.

Scenario of ALIEN AL/PBL lab use in a course

Course title: CSDA-311 Design & Analysis of Algorithm

Engineering curriculum where it belongs

Department of Computer Science.

Course description

The goal of this course is to give students the ability to understand and describe the fundamental techniques for algorithms, apply the theoretical tools and techniques for the analysis of algorithms and choose from the available algorithms the one that will perform better in given situation.

Number of students to be engaged

45.

PBL activities that will be integrated in the course

The objective of the activities to be performed is to understand the concept of different algorithms (sorting, searching, data structures construction. The problem will be displayed on the projector and students will be asked to:

- Take VR headset and controller, select the given technique and follow the assistive animation and place the data items / objects / cards / numbers appropriately
- In second step student will get set of random data objects they need to apply algorithm on their own by using given algorithm

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Equipment, software and educational material to be used

Equipment

- Projector
- VR Headsets and Controllers
- Computers

Software

- Microsoft Visual Studio

Educational material (books, scenarios, etc. and sources)

- Introduction to Algorithms (3rd Edition) by Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein

How the ALIEN equipment will be used

VR

To interact with given problem

Computer

To create assistive animation and showing steps to be followed for a given algorithm using Unity3d

Course title: Advanced topics in Computer Networks

Engineering curriculum where it belongs

Department of Computer Science.

Course description

This is a graduate level course that covers a set of advanced topics in computer networks. The focus is on principles, architectures and protocols used in modern networked systems,

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such as the Internet itself, wireless and mobile networks, high performance networks and data center networks.

The goal of this course is to expose students to recent advances in packets networks, with focus on the architectural and protocol aspects underlying the design and operation of these networks. The course covers protocols related to Application, Transport, Network and Data Link layers (including SMTP, FTP, HTTP, TCP and UDP), IP Subnetting, Bit error detection and correct techniques and some of the concepts of Network Security.

Number of students to be engaged

5 to 10 students are enrolled in this course per year.

PBL activities that will be integrated in the course

The objective of the activity to be performed is to understand the concept of IP addressing and IP Subnetting. The problem will be displayed on the projector. Students will be asked to:

- Wear the virtual reality headsets and visit the virtual office building and count the number of rooms on different floor in the building
- Draw the structure of the building on the worksheet to assume floors as Networks and rooms as End systems
- Use the given pool of addresses and identify the number of addresses that they require at particular floor
- Keep track of used and unused addresses
- Count the number of rooms that can be added on particular floor depending on the number of available addresses
- Convert this addressing scheme into networking IP addressing.
- Develop this scenario in Cisco Packet tracer

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Equipment, software and educational material to be used

Equipment

- AR/VR workstations and laptops
- Internet connection
- Projector

Software

- Cisco Packet Tracer

Educational material (books, scenarios, etc. and sources)

- Different Tutorials on How to use packet tracer (available on Internet)
- Different Tutorials on IP addressing and subnetting (available on Internet)
- Computer Networking – A Top Down Approach – 7th edition (available in Library)

How the ALIEN equipment will be used

- The instructor will start the session by giving some introduction on projector about IP sub-netting and the devices that will be used during the session
- The students will be given some time to understand the usage of devices
- The physical visit may cost time and money, while the virtual tour can be developed using 360 Camera and Unity3D software. A virtual office building environment can be created using Unity3D, showing various floors and rooms on each floor. Each room may contain various computing devices
- Student will visit the virtual environment using vive or oculus rift and analyze the requirements

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P7. Tallinn University (TLU)

Institutional mission, vision and strategy

Outline of higher education in Estonia

The Estonian higher education system follows the Bologna treaty. Bachelor level studies take 3 years, while Master's studies take 2 years. This structure is justified by the rapid changes at the job market. In order to cope with the fast changes in the labor market, the time spent at different school levels is limited.

Universities exercise a lot of freedom with regards to their teaching practices, but rectors of the bigger universities have signed a quality agreement - a document that describes the optimal teaching practices at the university level. The inner operations of different universities are structured differently, but in most of the cases they are divided into smaller units (schools, institutes, or faculties) that are semi-autonomous in decision-making and mostly independent in matters that concern teaching practices.

Unfortunately, the most dominant teaching method remains the traditional presentation-based learning: lectures and slide shows. Some of the university regulations and vocabulary used reflect traditional training methods (e.g. attending classes cannot be mandatory as study materials—slides—must be available to students; the school has to offer three "examination times" for students to choose between, etc.).

There is, however, a growing trend towards using active learning approaches in higher education. For example, in more technically-oriented programs in particular, practice-based subjects were already introduced decades ago (such as internships and design- and development-based learning activities). In general, society and especially the industry representatives can see the value of more practice-oriented teaching methods. Internship

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programs, conducting projects and designing prototypes are largely accepted by all the stakeholders, while other, more unconventional methods like gamification, game-based learning and flipped classroom are not yet universally approved by the different players.

Estonian active learning initiatives

While the higher education institutions exercise considerable autonomy with regards to their educational process, teaching activities at the primary and secondary school levels are subject to the state educational program, which is mandatory for all schools in the country. The latest version of this program places extra emphasis on increasing the number and quality of active learning activities. It suggests, for example, replacing traditional presentation- and drill-based activities with techniques that support learners' creativity and collaboration. Various national and European initiatives exist to provide support for teachers who have difficulty adapting to these changed circumstances. One such initiative was the iTec project (FR7 2010–2014) whose goal was to promote innovative teaching strategies such as 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. The following is just a selective list of support 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)

- University of Tartu's tips for students on how to be actively involved in their studies, including how to use effective memory strategies: take notes, use mind-maps, check-

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lists, etc. (http://www.test.tudengiveeb.ut.ee/et/esileht/tulemuslik-korgharidus2/15-oppimine-korgkoolis/106-naepunaeiteid-aktiivseks-oppimiseks)

- A book by Mari Karm (University of Tartu) on higher education teaching methods such as active presentation, questions-based guidance, discussion, debates, group work, case study, problem based learning, role play, infographics, etc. (https://ec.europa.eu/epale/sites/epale/files/oppemeetodid.pdf)
- A set of guidelines concerning active learning methods created by Mari Karm, Triin Marandi, Einike Pilli, Katrin Poom-Valickis and Lehti Pilt (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)
- Arno Baltin's course on group work methods (https://sites.google.com/site/ryhmatooe6piobjekt/Home)
- Jaan Mikk and Hiie Hasser "Problem-Based Learning in Higher Education Institutions" (http://kodu.ut.ee/~jaanm/probleemope.htm)
- Maia Lust's website on problem-based learning methods in e-learning (http://aktiivopemeetodid.weebly.com/probleemipotildehine-otildepe.html)

In general, teaching faculty at Estonian universities has access to a wide range of guiding materials and supportive activities in the field of active learning. The implementation of these in practice depends on educators' motivation and teaching habits. Slowly but steadily the teaching practices have started to shift from conventional presentation-based techniques towards active learning. (Unfortunately, most of the guidelines, including many of those listed above, are only available in Estonian.)

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Extracurricular active learning initiatives in Estonia

In addition to the materials discussed above, a variety of extracurricular opportunities exist in Estonia that enable students to apply their STEM-based skills in a practical context. The following is a short sample of such opportunities.

Garage 48 is a series of events aimed at turning ideas into prototypes (garage48.org/en). They organize events focusing on different societal problems (e.g. how to support elderly people with the help of innovation and technology). At the beginning of each event, participants present their ideas. Small teams are then formed around the most promising ideas. The teams work intensively for 48 hours, developing an initial prototype. The event concludes with a presentation of the prototypes and the announcement of the winners. Throughout the process, teams receive support from mentors and experts. Garage 48 events have been a starting point for a number of successful products and startups (see http://garage48.org/success-stories).

Hackathons are active learning events similar to Garage 48 events. The main difference is that they are coordinated by different organizations (Garage 48 is one specific institution) and in different formats (Garage 48 is a registered trademark). The common denominator is that the events involve people who do not know each other gathering together, forming teams and designing prototypes or solutions to specific problems during a limited time period. Each hackathon can be different depending on its duration (from half a day to one week), participation requirements and follow-up activities. Hackathons are coordinated, among others, by universities, research institutions and non-profit organizations (e.g. the Estonian chapter of the Independent Game Developer Association 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 indie studios. On the one

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hand, it is a business initiative that invests in promising game startups. On the other hand, it is a unique arrangement of game-related learning activities. Teams and studios selected for this program have to change their physical location and work next to each other for 3 months. Game Founders also provide mentoring program and organize regular design and development sessions. Team members can learn from each other, through practice and from different game industry experts. Alumni's feedback has been very favorable in terms of receiving support from experts to address their current development, design and marketing needs.

Mektory is an innovation and business center hosted by Tallinn University of Technology (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 as Wood Lab, Welding Lab, Paint Lab, Automatism, Electronics Lab, Mechatronics Lab, Cool Tool Studio, 3D Printing Innovation Lab, App Lab, LEGO Lab, Smart Lab, Virtual Reality Lab, eHealth Lab, Space Centre, etc. Mektory offers trainings, consultations and support for students, startups and other actors interested in R&D and innovation.

Bank of Ideas is an example of how industry partners collaborate with Mektory (www.ttu.ee/projects/mektory-eng/mektory-center/reservable-rooms/bankofideas). On the one hand, this is a seminar room sponsored by Swedbank, a leading finance institution in the Baltic and Scandinavian area. On the other hand, this is an example of collaboration between universities and private companies. Swedbank is particularly interested in developing innovative solutions for supporting financial literacy in youth 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 at different universities and game companies in Tallinn (game-

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lab.ee). All activities are based on volunteers' effort and the main learning strategy is community-based learning, i.e. learning from each other and from industry experts. Game Lab's target group is not restricted to any age or demographic and they organize a variety of game development events, including hackathons.

PBL Lab

Tallinn University and particularly the School of Digital Technologies, has several labs equipped with cutting edge technology in order to support both students' and faculty members' creativity and teamwork (see www.tlu.ee/en/dti-labs and https://dtilabs.tlu.ee/). These include:

1. TECLAB (Technology Lab) supports the teaching processes in the School of Digital Technology by providing the necessary know-how and technical equipment for projects in the field of robotics, Internet of Things and automatization. The lab also provides tutors and working/study space for organizations and individuals who are interested in developing prototype solutions in above mentioned fields. More information is available on the lab's website (https://dtilabs.tlu.ee/technology-lab/).

   The lab's activities for the spring 2019 semester included:

   - Robotics Winter School, 20 students, 2 supervisors, teamwork with supervision
   - LIFE project Betterself, 18 students, 2 supervisors, teamwork with supervision (https://elu.tlu.ee/project/353)
   - Internet of things course, 60 students, 1 teacher, hands on practical work
   - Robotics course for BA students, 60 students, 1 teacher, hands on practical work
   - Robotics course for teachers, 50 students, 1 supervisor, practical work
   - Robotics course for mathematics, 15 students, 1 supervisor, hands on course
   - Experimental interaction design Winterschool, 20 students, 1 supervisor, theory and practice

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- Master seminars, 20 students, 1 supervisor, discussions
- Using robots in preschools 1-day course, 20 students, 1 supervisor, hands on workshop
- Informatics didactics, 20 students, 1 supervisor, lecture and practical work
- Training for German educators, 20 teachers, 1 supervisor, training
- Robotics for 2. Nd grade students, 20 students, 1 supervisor, practical work
- Erasmus+ training, a 3-day long course for 20 participants, 1 teacher, workshop
- Educational programming languages, 20 students, 1 teacher, practical course
- Ozobot practice, 20 students, 1 teacher, training
- Software developing practice, 2-week practical training, 60 students, 3 teachers

2. IDLAB (Interaction Design Lab) is a research, design and innovation unit contributing towards the knowledge and skills of the School of Digital Technologies in the field of Interaction Design (http://idlab.tlu.ee/). This lab is equipped with a wide range of hardware (http://idlab.tlu.ee/hardware/) and software (http://idlab.tlu.ee/software/). The usage statistics are difficult to estimate due to the lab being open for students to use at any time. Officially scheduled activities in Spring 2019 included development practice for Human-Computer Interaction students (20 students, different supervisors, practical work).

3. 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

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development related challenges (https://dtilabs.tlu.ee/software-lab/). Events hosted by the lab in Spring 2019 included the following:

- STEAM innovation laboratory
- Digital cooperation tools workshop
- Gamification workshop
- Development of Interactive Systems course
- Student project
- Blended Learning seminar
- Informatics teachers retraining
- Software development practice
- Robotics workshop
- Learning Game Design course
- Using robots in preschool
- HCI hackathon
- Educational Technology workshops
- Apple School Manager demo
- Teachers innovation laboratory - co-creation practices
- Teachers innovation laboratory - possibilities of IOT in learning
- Design of learning processes of nature and technology courses

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Figure 19: PBL lab in TLU

4. GLAB (Game Lab): a meeting place for students and faculty who are interested in making games. It offers facilities for meetings, group work and workshops, as well as a gaming computer with relevant software (Unity, Adobe Creative Suite, etc.), a graphic tablet and an Oculus VR headset (https://dtilabs.tlu.ee/game-lab/). The lab's main uses during the spring semester were:

- Project work and group work for Digital Learning Games MSc students, 32 students
- Game development internship for Computer Science BSc students, 12 students

5. MEDIT is a 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 focuses on developing innovative audiovisual applications in cooperation with partners inside and outside of the university (http://medit.tlu.ee/creative-lab). The current technical focus of the Creative Lab is on Virtual Reality and Augmented Reality solutions. The Lab offers an opportunity to test VR and AR gear and development platforms. Its equipment includes Oculus Rift,

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HTC Vive, PlayStation VR, Microsoft HoloLens, GoPro 360, Ricoh theta 360, Leap Motion, Samsung Gear VR, etc.

6. Digipaja is a newly established robotics laboratory for teachers in training. It has more than 70 robotics sets, as well as sensors, pads, voice recognition tools, cameras, IOT sets, soldering irons, etc. (https://www.tlu.ee/dt/meediavarav/digipaja).

Possibility to include Active Learning in the University strategic options

While the term "active learning" is not universally adopted at Tallinn University, various forms of AL are used extensively. These include project-based learning, group work, gamification and class discussion. These approaches are seen as part of the university's institutional mission "to promote an intelligent lifestyle," which includes active learning and life-long learning skills. (The mission is discussed at length in the Tallinn University Development Plan 2015–2020: www.tlu.ee/public/eng-arengukava/.)

The following overview introduces some notable examples of active learning at Tallinn University, as well as the facilities established to support it and the training opportunities offered to faculty that focus on AL.

Examples of AL initiatives

LIFE (Learning in an Interdisciplinary Focused Environment, rendered in Estonian as **ELU**), is an initiative at Tallinn University that provides an alternative to subject-based education by inviting students to collaborate on interdisciplinary projects (Sillaots & Fiadotau, 2018). LIFE / ELU 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 at 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

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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 a compulsory course for all bachelor and master's level students at Tallinn University.

DLG (Digital Learning Games) is a two-year master's program at Tallinn University (www.tlu.ee/en/DLG) whose main objective is to bring together people with different backgrounds (mainly software engineers, designers and educators), form heterogeneous teams and create educational digital games. Most of the courses in the core module of the program are structured as group work-based workshops, which culminate in a collaborative game design project. Students are free to choose the focus and scope of the project, but are encouraged to work on projects that address real-life societal or educational programs. While the main focus of the program is on game design (conceptual design of game rules), students can choose to study more technical (game development) or "softer" subjects (human-computer interaction; educational psychology).

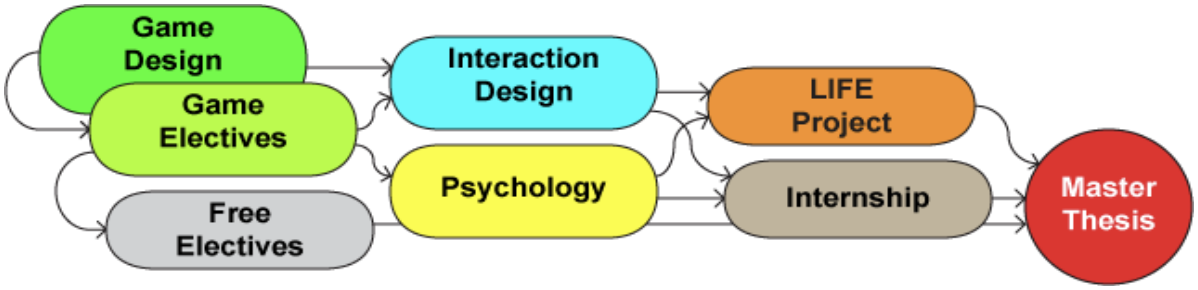

Figure 20: Courses in TLU

Active learning and project-based learning, is implemented throughout the program. For example, in the beginning of their studies, students are asked to work individually and generate game ideas that provide solutions to education-related problems. During the course on the Basics of Game Design and Research, these ideas are developed into initial game concept documents. During the following course, Design of Gameplay and Mechanics, students start working in pairs and develop selected game concepts further by designing and testing the games' challenges and rules. In the spring semester, the project work

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continues during the Design of Game Assets course, where students work in bigger teams (3-4 members) and design the sound and graphics for the game. Then, in the Learning Game Design course the team has grown 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 has grown to the size of 6-8 members. The second iteration of a bigger learning game will be conducted.

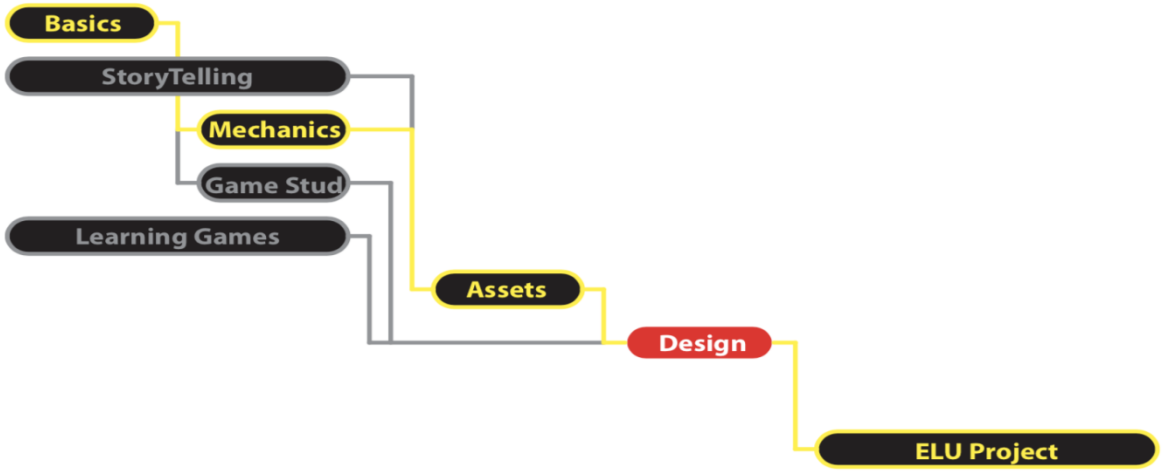

Figure 21: TLU courses

Other study programs offered by Tallinn University, such as Computer Science BSc, Human-Computer Interaction MSc, Educational Technology MSc, etc. also employ active learning methodologies.

Faculty support

Training opportunities for faculty

Tallinn University offers a range of training opportunities for its staff, including some that focus on promoting and implementing active learning methods. An initial effort at raising awareness about AL was the Active Learning Week, held on 7-11 April, 2016. Since then, a

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number of workshops and courses involving invited lectures have taken place, including most recently:

- A lecture by Tom Taylor (Association for Project Management) on facilitating group work and project management in PBL — 27 Sep 2018
- An intensive course by Terry Haydn (University of East Anglia) on teacher education, including active learning — 26 Feb to 1 Mar 2019
- A training session by Merel van Goch and Diederick van den Ende (Utrecht University) focusing on teaching interdisciplinary courses and facilitating brainstorming sessions — 22-23 Aug 2019
- A workshop by Mari Karm (University of Tartu) on student reflection and assessment in higher education — 26 Aug 2019

In addition, faculty involved in the supervision of LIFE projects (as described above) are able to take part in regular training sessions both at Tallinn University and abroad. The latter focus on exchanging experience and learning from colleagues at foreign institutions and most recently have involved visits to Malmö University (April 24-46), University of Milan (May 7-9), University of Zagreb (May 15-17).

Support centers for faculty and students

On a more permanent basis, the university operates three centers whose mission involves offering continuous support to university faculty and students in order to promote active learning methods and innovative teaching techniques.

The **Centre for Educational Technology** (http://htk.tlu.ee/htk/) focuses on theoretical, methodological and practical questions related to educational uses of technologies for teaching and learning in formal and informal educational settings. The Centre investigates

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the development, adoption and use of technologies in several areas of society with a data-driven focus. Special emphasis is put on technologies in education (learning environments and technologies, organizational level digital transformation, digital competencies, game-based learning, STEM education and location-based technologies) and industry (ICT sector, healthcare, construction etc.).

The center encourages links between research and teaching. The teaching is research-led and the research is informed by teaching. The Centre involves MSc and PhD students into its projects and research activities. The Centre is actively involved in three MSc-level programs: Digital Learning Games, Open Society Technologies (both delivered in English) and Educational Technology (delivered in Estonian). The Center also actively collaborates with Estonian schools to pilot research-based solutions and methodologies.

The **Centre for Innovation in Education** (https://www.tlu.ee/en/hti/centre-innovation-education) runs projects, training sessions and offers support to university faculty, school teachers and teachers-in-training, with an emphasis on innovative and active learning methodologies. Its main goals are to:

- Create and support networks for cooperation between scientists, teachers and trainee teachers
- Create, manage and develop contemporary open-learning environments and interactive classrooms
- Launch and implement scientific and developmental projects related to lifelong learning
- Develop and elaborate innovative curricula and modules, in pre- and continuous teacher training
- Develop and implement innovative teaching methods, including learning material, technologies and forms of training
- Consult with teachers, subject didactics lecturers, students and develop training

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- Involve international lecturers, scientists and doctoral students in the activities of the center
- Systematize the formation of teachers' professional identity and contribute in creating a recognizable and respected teachers' professional identity.

The **Center of Excellence of Innovation in Education** (https://www.tlu.ee/en/hti/research/center-excellence-educational-innovation) is a research center whose purpose is to develop an interdisciplinary research field that focuses on innovative and evidence-based teacher education, school management and educational policy.

The Centre has been created under the aegis of the Cross-Border Educational Innovation through Technology-Enhanced Research (CEITER) project, which is financed from the European Commission´s ERA Chair measures. With the support of the ERA Chair project, an international research group is to be created at Tallinn University whose main focus will be on the following Information and Communication Technology (ICT) areas:

- the next generation of digital learning environments and resources;
- new ICT-based methods for promoting learning analytics;
- educational research.

The Centre views educational innovation from a broad perspective. It addresses the need to create a scientific base for the development of a new learning and teaching culture and to ensure it is firmly rooted in Estonian education.

Scenario of ALIEN AL/PBL lab use in a course

Course title: Basics of Game Theory and Design

Engineering curriculum where it belongs

MSc Digital Learning Games.

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Course description

An introductory course providing an overview of digital game research methods and design principles, with a particular focus on serious and educational games.

Number of students to be engaged

30.

PBL activities that will be integrated in the course

- Group quiz and follow-up discussion on the history of digital gaming
- Extracurricular discussion: students receive extra points for posting additional examples, references and ideas relating to the topics covered in class to the online discussion on the LMS
- Game idea generation workshop and group brainstorming exercise: coming up with a game idea to address a given societal issue
- Individual final project at the end of the course: concept document for a serious/educational game
- Peer review of final assignments (evaluation according to provided criteria; feedback on improving/refining the game idea)

Equipment, software and educational material to be used

Equipment

- Windows PC x 30
- Projector
- speakers

Software

- Web browser

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- Office suite, etc. - no specialized software needed

Educational material (books, scenarios, etc. and sources)

- Frans Mayra (2008) An Introduction to Game Studies
- Jesse Schell (2008) The Art of Game Design: A Book of Lenses
- Marc Prensky (2007) Digital Game-Based Learning
- Ernest Adams (2009) Fundamentals of Game Design
- Brenda Brathwaite and Ian Schrieber (2008) Challenges for Game Designers: Non-Digital Exercises for Video Game Designers

Course title: Computer Games

Engineering curriculum where it belongs

Computer Science (B).

Course description

The goal of this course is to provide an overall understanding of game research and theory, design and implementation. More information https://ois2.tlu.ee/tluois/subject/IFI6099.DT

Number of students to be engaged

30.

PBL activities that will be integrated in the course

Gamification, flipped classroom, Design Based Learning and Project based learning. Students are asked to read the theoretical documents as home assignment. In the beginning of every class students are checked with the help of Kahoot quizzes. Classroom time is dedicated to team assignments where students design and develop a game from idea to a digital prototype.

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Equipment, software and educational material to be used

Equipment

- Students are using their own laptops

Software

- Free software like Gimp and Unity are used

Educational material (books, scenarios, etc. and sources)

- Course book for this subject is Ernest Adams Fundamental of Game design (2009)

Course title: Design of Game Assets

Engineering curriculum where it belongs

MSc Digital Learning Games.

Course description

A course focusing on creating assets (graphics, sounds, UI elements, etc.) for digital games and their integration with popular game engines

Number of students to be engaged

30.

PBL activities that will be integrated in the course

- Workshops followed by individual assignments: audio processing in Audacity + sound effects for the game/trailer; photo processing in Photoshop + integration with the Ren'Py visual novel engine; pixel art in Photoshop + integration with Construct3; 3D environment design in Sketchup + integration with Unity
- Workshop followed by a group assignment: character and story design

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- Student teaching: students offering short workshops on their area of expertise in game assets design
- Final project (team-based): a prototype or a trailer for a digital game using custom game assets

Equipment, software and educational material to be used

Equipment

- Windows PC x 30
- Projector
- Monitor headphones x 30
- Speakers
- Zoom H1 audio recorder
- Scanner

Software

- Adobe Photoshop
- Audacity
- Avidemux
- Construct 3
- Ren'Py
- Sketchup
- Unity

Educational material (books, scenarios, etc. and sources)

- Ernest Adams (2009) Fundamentals of Game Design
- Petri Lankoski (2010) Character-Driven Game Design: A Design Approach and Its Foundations in Character Engagemen

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- Ann Latham Cudworth (2014) Virtual World Desig
- Ric Viers (2011) Sound Effects Bibl
- Karen Collins (2008) Game Sound: An Introduction to the History, Theory and Practice of Video Game Music and Sound Design
- Patrick Felicia (2015) Unity 3D from Zero to Proficiency
- Unity Tutorial Directory: https://learn.unity.com

Course title: Design of Gameplay and Core Mechanics

Engineering curriculum where it belongs

Digital Learning Games (M).

Course description

Goal of the course is to provide examples and generate ideas for designing gameplay and core mechanics. Course will provide knowledge and skills in designing game logics, rules and interactions. More information https://ois2.tlu.ee/tluois/subject/IFI7178.DT .

Number of students to be engaged

30.

PBL activities that will be integrated in the course

Problem Based Learning, Design Based Learning. Students are asked to form pairs and conduct all analytical, design and presentation-based activities as partners. Students are asked to analyze and design aspects of game interaction and mechanics. The class ends with the game fest – playing game paper prototypes designed during this course in order to test the game engagement and logics.

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Equipment, software and educational material to be used

Equipment

- Students use their own laptops. Previously this course took place in the computer lab but there is no need for that

Software

- Mostly Google Drive is used

Educational material (books, scenarios, etc. and *sources)*

- Ernest Adams – Game Mechanics Advanced Game Design (2012)

Course title: LIFE Project (Learning in Interdisciplinary Focused Environment)

Engineering curriculum where it belongs

This is a cross curricular subject in the Tallinn University. Students from min 3 different fields are expected to join and form teams.

Course description

The purpose of LIFE course is to support the development of generic competences and teamwork skills through an interdisciplinary problem or topic in a team. More information https://ois2.tlu.ee/tluois/subject/YID6001.YM

Number of students to be engaged

Minimum 8 to maximum 24 per course (but in total all TLU students through different LIFE projects ~8.000).

PBL activities that will be integrated in the course

Project Based Learning

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Equipment, software and educational material to be used

Equipment

- Students use their personal laptops

Software

- Google Drive

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P8. Technical University of Gabrovo (TUG)

Institutional mission, vision and strategy

In recent years AL has been increasingly discussed among educators and decision makers in Bulgaria. However, the Ministry of Education and Science has placed an emphasis on turning universities, especially technical ones, into scientific and research hubs and the role of university lecturers as teachers has been pushed into the background.

Consequently, the majority of the university academic staff of the Technical University of Gabrovo experience unawareness of state-of-the-art teaching/learning techniques. One of the main reasons is a lack of further training focusing on updating their pedagogical skills at tertiary level. Furthermore, most of university lecturers are not motivated to educate themselves so as to improve their teaching competence largely due to ageing and lack of university policy in this area.

To sum up, there isn't any strategic document related to AL at the Technical University of Gabrovo, as well as support of the University management. Nevertheless, some university lecturers are making an attempt to introduce active learning tools, yet partially within European projects, but no institutional mission or vision is available.

The first more thorough intervention in Active Learning was done within the ALIEN project, when two focus groups were organized to identify the awareness and disposition of academic staff in relation to Active Learning.

The two focus groups were organized in September 2018. The first one involved 10 university lecturers, of whom 5 are over the age of 50 and 5 between ages 30-49. Of these, 6 are male and 4 females. In terms of faculties, 4 teach at the Faculty of Mechanical and Precision Engineering, 4 at the Faculty of Electrical Engineering and Electronics and 2 at the Faculty of Economics. The second group included 10 university students aged 19-23, of whom 7 male and 3 females. Of those, 4 follow bachelor degree courses in Mechanical

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Engineering, 4 follow bachelor degree courses in Electrical Engineering, Electronics and IT and 2 follow bachelor degree course in business, administration and management.

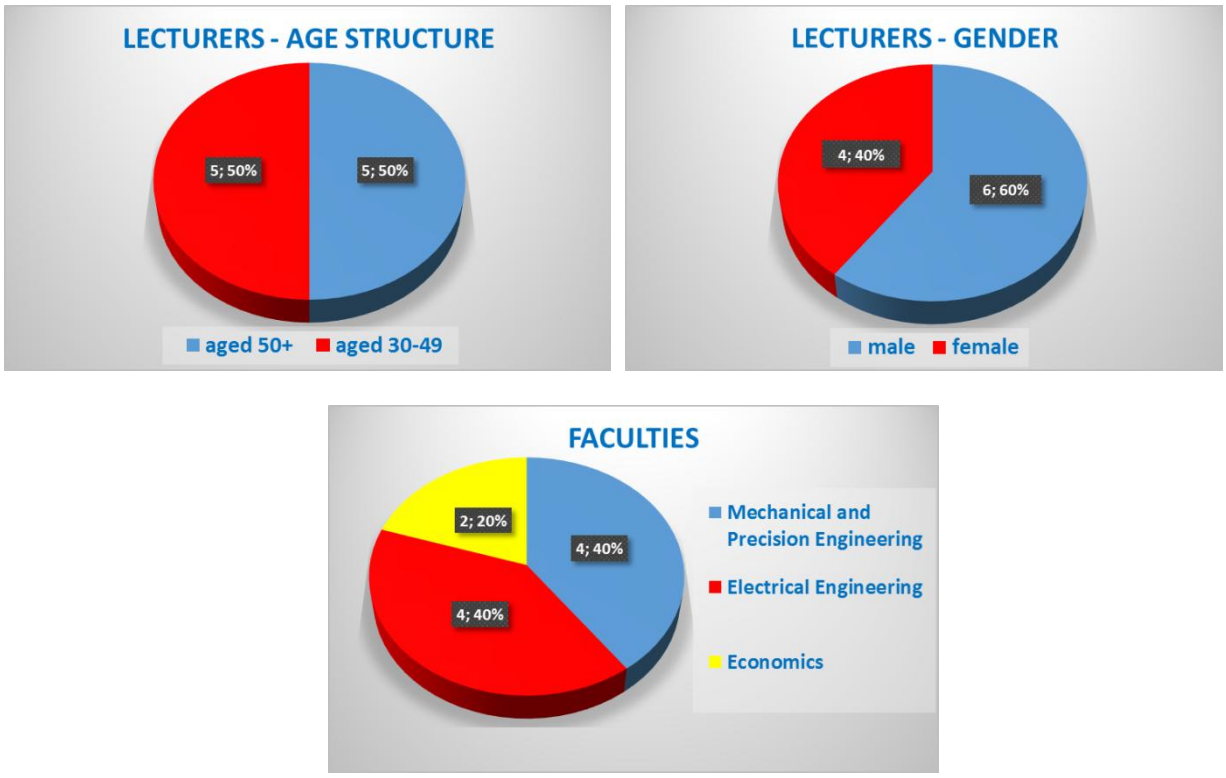

Figure 22: Lecturers' profile in TUG

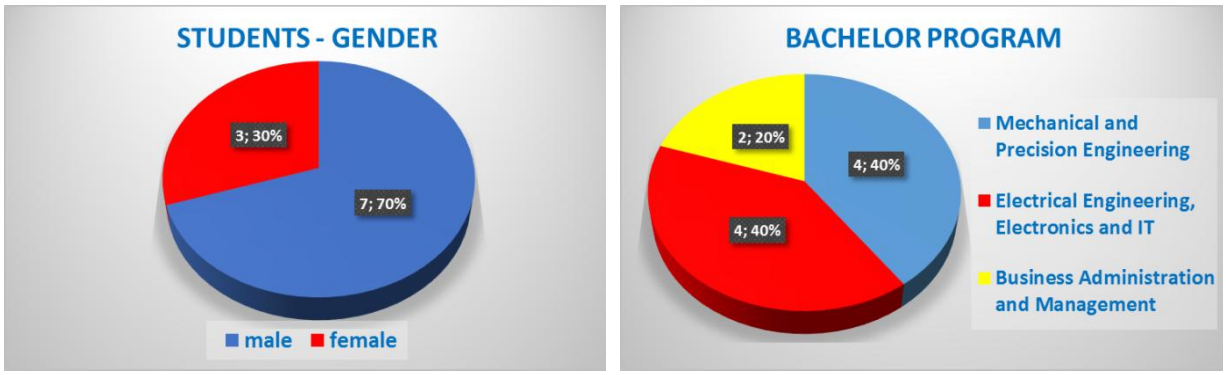

Figure 23: Students' profile in TUG

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The 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 (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 the term “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 AL and PBL, the study showed that the two lecturers teaching business and management subjects and the two IT lecturers used PBL 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. Therefore, AL and PBL as a form of teamwork, discussion and active participation are not used in their classes. When asked about their willingness to introduce AL and PBL, 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 AL and PBL in the classroom and the other 20% did not give any definitive answer.

In relation to the lack of structured AL and PBL at the University the following reasons were given:

Academics

- Limited class time and density of curriculum

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- 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, which include 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 AL and PBL
- 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 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

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

To sum up, the University AL and PBL pattern does not differ from that of other Technical Universities in Bulgaria regarding engineering degree courses. It is still teacher-centered and

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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 AL and PBL at their classes.

AL and PBL and their application

AL and PBL will be used in 2 phases:

Phase 1 – Pilot phase: AL and PBL will be initially introduced into a few obligatory or elective courses in the Faculty of Electrical Engineering and Electronics and Faculty of Mechanical and Precision Engineering. About 120 students following a degree in Mechatronics, Computer-Aided Mechanical Engineering, Industrial and Automobile Electronics, Automation, Robotics and Computer-Aided Control Systems and Equipment and Technology for Environmental Preservation are expected to be involved.

Example of courses:

- Basics of Automation
- Control Theory II
- Reliability of Electronic Systems
- Mechanics of Fluids
- CNC Tools, Machines and Technologies
- Resistance of Materials
- Mechanics II
- Computer-Aided Measurement
- Calculus
- Environmental Chemistry

Phase 2 – Deployment phase: The main deployment approach will be to introduce AL and PBL into other subjects of the above degree courses and other degree courses in both

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faculties mentioned above such as Computer Science and Technology, Software Engineering, Textile Engineering, Communications, Safety at Work, etc. AL and PBL will also be introduced into the Technical College of Lovech, which is part of the Technical University of Gabrovo. About 300 students will be targeted.

Furthermore, the ALIEN solution will be promoted to other technical university such Technical University of Sofia, Technical University of Varna, Rousse University, etc.

Possibility to include Active Learning in the University strategic options

The first step is likely to be making University management aware of the very concept of AL and convincing them in its benefits for both university lecturers and engineering students and of course the University as a whole.

Another possibility is to involve the University Centre of Postgraduate Qualification in the process of retraining academic staff in relation to how to use AL techniques in their classes. Currently the Centre provides further training of school teachers with focus on improving their teaching competency. Therefore, it could expand its educational provision and offer training services to the University lecturers.

A good option could be to give a higher priority to teaching competence in the assessment forms of academic staff. This could increase their motivation to apply up-to-date teaching/learning methods, including AL.

Faculty support

According to the project work plan, particularly WP3, the organization has organized and carried out a university teacher training workshop in May 2019, where 20 university lecturers from the Faculty of Mechanical and Precision Engineering and Faculty of Electrical Engineering were trained in AL techniques. A special AL activity, a team game, was implemented in practice. Initially, the participants were negatively biased and rather reluctant to take part in the game. However, in the course of the activity they got very

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enthusiastic and finally highly appreciated the team game getting aware of its positive effects. After the workshop they expressed their willingness to apply that approach in their classes.

In the future, it is possible to organize such workshops every year by the Centre of Postgraduate Qualification to update teaching competences.

Scenario of ALIEN AL/PBL lab use in a course

Course title: Control Theory II

Engineering curriculum where it belongs

The course is included in the third year of study in the curriculum of the bachelor degree course of Automation, Robotics and Computer-Aided Control Systems.

Activities challenge students to start by creating a mathematical model of a simple Direct Current motor and then to simulate its operation with MATLAB either with its SIMULINK graphical programming environment or with an appropriate m-file from the command window.

Upon completing the course the students are able to:

- Understand concepts and principles of controlling different systems
- Build mathematical models
- Compose matrices
- Create simulation models by using MATLAB SIMULINK where Control theory is applied

Number of students to be engaged

35.

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PBL activities that will be integrated in the course

Context

One of the most common electromechanical systems used in the actuators in different types of control systems is the Direct Current motor. It is a rotary electrical machine that converts direct current electrical energy into mechanical energy which is used to drive different machines. It is very useful for students of different engineering degree courses to be able to model and simulate such motors.

Problem description

How to describe the operation of a DC Motor by means of differential equations? How to convert the obtained description in the more universal state space representation? How to simulate the state space model with the MATLAB software?

Instructions

The prerequisites for the successful completion of the tasks are some basic knowledge of electrical engineering and mathematical modeling and also some basic knowledge of the principles of simulation in MATLAB, and in particular in SIMULINK.

The students will be asked to:

- Take a simple functional scheme of a DC motor from the resources
- Derive the electrical part of the mathematical model of the DC motor by applying the Kirchhoff's First and Second laws
- Derive the mechanical part of the mathematical model of the DC motor by applying the known laws for the rotary motion, e.g. the law for the motor's torque
- Combine the obtained equations into a generalized mathematical model of the motor

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- Obtain the Cauchy form of the mathematical model
- Compose the A, B, C and D matrices of the state space model from the Cauchy form.
- Take the parameter values for each of the motor's magnitudes from the teacher/trainer
- Given the A, B, C and D matrices and the parameter values, create a SIMULINK model of the motor, using the common blocks from the SIMULINK library
- Make many simulations with different input signals and different parameter values and observe the effect of these changes in the "Scope" blocks
- Create a m-file in the MATLAB editor. Enter the A, B, C and D matrices of the state space model of the motor and with common Control system toolbox instructions like "Step", "Impulse" etc. do the appropriate simulations without using SIMULINK
- Repeat the simulations with different input signals and different parameter values and observe the effect of these changes in the respective plots
- Compare the results obtained from the two approaches (with SIMULINK and with a m-file). Are they the same?

Solution

The task is completed when the appropriate plots of the motor shaft's rotary motion and angular speed are obtained.

Students who finish earlier

There are great many possibilities for additional tasks for trainees who finish earlier than the others. It is possible to give them some similar electromechanical system which model is very close to that of the original DC motor, e.g. again a DC motor, but with different type of control. Then the trainees will be able to obtain the model of the new system very fast and to simulate and compare it with the original system. Other additional tasks may be simulation experiments with varying one or more of the system parameters. Students who

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have basic programming skills can automate these experiments with a simple program loop in the m-file.

Variants

From the beginning of the exercise, each team may obtain slightly different system. There are different types of DC motors according to various signs. Thus, each group will work on its own problem. In this case there should be no competition element between the teams because for some of the variants more time should be needed for the solution. However, the competition element within each team between the subgroups working in SIMULINK or with m-file remains.

Instructions for lecturers

Do a short briefing to the trainees to acquaint them with the problem. The trainees must have some basic knowledge of electrical engineering and control theory and also some computer skills, in particular with the MATLAB software. The optimal form for the completion of the task is to divide the entire group of trainees to small subgroups of 3-4 trainees. Each subgroup should act as a team. It is a good practice to introduce some element of competition between the teams, e.g. the team which obtains the results first will receive some kind of prize.

It is important to specify in front of the students the three main stages of the solution of the task:

- **The first stage** is to obtain the mathematical model of the motor in the form of differential equations. It is the most crucial stage, because there are many possibilities for errors when composing the equations. To minimize the possible errors, it is appropriate to choose the simple-model mathematical modeling, where the task is not to create a model which represents every single detail and action of

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the motor, but to create the simplest possible model which represents only the basic features of the motor and which model is suitable for computer simulation.

- **The second stage** is the teams to construct the state space form of the model and to derive the A, B, C and D matrices. This stage is less error-prone but nevertheless the teacher must observe carefully the work of each team mainly for oversight errors. Such errors are quite widespread when there is the element of competition between the teams which team will complete the task first. One such error, for instance a wrong sign of only one of the elements of one of the four matrices can cause an absolutely wrong and useless simulation.
- While the first and the second stages of the solution are analytical, is computer based. The trainees must have some basic knowledge of MATLAB and SIMULINK. If there are more computers available, the lecturer may encourage one part of every team, e.g. 1-2 trainees to make the simulation in SIMULINK and the other part of the team to choose the other approach with m-file. Thus, every part of the team will be ambitious to do the work faster than the other part and the whole team will have additional stimulus to work fast, because such is the situation with the other teams too. However, by doing so, the chance of random errors increases, so the lecturer should explain this to the trainees.

According to the type of the classes, the task for modeling and simulation of a DC motor may be done as a one day only exercise or as a more full-value task where some preliminary work must be done by the trainees. In the second case the lecturer assigns the task to the teams and gives them 3-4 days to do some research with the resources. By doing so, the obtained mathematical model by each team may vary significantly, but still be usable. If the lecturer chooses everything to be done as a one day only exercise, he has to help the trainees with the first task of obtaining the mathematical model.

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Equipment, software and educational material to be used

Hardware

- 4-5 workstations, depending on the number of students
- Internet connectivity

Software

- MATLAB applications

Educational material (books, scenarios, etc. and sources)

- Resources for Electrical engineering - there are plenty of textbooks of Electrical engineering in which the DC motors are described thoroughly
- Hughes, A. Electrical motors and drives – Fundamentals, types and applications. Newnes, Elsevier Ltd., 2006
- Keljik, J. Electrical motors & Motor controls. Cengage learning, 2006
- https://en.wikipedia.org/wiki/Brushed_DC_electric_motor#Torque_and_speed_of_a_DC_motor
- Resources for Control theory – textbooks and web resources in which the state space approach for system representation is described
- Brogan, W. Modern control theory. Pearson, 1990
- Gopal, M. Modern control system theory. John Wiley & Sons, 1993
- http://dl.icdst.org/pdfs/files/4fd6e5ae41a6b686d1f9bbb20de891f7.pdf
- Resources for MATLAB – user manuals for MATLAB and SIMULINK
- Gilat, A. MATLAB: An introduction with applications. Wiley, 2014
- Beucher, O., M. Weeks. Introduction to MATLAB & SIMULINK: A project approach. Jones&Bartlett Learning, 2007

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Course title: Reliability Indicators of AC/DC Converters

Engineering curriculum where it belongs

Master program in Electronics, course Electronic System Reliability, first study year, second semester.

Course description

The goal is to calculate the quantitative reliability indicators of an electronic system – failure intensity of components and the system at large, probability of failure-free operation, failure probability and the average time of failure-free operation of the whole electronic system.

At the end, the students will be able to:

- calculate the failure intensity of electronic components by using ItemTool Kit application;
- determine the probability of failure-free operation of the electronic system;
- define the components that most influence the reliability of the electronic system.

Number of students to be engaged

12.

PBL activities that will be integrated in the course

Context

Reliability is a quality of the components and objects to keep their technical indicators for a specified period of time under given running conditions in particular electrical and thermal modes. To calculate it, it is necessary to thoroughly know the electronic system (in this case, a DC/DC converter), to select a calculation method (MIL-HDBK-217F, FIDES, RDF2000,

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217PLUS, etc.) and to define the electrical and thermal modes of the components involved in the system.

Problem description

To calculate the reliability of electronic components and systems it is necessary to determine the type of electrical modes of the electronic components of the DC/DC converter. It is calculated according to the method of failure intensity of all electronic components involved in the DC/DC converter by using ItemTool Kit application. A method is selected or the method is specified by the teacher. MIL-HDBK-217F and FIDES methods are the most widely spread. Students get familiar with the two methods and make a well-grounded decision which one to use. Students also get familiar with Reliability Theory, types of replacement reliability circuits – in series, parallel or a combination of the two and choose which one to use. The following indicators are calculated according to the circuit been chosen – failure probability, probability of failure-free operation and mean time between failures.

Instructions

The class is divided into 4 teams. Students get familiar with the requirements, resources, circuits to be used. The assignment is divided into several stages: getting familiar with the circuit, components and principle of operation of the DC/DC converter; recording the nominal and operating values of the parameters of the electronic components of the DC/DC converter. If there are circuits of a step-up and step-down DC/DC converter the teams record data for the electrical and thermal modes of both converter types. Calculations are done by using ItemTool Kit application.

Team 1: Calculate the failure intensity of the electronic components of a step-down DC/DC converter according to the MIL-HDBK-217F method.

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Team 2: Calculate the failure intensity of the electronic components of a step-up DC/DC converter according to the MIL-HDBK-217F method.

Team 3: Calculate the failure intensity of the electronic components of a step-down DC/DC converter according to the FIDES method.

Team 4: Calculate the failure intensity of the electronic components of a step-up DC/DC converter according to the FIDES method.

Each team is to choose a replacement reliability circuit and calculate the quantitative reliability indicators: failure probability, probability of failure-free operation and mean time between failures. In addition, the components of the circuits having the highest failure intensity are determined and recorded.

Finally, all teams swap data and make an analysis of the results obtained by comparing the findings for the two circuits and the two calculation methods.

Solution

The problem is solved when the values of the probability of failure-free operation and the average time between failures for the two types of converters are obtained.

Students who get ready earlier

If the obtained results are correct, solutions for enhancing the reliability of the circuit and electronic components are sought.

Variations

The calculations could be combined with other problems such as a change in the output circuit parameters, a change in the circuit operating modes and running conditions or a change of the very components.

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Instructions for the teacher

The class is divided into 4 teams. Students get familiar with the requirements, resources, and circuits to be used. The assignment is divided into three stages:

Stage 1: collecting data on the type, electrical and thermal modes of the electronic components involved in the two circuit types.

Stage 2: calculating the failure intensity of the electronic components involved in the two circuits.

Stage 3: choosing a replacement reliability circuit and calculating the reliability indicators, including failure probability, probability of failure-free operation and mean time between failures.

Each team works independently by calculating the failure intensity according to the specified circuit and calculation method. Each team makes analysis of the results obtained for their specific assignment. Finally, all teams swap data and make a comparative analysis of all results obtained.

Equipment, software and educational material to be used

Educational material (books, scenarios, etc. and sources)

- FIDES method: https://www.fides-reliability.org/en/node/610
- MIL-HDBK-217F method: https://snebulos.mit.edu/projects/reference/MIL-STD/MIL-HDBK-217F-Notice2.pdf
- Reliability Theory: https://www.reliabilityeducation.com/reliabilityeducation/ReliabilityPredictionBasics.pdf
- https://www.relyence.com/2018/05/08/what-is-reliability-prediction/
- https://www.itemsoft.com/download_resources_websites.html

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Software for reliability calculation

- https://www.itemsoft.com/download_demo.html

Equipment

- DC/DC converters: https://www.watelectrical.com/dc-dc-converter-operating-principle-functionality/

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P9. Jon Von Neumann Institute – Viet Nam National University Ho Chi Minh City (JVN)

Institutional mission, vision and strategy

John von Neumann Institute (abbreviated as JVN) is an institute directly belonging to Viet Nam National University of Ho Chi Minh City. JVN operates as a center of excellence in the domains of data science and quantitative computational finance.

JVN has 2 scientific programs, one for data science-oriented information technology (ICT) and other for quantitative computational finance (QCF). Each scientific program includes one master program and one laboratory.

JVN's mission, vision and strategy in Active Learning implementation

Following is a description of the organization's mission, vision and strategy:

Mission

The main mission of JVN is to build a high-quality and sustainable model that links post-graduate education, scientific research and initiative application into enterprise innovation. This model is expected to create many breakthrough values in bringing new knowledge about 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 and being active in their learning because the outputs are likely to be directly assessed and used by enterprises.

Vision

To fulfill the mission JVN aims to become a highly interactive and student-centric environment where students are encouraged to equip new skills and methods that make them more active in their learning, both theoretical and practical.

Strategy

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The strategy of JVN is focusing on creating a highly interactive environment and providing more active approach for students during their learning time. Students may select actively the subjects in their learning program.

The laboratories are open 24/7 for the students and most of the time there are lecturers, researchers or classmates to work with them. Each student is equipped a PC being connected to the system of servers for their individual or more complicated tasks. The laboratories also include space where the students can learn or work in groups under the supervision of lecturers or researchers.

In each master program there are 4-5 subjects that the students are required to practice a lot. Besides, JVN organizes weekly seminars in each Friday afternoon with the participation of industrial experts, lecturers, researchers and students. They present various topics about professions, skills and new ideas. JVN also organizes monthly the mini-hackathons or competitions for the students to practice their skills and make familiar with the real conditions in their future work. JVN equipped some software and database of Vietnamese stock market that can be applied in the PBL lab for the QCF program.

PBL Lab

A PBL lab will be established at the Tenpoint7, which is one of JVN's industrial partners, laboratory.

This lab has a well decorative space and appropriate for the small groups of lecturers and students working together. The organization will arrange working tables in the form of pentagons to encourage discussion in a manner similar to that deployed in the data science laboratory (see Figure 25).

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Figure 24: Innovative space in Tenpoint7 laboratory

Figure 25: Group working space in the laboratory of data science

To enhance the interaction and the active contribution from students during the course the PBL lab procured from ALIEN's funding will include 5 high performance laptops, one for

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lecturer and 4 for students, a high speed network switch with wireless connection, a server for computational and storage purposes and a SmartBoard (see Figure 26).

Figure 26: Configuration and setup of PBL lab

In the first step, the PBL lab will be used for groups of students and lecturers during selected specific courses. They will register for the usage within a diary managed by a researcher. The registration plan will be approved by the lecturers and the project manager.

The details of the courses, number of students, lecturers that will join and pedagogical methodology to be used are described in the following table:

Programs	Courses	No. of students	No. of lecturers	Pedagogical methodology
Data Science	Decision analysis (1st semester)	20	2	Increasing visual interaction to help students understand better the theoretical issues
	Time series analytics and forecasting (2nd semester)	20	2	Learning by examples, practical enhancement with exercises
Quantitative	Advanced	20	2	Learning by examples,

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Computational Finance	Programming in Finance (1st semester)			practical enhancement with exercises
	Numerical methods in finance (2nd semester)	20	2	Increasing visual interaction to help students understand better the theoretical issues
Total		***80***	***8***	

Table 9: Details of courses in JVN

There will be reports on a semester basis on how to use the PBL lab more effectively or improve AL for students.

Equipment

- 1 Mobile Precision 7530 CTO Base
- 4 Dell Latitude 7490
- 1 Dell Power Edge R330 Rack Mount Server
- 1 Dell Networking Aerohive
- 1 Interactive Screen Benq RM5501K
- 1 Switch Dell

How the equipment will be used for active/problem-based learning

AL or PBL will be applied in the courses that have a great proportion of programming. The lecturers will instruct their students' exercises and practices in an interactive manner during the courses. The exercises and practices will be designed as problems that will be solved by the students themselves.

The courses that will be taught in PBL lab are listed as follows:

- Decision analysis

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- Time series analytics and forecasting
- Advanced programming in finance
- Numerical methods in finance

The configuration of PBL lab includes:

- 5 high performance laptops (one for lecturer and 4 for students) to help lecturers and students work together in a mobility environment, that can be extensible for more
- 1 high speed network switch with wireless connection to connect lecturers and students to the working environment and equipment of the working environment themselves
- 1 server for computational and storage purposes to process and store the computational missions built by lecturers and students
- 1 SmartBoard to help lecturers instruct their students interactively
- 1 PBL application to help lecturers and students work in the defined problems

The equipment

- The equipment of JVN's PBL lab was purchased from one vendor. There is no split in the overall configuration of the system from the procurement viewpoint.

Faculty support

Support from JVN scientific programs

As mentioned above, JVN operates the scientific programs around the laboratories where lecturers, researchers and students work together out of class time. The students will learn through projects, course work and subjects in the curriculum under the supervision of the lecturers and researchers. To promote AL in JVN, lecturers will be informed and joined in designing the working environment of the PBL lab, mostly in terms of the platform for programming and communication and the materials that will include examples and

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exercises to be used in their courses. Due of the limited number of equipment units, academic support staff will help prepare a plan with multiple time slot that are suitable for students to do the exercises or small projects in the PBL lab. The students will register their time slot actively to maximize the lab's usage.

In the initial phase, 2 courses per master program will be selected for deploying activities in the PBL lab. The courses will start in September of 2019 and will engage the new intake of students. Starting now, to prepare for the courses that enhance active learning methods for the students JVN will organize seminars with the lecturers to discuss on how to change course schedules and how to structure courses to adapt them to the new requirements of AL. Students of the current intake will be invited to join, use the PBL lab and comment.

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P10. Hanoi University (HANU)

Institutional mission, vision and strategy

Recently, AL has been included in Hanoi University's vision. The university managerial board always encourages the improvement of instructors' effectiveness and the increase of student learning. In each semester, workshops on AL are organized to train teachers and staff. During these workshops professional speakers equip participants with practical knowledge and relevant skills to be effective academics leaders in the organization. Moreover, participants become informed on the role of technology in teaching and learning in the digital age and on organizational and curricular changes that are needed to prepare students to be competitive in the new economy. For example, as a response to the Industry 4.0 survey that took place in 2018 by PWC and focused on the digital transformation of Vietnam, there was one workshop in January 2019 that placed emphasis on applying new methods, techniques using high technology in the classroom settings to enhance student engagement.

In addition, seminars are also offered for all teachers to share experiences on AL, sharing practices what they have been using recently and outcomes. Such seminars are held within a faculty or for the whole university. On the other hand, teachers sometimes are required to set up projects to master teaching skills such as identify teaching challenges and solutions using new strategies and so on.

PBL Lab

The PBL lab contains 3 hexagon tables and 1 rectangle table as shown in Figure 27.

The rectangle table is fixed while all hexagon tables are moveable. Each side of these tables is a smaller table so that students can change the order to form smaller groups. In the

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middle of a table lays a PC for each group to use. One projector is fixed on the wall in front of the class.

Equipment

Equipment for PBL lab:

- Multimedia workstations with hi-end graphics
- MacBook pro
- Scanner a4
- Short throw projector
- I-Board

Figure 27: PBL lab design in HANU

Other facilities of the lab include:

- Air conditioners
- Bookcases
- Laser printer A3
- Swivl robot and solution

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- Accessories for projectors
- Wi-Fi

How the equipment will be used for active/problem-based learning

The PBL lab is used to learn and design multimedia products. At least 4 classes deploy the lab in 1 semester. The lab is mainly used to teach the following courses:

- Special subject 1
- Special subject 2
- Multimedia design

However, the lab may be used in other courses if applicable. About 20 students use the lab at a given time. There are 4 lab sessions per week, 15 weeks per semester and 2 semesters in an academic year. The number of teachers involved is 3 main teachers and many others if they interest.

This lab is used to promote new pedagogical methodologies such as game-based learning and PBL. Practical problems and games are used as a means of motivating students to learn concepts and principles with support from modern equipment in the lab.

Faculty support

Plan and schedule teacher training courses/workshops for your Faculty

Last school year, some workshops were carried out for introducing ALIEN project and AL in the faculty of Information Technology. All teachers were required to take part. In these workshops, some teachers showed the results of their research related to AL and their teaching experiences. All attendees discussed the topic and exchanged ideas.

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Next year, the faculty will hold at least 2 other seminars. One seminar will be set up focusing on training teachers about AL in details, including methods, tools and techniques, and how to use the new PBL lab. After that teachers will submit the curricula, teaching methods applying AL and schedule to the executive board of the faculty for evaluation and feedback. At the end of the semester, the teachers will report the effectiveness and drawbacks from the application of AL in their courses. The dean and the others will give feedback and support to help the teachers improve their teaching methods in the following semester.

Is it possible to have support services for teachers implementing AL?

In the Faculty of Information Technology (FIT), Hanu it is possible to have services including staff support and tools to assist teachers in applying AL. Many useful applications which teachers can use to implement AL were introduced in prior seminars and are currently used to enhance teaching and learning among faculty members. For example, the organization has been using the FIT portal for several years. This is a website that allows teachers to provide learning materials, flexible assessment methods and convenient student management. If teachers have any problem with using such applications, they always have support team help them address them. The support team is responsible for guiding users to use new tools and helping during the deployment of with these tools. Moreover, the faculty will form a consulting board to help build content for AL classes to be used before and during the application of AL. All participants in the consulting board have experience in designing AL and PBL activities.

Scenario of AL/PBL lab use in a course

Course title: Multimedia design

Engineering curriculum where it belongs

Multimedia.

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Course description

The objectives of the course are to:

- Teach the basic elements of multimedia
- Teach how to combine different elements in one multimedia product
- Teach how to leverage text, image, sound, animation and video clip to convey meaningful messages
- Guide on how to design and manage a multimedia project

Number of students to be engaged

70.

PBL activities that will be integrated in the course

There is a series of activities that will be included in the course to contribute to the understanding of elements of multimedia, stages and skills in making multimedia, multimedia tools and more. Activities will be organized in tutorials. Each tutorial will have a different learning objective and will include different activities and teaching methodologies. The following are some examples:

- Analyze different multimedia product to see how they are used in different fields, such as in business, in education, at home, at market places, etc.
- Revise lessons with fun and interactive games in Kahoot (https://kahoot.com/b/) or Quizlet (https://quizlet.com/latest). After having students play the games, teachers will ask students to identify the benefit of multimedia in education
- Play “fonts have felling” game: printing off some messages that have bad font choices and ask students how the fonts and words make them feel and whether they can they find a better font for those messages. For example:

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Figure 28: Example of Fontstruct

- Have students design their own font using Fontstruct (https://fontstruct.com/)
- Select 5 different web pages, each from a different web site. Select pages that contain lots of colors and images, both photographs and graphics. View the 5 different pages on both a Macintosh and PC screen, preferably side by side, as well as on more than one computer on the same platform, for example one Mac and two Windows computers. Note the differences in how each page appears across platforms and screens. For each page, write a paragraph describing how they differ in terms of color tone, saturation and any other characteristics that you notice
- Play the "Heads-up" game to enhance memory of 12 principles of animation by Disney (Thomas and Johntson, 1981); this activity requires a projector
- Show samples of animation, some of which follow the 12 basic principles and some do not. Ask students the differences among them and challenge them to build their own animation based on the 12 principles. Students may present the final result in class
- Require students to record sound and then use Audacity to edit the sound to fit for specific purposes
- Locate three multimedia projects and review the credits. Require students to identify: How many members were on the team? What were their titles? How many team members performed more than one role? What tasks were "outsourced", i.e. executed by outside companies? Make a table that compares the titles for similar

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roles among the three projects. For each, discuss how the team related to the product

Equipment, software and educational material to be used

Equipment

- Computers
- Multimedia workstations with hi-end graphics
- 2 laptops
- Scanner A4
- Short throw projector
- I-Board, laser printer A3
- Swivl robot and solution
- Accessories for projectors

Software

- MS office
- Audacity
- Adobe Photoshop
- Dreamweaver
- Pencil2D
- Blender

Educational material (books, scenarios, etc. and sources)

- Books:
    - Multimedia: making it works by Tay Vanghau, 8th edition
    - Li, Z. and S. Drew, M. (2004). Fundamentals of Multimedia. 1st ed. Prentice-Hall

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- Fit portal : http://fit.hanu.vn/
- Other materials: Google email, google drive, fontstruct (online)

How the ALIEN equipment will be used

Computers and laptops

Students will work in groups. Each group will use 1 computer and/or 1 laptop to design their multimedia product in class. It's is important to test the final product on different computers so both desktop computers and laptops must be used.

Multimedia workstations with hi-end graphics

The multimedia workstations offer high-quality design especially suitable for making animation and video in the course.

Scanner A4

Scan images and documents by students who study image editing. It may also be used to scan required documents for the course such as leaflets or book covers.

Printer A4

Students may use the printer to print documents or images when they learn image editing and typeface designing. Moreover, the printer may be used by students who need to see differences between the soft version and printed version of an image or document.

Short throw projector

The projector may be used by teachers and students to deliver presentation or product demonstrations and for playing educational games like mentioned above.

I-Board

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The I-Board will be used for displaying students' multimedia products or ideas. Moreover, it may be used in combination with the short throw projector to deliver effective presentations.

Laser printer A3

The printer will be used to print documents or images when by students who study image editing and typeface designing. Two different printers will be used for addressing different requirements of the course.

8.8 Swivl robot and solution

It will be used to record all lectures delivered by teachers. All recorded files will be used as material for making online class as good practice examples of deploying multimedia in education.

Accessories for projectors

They will be used for supporting the deployment of projectors.

Wi-Fi

It will be used for providing internet access to laptops and cell phones.

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P11. University of Battambang (UBB)

Institutional mission, vision and strategy

UBB is a young public university in Cambodia, established in 2007, to provide opportunities to students living in rural areas, especially in the north-western part of Cambodia, to have access to higher education services in order to develop their individual careers as well as to that of local communities while also reducing knowledge gaps between rural and urban areas. UBB's goal is to educate the leaders of tomorrow in a wide range of fields through a balance of theory and practice. UBB works closely with local community, government and non-governmental organizations, companies and consortium universities in the region and the world. It has five faculties and one institute include:

- Faculty of Business Administration and Tourism
- Faculty of Agriculture and Food Processing
- Faculty of Sociology and Community Development
- Faculty of Arts, Humanities and Education
- Faculty of Science and Technology and
- Institute of Foreign Languages

UBB has over 2.570 local students who are currently studying in its graduate and post-graduate programs. It is expected that UBB, by participating in the ALIEN project, will be able to upgrade the international and regional recognition, capacity and skills of its lecturers and students, it will enrich educational competence and it will economically contribute towards local and regional development.

UBB promotes networks leading to better academic results and will foster international links and strengthen the skills for scientific and technical research work. To achieve the university

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'vision, UBB has to improve the quality education through strengthening STEM and Agriculture to be recognized in regional and international levels. Therefore, international cooperation, professional training courses and resources obtained from Asian and European university partners will improve the quality of education and research for UBB's students and faculty members in conformity with our university's mission and government policy.

In order to achieve its vision, the organization has to improve the educational equality and teaching pedagogy. In terms of innovative pedagogy, the university introduced AL and PBL methodologies in the university's mission, curriculum and syllabus. The organization's mission and strategies have been revised to modernize the teaching and learning environment as follows:

Mission

- To educate and train students in science, technology, arts, culture and languages at all levels through active learning pedagogies, problem based learning and digitalized technologies in accordance with the needs of the country, especially in north-western part of Cambodia
- To conduct research on social and technological issues, develop appropriate solutions and disseminate the findings to communities
- To contribute towards the national development by collaborating with local authorities, government and non-governmental organizations and consortium universities in the world

Vision

UBB is an international standard university in Cambodia by 2030.

Goal

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UBB's goal is to educate the leaders of tomorrow in a wide range of fields through a balance of theory and practice and the integration of real-world experiences into academic education.

Figure 29: UBB's strategy

PBL Lab

The university has developed and equipped a PBL lab. More equipment will be added to the lab for supporting upcoming activities. The equipment is already in use by students and lecturers to support their learning and teaching activities. Other faculties can use this PBL environment as well. The PBL lab includes:

- 6 computer desktops
- 2 laptops
- 5 Smart TV's and stands
- Router for Wi-Fi use

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- LCD projector

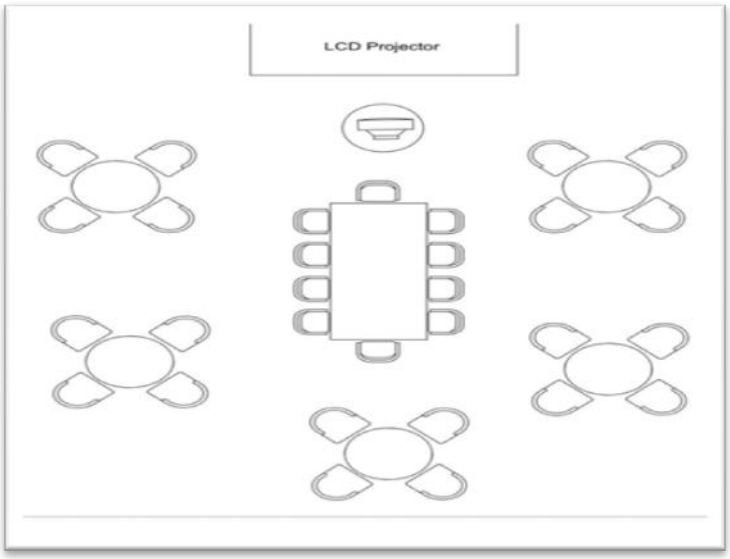

Figure 30: Blueprint of ALIEN PBL lab in UBB

Equipment

- 6 Desktop Dell Core i7 complete sets
- 1 WiFi router
- 5 Smart TV's 43'' and stands
- 2 Macbook pro 15*, 2018
- 1 EPSON projector EB-695Wi

How the equipment will be used for active/problem-based learning

The PBL lab will be used as follows:

Faculty: Science and Technology

Students: up to 150 following a bachelor's degree course in Information Technology and Civil Engineering.

Teachers: 10.

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Courses:

- English for computers
- System analysis and design
- Internet programming with PHP
- Advanced calculus
- Construction technology
- Construction organization
- Scientific writing
- Safety in construction
- Structural analysis
- E-Commerce

Figure 31: ALIEN PBL lab in UBB

Faculty support

According to the project work plan, the university organizes instructor training events. A teacher training workshop was already organized in 2019. 14 university lecturers and 145 students from the Faculty of Science and Technology were trained on AL and PBL.

Following are some of the UBB instructor training activities already implemented:

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1. UBB provided 7 training courses for lecturers to improve their teaching pedagogies in UBB
2. UBB sent 7 lecturers to attend professional development workshops related to STEM Education and Blended Learning at Phnom Penh
3. UBB invited national and international experts as guest speakers to share their knowledge with lecturers and students
4. For the next semester in October 2019, UBB will provide professional training on problem-based learning pedagogies and curriculum development and revision (introduce PBL/ Active Learning, Games and Project Based Learning).

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P12. Institute of Technology of Cambodia (ITC)

Institutional mission, vision and strategy

Institute of Technology of Cambodia is a Cambodia Higher Education founded in 1964 with the mission to provide high-quality education in the field of Science, Technology of Engineering. Education quality is always mandated in ITC development axe.

In 2014, with the aim to improve the organization's education quality and strengthen partnerships with industry ITC joined USAD's Connecting Mekong through Education and Training (USAID-COMET, 2014-2019). The main goal of this project is to minimize the skills gap provided at university and skills needed in industry by improving education quality and industry partnership. One important component of this project is the Innovative Instruction and Professional Development (PD) which aims to improve instructors teaching quality by introducing different Teaching and Learning (T&L) approach and toolkits: Work Readiness Skills, Community of Practice, Facilitation Skills, Participatory Learning, Instructional Design, Project Oriented Learning, Learner Center Assessment, Blended Learning, Finding, Evaluation and Using Online Resource. Thus, several AL methodologies were introduced. ITC instructors have been deploying these teaching and learning approaches and toolkits in classrooms since 2015. This project will finish in June 2019.

In 2018, ITC joined Erasmus+ Active Learning in Engineering Education (ALIEN, 2018-2020) to further improve the T&L approach in AL and exchange experiences with project partners. Through this project, ITC would like also to strengthen the organization's network and collaboration with universities in Europe and Asia.

In the same year, 2018, Ministry of Education, Youth and Sport (MoEYS) proposed the Higher Education Improvement Program (Phase I: 2018 – 2024. Loan of World Bank: USD 92.50 million). The project includes 4 components:

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- C1: Improving teaching and learning capacity
- C2: Improving research in STEM and agriculture
- C3: Strengthening sectoral governance and project management
- C4: Contingent emergency Response

As clearly stated in this project, the aim of MoEYS is to improve teaching and learning capacity in Cambodia's Higher Education. AL is discussed and considered as methodology to improve education quality.

In the HEIP project, ITC received USD 23 million for implementation. ITC included two sub-components in C1:

- Strengthen the teaching and learning approaches to fill the skill gap between university and industry: ITC plans to apply the USAID-COMET Professional Development Teaching and Learning approach and toolkits, including AL methodologies, in the organization's long-term plan to improve education quality
- Extending flipped and blended learning models widely at ITC: flipped and blended-learning is a form of AL and part of activities to improve teaching and learning quality

PBL Lab

Currently, ITC doesn't have a resource person specialized in PBL. The university has an expert who is specialized in different AL methodologies introduced in the project USAID-COMET PD Teaching and Learning approach and toolkits. ITC will apply these teaching and learning approaches and toolkits as AL methodologies.

Figure 32 shows pictures of the installed ALIEN PBL lab, with all the equipment bought.

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Figure 32: PBL lab in ITC

Equipment

The hardware acquired in the framework of the ALIEN project consists of 20 laptops and 2 TVs. With this equipment, the University has developed a blended learning classroom in March 2019, even though not everything has been fully deployed yet. The university plans to open this classroom for students in September 2019. The classroom will be used as PBL lab in the future and it will help ITC to acquire knowledge and build capacity in delivering PBL.

- 10 laptops Asus X507UF
- 10 laptops Asus S510UN

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- 2 LG 55UH8500 Super UHD 4k HDR SMART

How the equipment will be used for active/problem-based learning

Through USAID's Connecting Mekong through Education and Training (COMET) Project, 2014 – 2019, which ends in June 2019, ITC has applied different AL pedagogies, including: participatory learning, instructional design, project-oriented learning, learner center assessment and blended-learning. ITC plans to continue to apply these teaching & learning approach in the future through ALIEN project and Higher Education Improvement Program (HEIP) of Ministry of Education, Youth and Sport (MoEYS). ITC also wishes, through ALIEN, to build the organization's capacity to apply PBL in the future.

The equipment bought through ALIEN will be used for PBL and for blended-learning from October 2019. Following is a list of courses in which the ALIEN lab will be used in the initial phase. Subsequently, the lab will be used in additional courses.

Course	Semester	Year	Department	Lecturer
Database Analysis and Design	I	3	GIC	Mrs. Chhou Vanna
Introduction to Computer Systems and Network	I	3	GIC	Mr. Hean Samboeun
Automata Theory	II	3	GIC	Mr. Valy Dona
Integrated Water Resource Management	II	3	GRU	Ms. Hang Leakhena
Advanced Computer Architecture	II	4	GIC	Mr. Chun Thavorac
Introduction to Computer Science	II	1	TC	Mr. LAY Heng, Dr. Chhun Sophea
Electrical Power Plant Engineering	I & II	3	GEE	Mr. Duch polak

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Theory of Information	II	3	GIC	Mr. Kong Phut Phalla
General Microbiology	II	3	GCA	Dr. Tan Reasmey
Material Operation	II	4	GIM	Mr. Seng Piseth
Software Engineering	I	4	GIC	Mr. Tal Tongsreng
Environmental Geology	I	5	GGG	Dr. Pich Bunchoeun
Food Microbiology	I	4	GCA	Dr. Mith Hasika
Image Processing	I	5	GIC	Mr. Kong Phut Phalla
Geographic Information System and Remote Sensing	I	4	GRU	Dr. Ly Sarann
Experiment of sand and gravel	II	3	GCI	Mr. Han Virak
Topographic Surveying	II	4	GRU	Dr. Ly Sarann
Internal Combustion Engine Theory	I	5	GIM	Dr. Rey Sopheak
Soil Mechanics	II	3	GGG	Dr. Por Sopheap
The Plumbing	II	4	GRU	Dr. Doung Ratha
Environmental Science	I	1	TC	Ms. Phoeurn ChanArun, Ms. Hang leakhena
Food Biotechnology	II	4	GCA	Dr. TAN Reasmey
Geodesy and Topography	I	3	GGG	Mr. KAING Sainglong
Compilation	II	4	GIC	Mr. NOU Sotheany

Table 10: List of the courses being operated at ITC using blended-learning

Faculty support

ITC plans to apply the USAID-COMET Professional Development (PD) Teaching and Learning approach and toolkits, including AL methodologies, to improve educational quality. Following is the organization's annual activities plan:

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1. Training on teaching and learning approaches and toolkits: ITC will invite 3-5 faculty staff in each of its 7 departments to join the training. Two workshops will be organized:
    - Workshop level 1, semester 1
    - Workshop level 2, semester 2
2. Implementation of the teaching and learning approaches at ITC: faculty staff members who received the training will implement the methods and toolkits in their classrooms in the following activities:
    - Lesson planning
    - Open classroom
    - Classroom observation

Since 2012, ITC has adopted flipped classroom and blended learning methodologies. Figure 33 shows the implementation and progress of blended-learning.

Figure 33: Blended-learning Content Operation since 2012

To promote innovative teaching and learning approaches, ITC will build a key resource person in the context of the USAID-COMET project. The key resource person will provide the training to instructors and coach them during implementation of the approaches in the classroom. During implementation, ITC will organize a few coaching and sharing sessions per semester through:

- Lesson planning

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- Open classroom
- Classroom observation

Scenario of ALIEN AL/PBL lab use in a course

Course title: System and Network Administration

Engineering curriculum where it belongs

Network Security.

Course description

The purpose of the course is to build student experience on strategies for managing networks. The overall objectives include understanding computer network management, network security and other important components of networks as well as developing effective solutions to solve network problems.

Number of students to be engaged

23 students will be engaged in semester 2, 2019/2020.

PBL activities that will be integrated in the course

The objective of the activities is to understand and be able to manage computer network security. Following is a description:

- The teacher introduces students to the problem and asks some questions to raise awareness on the challenge to be addressed
- The teacher provides all necessary resources for students to research and learn, such as operating systems, software, internet connection and eBooks
- The teacher goes around the class while the students collaboratively research the solution to make sure each student is on the track
- Students may raise questions, and the teacher explains the answer to the entire class

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- The teacher checks the results of student work and evaluates whether students have reached the expected outcome or not. The teacher may encourage students that do not reach the desirable solution to repeat the exercise
- At the end of each class, the teacher summarizes tasks and wraps up objectives

Equipment, software and educational material to be used

Equipment

- Projector / TV
- Laptop computers

Software

- Web browser
- Office document reader
- Virtualization software
- Network software
- Server and client operating systems

Educational material (books, scenarios, etc. and sources)

- eBook and lecture notes on computer network security, internet connection

How the ALIEN equipment will be used

TV

The instructor will use the Smart TV to demonstrate a problem on network security at the beginning of each session. After working with the problem, students will share their results and solutions with their classmates. The comments and feedback on the solutions will be shown and synchronized on the TV.

Laptop

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Students will use the laptops to do research online in relation to computer networking and security concepts. As a second step, students will setup the virtualization software. Inside the software, the students will create a virtual server and virtual clients, that combined with constitute a virtual local area network. The virtualization software is very important for this course since the lecturer can use it to setup the problem or project on behalf of the students, while students can use the software to safely experiment in a virtual environment towards solving the problem by creating virtual machines without affecting actual computer hardware.

Course title: Cloud Computing

Engineering curriculum where it belongs

Computer Science.

Course description

The purpose of this lesson is to build student knowledge on cloud computing and big data. Through the course students will understand why cloud computing is beneficial in offering data management. They will also understand cloud management technologies and build knowledge on cloud infrastructure development strategies.

Number of students to be engaged

36 students will be engaged in semester 1, 2019/2020.

PBL activities that will be integrated in the course

The objective of the activities is to understand and be able to build cloud infrastructure as a service (IAAS). The methodology used by the teacher is similar to that described above for the computer security course, namely the instructor introduces the problem to the students and initiates a discussion for understanding its parameters, provides the necessary

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environment for research, is available for answering questions, evaluates student answers, and summarizes the session objectives upon completion.

Equipment, software and educational material to be used

Equipment

- Projector / TV
- Laptop computers

Software

- Web browser
- Office document reader
- Virtualization software
- Cloud IAAS software
- Server and client operating systems

Educational material (books, scenarios, etc. and sources)

- eBook and lecture notes on cloud computing, internet connection

How the ALIEN equipment will be used

TV

The instructor will use the TV to demonstrate technologies and implementation of cloud computing and big data. Through the TV, the instructor will present challenges in cloud computing and strategic solutions.

Laptop

Students will use the laptops to do research online on cloud computing, and particularly on cloud infrastructure as a service (IAAS). Subsequently, students will setup the virtualization software. Through the visualization software students will create 4 types of virtual servers,

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including control, computing, storage and network, as well as virtual clients. The combination of these will constitute a virtual cloud service. The virtualization software is very important for this course as it allows the instructor to setup the activity on behalf of the students while it also allows students to experiment in a virtual environment with cloud computing concepts.

Course title: Natural Language Processing (NLP)

Engineering curriculum where it belongs

Computer Science.

Course description

This course builds student knowledge on the concepts and techniques used in NLP. It is a bridge course that prepares students for pursuing a Master's degree.

Number of students to be engaged

34 students will be engaged in semester 1, 2019-2020.

PBL activities that will be integrated in the course

Lab activities will encourage students to apply concepts and knowledge that are taught in class to a real-world problem using the Python programming language and the Natural Language Processing Toolkit (NLTK). At the start of each session, students will be divided into working groups. Each group will consist of 3 members. Members in each group will be working together throughout the semester on lab exercises. The lecturer will explain problem-based exercises to students and let students ask questions. Group members will be assigned exercises. The lecturer will be available during lab sessions to support student efforts. Team members will collaborate, sharing ideas towards potential solutions. At the end of the class, students will submit their work for evaluation.

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Equipment, software and educational material to be used

Equipment

- Projector / TV
- Personal computers
- Lab computers
- Slider pointer

Software

- PyCharm IDE
- Python and NLTK library

Educational material (books, scenarios, etc. and sources)

- Lecture notes on Natural Language Processing

Following is a description of how the ALIEN equipment will be used.

TV

The instructor will use the TV to demonstrate basic knowledge and concepts of how to implement NLP.

Laptop

Students will use the laptops to program the solution to specific NLP activities.

Course title: Algorithm and Programming

Engineering curriculum where it belongs

Software Engineering, Computer Science.

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Course description

This course builds student skills on effective programming. This is achieved by encouraging students to build programs for specific algorithms. The activities include a range of programming elements, from basic to advanced. Examples of programming concepts covered include variables, constants, operators, decision making, loop, data structures (structures, linked lists, stacks, queues and trees), file IO and some introduction to object-oriented programming including classes and objects, access modifiers, overloading and overriding functions and inheritance. The introduction of students to object-oriented programming enables them to perform better to subsequent programming courses.

Number of students to be engaged

50 students will be engaged in semesters 1 and2, 2019-2020.

PBL activities that will be integrated in the course

The objective of the activities is to understand concepts and methods related to designing and programming algorithms. Students build programming skills through actual coding activities that take place in the lab using the C and C++ programming languages. At the start of each session, students will be divided into working groups. Each group will consist of 3 or 4 members. Members in each group will be working together throughout the semester in lab activities. The lab learning methodology will be similar to that described above for the cloud computing course, namely the lecturer will explain the challenge at hand and encourage questions for fostering understanding of the problem parameters, students will work in groups with each team member being assigned specific sub tasks, students will present their solutions to class and will submit them for evaluation at the end of the session.

Equipment, software and educational material to be used

Equipment

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- Projector / TV
- Personal computers
- Lab computers
- Slider pointer

Software

- Code Block IDE

Educational material (books, scenarios, etc. and sources)

- Lecture notes on algorithm and programming

How the ALIEN equipment will be used

TV

The instructor will deliver a lecture on basic concepts related to algorithm design and programming. Subsequently, the instructor will demonstrate how the algorithm may be implemented in a computer programming language using C or C++. The instructor will assign problems or programming exercise to students, who will program a solution and present it to their peers.

Laptop

Student will use the laptops to programming and testing solutions to given problems and for demonstrating their work to peers.

Course title: Image Processing

Engineering curriculum where it belongs

Computer Science.

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Course description

The course focuses on basic concepts related to image structure, image conversion and image analysis.

Number of students to be engaged

41 students will be engaged in semester 1, 2019/2020.

PBL activities that will be integrated in the course

Exercises will focus on specific image processing activities, such as converting a color image to grayscale. At the start of each session, the instructor will deliver a lecture that will be following by an on-line video. The instructor will divide students in groups of 5 and assign the same image processing exercise to each group. The instructor will allow time for experimentation, during which students will explore different methods for converting the image. Students will then present their results, will compare their outcomes with those of other image processing methods and will discuss pros and cons.

Equipment, software and educational material to be used

Equipment

- Projector / TV
- Computers

Software

- C++ IDE
- OpenCV library

Educational material (books, scenarios, etc. and sources)

- Lecture notes on image processing top

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How the ALIEN equipment will be used

TV

The instructor will use the TV to demonstrate the concepts of image structure, image conversion and image analysis. Students will use the TV to share and compare results and to facilitate class discussion.

Laptop

Students will use the laptops to access online learning material that they will apply for implementing image conversion.

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P13. Mean Chey University (MCU)

Institutional mission, vision and strategy

Mean Chey University is established in accordance with the wise leadership of the Royal Government of Cambodia and the initiative of M.C.U founders H.E. Ke Kim Yan and his wife, Lok Chom Teav Okgna Mao Malai and with the contribution from local authorities and local and over-sea charities. H.E Sor Kheng Deputy Prime Minister, Minister of Interior opened its first academic year on 17 March 2008, presided.

Formal inauguration took placed on 4 April 2008 under the presidency of Samdech Akka Moha Sena Padei Techo Hun Sen, Prime Minister of Cambodia and Lok Chumteav Kittiprittbandit Bun Rany Hun Sen.

Mean Chey University has five faculties such:

1. Faculty of Arts, Humanities and Languages
2. Faculty of Science and Technology
3. Faculty of Sociology and Community Development
4. Faculty of Business Management and Tourism
5. Faculty of Agriculture and Food Processing

AL or student-centered approaches to instruction have been increasingly promoted worldwide by national governments as well as international organizations. The range of support for AL pedagogies is much greater today than it was quality of education in developing countries initiatives were initially introduced.

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AL encourages students to take interest in their study by action, solve problems, use PBL labs and participate in group discussion. In order to encourage the use of PBL digital labs, instructors must prepare related documents for teaching and learning.

Objectives of MCU

The objectives are the following:

- Turning a bloody battle field into a quality human resources training center
- Giving opportunities to students in the north-west part of Cambodia to undergo higher education, without leaving their villages and spending much money on travelling, food and accommodation
- Contributing to the national poverty reduction of the people, complying with the dimension in the rectangular strategies of the Royal Government of Cambodia

From the date of commencement, MCU has always enjoyed the attention of the head of the government, the Ministry of Education, Youth and Sport, local authorities, people and other stakeholders.

Strategic Plan

Vision

MCU aims to provide academic and professional opportunities in digital education, research and innovation responsive to the needs of a rapidly changing world, elevating the national and global digital economy.

Mission

The organization’s mission is:

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- To provide increased access to basic education for all (EFA) including formal and non-formal using ICT for learning and teaching 2004
- To improve the quality of learning by implementing PBL
- To develop a research environment that equips learners and staff with opportunities to pursue their professional and academic goals in the digital era

PBL Lab

A PBL lab has been installed in a dedicated room. It includes the following equipment:

- Computer Desktops 5 sets
- Laptops 2sets
- Smart TV and stand 5 sets
- Router Wi-Fi use in PBL lap.
- LCD Projector 1 set

Figure 34: Student photos using the existing lab in MCU

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Figure 35: ALIEN project activities in MCU

Equipment

- 6 Desktop Dell Core i7 complete sets
- 1 WiFi router
- 5 Smart TV's 43'' and stands
- 2 Macbook pro 15*, 2018
- 1 EPSON projector EB-695Wi

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Faculty support

Faculty support aims at building instructor skills. Faculty is committed to promote the use of AL among the college's teachers, who are requirement to use the method for 2 hours a week. Teacher training aims to increase the use of the PBL lab in practice and build applied skills and knowledge. The goal is to enrich the skills of the existing faculty of 8 and build faculty knowledge and skills on using new technologies. The deployment of AL and PBL is expected to raise student enrolment in engineering education.

Another objective is to develop a curriculum that responds to the needs of students in the digital era. The organization aims to promote the role and function of AL as a teaching and learning tool in different subjects and as a subject in itself.

The organization aims to promote access to information on the Internet and increased communication via email between colleges and individuals, which can play an important role in the professional development of educators. In addition to radio and television as a teaching and learning tool this policy stresses the benefits of using computers for accessing information, knowledge, skills and communication. In February 2019 the faculty conducted a presentation to 20/13 IT students on active learning concepts. Another presentation on how to write code and robot software was delivered by Bacamb on 24 May, 2019.

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P14. Institute of Engineering, Tribhuvan University (IOE/TU)

Institutional mission, vision and strategy

The Institute of Engineering, Tribhuvan University is the largest public engineering institution in Nepal which provides engineering education across the country with degrees offered in the diversified field of engineering disciplines. It offers 11 undergraduate, 27 graduate and PhD degrees with annual intake capacity of over 4,600 students in 14 different constituent campuses and affiliated colleges. Though the term “active learning” is not used in the official documentation of the institution, approaches similar to AL such as PBL or project-based learning are already in practice. Problem and project-based learning is part of all the degree programs as last semester of bachelor and last year of master’s programs are based on the required thesis research. In case of PhD degrees, dissertation research works start from the second year. Besides, project and problem-based case studies are part of the all Bachelor and Master programs. Furthermore, 2-6 months internships are part of selected Bachelor programs, such as Mechanical and Architecture programs. PBL is also applied through Robotics Clubs of the IOE/TU, which engage students from different departments to design, develop and participate in the theme oriented ROBOCON international and national competitions with outstanding performances as evidenced by prizes received. Besides, an Innovation and Incubation Center has been recently established to facilitate the incubation of the innovative ideas developed during the thesis and dissertation research phases.

These are also reflected in vision, mission and objective statements of IOE/TU documents as following:

IOE/TU Vision

IOE aims to act as a center of excellence of engineering knowledge in national and regional level.

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IOE/TU Mission

To offer quality engineering education and conduct research in the frontier engineering areas relevant primarily to the national priorities.

IOE/TU objectives

The objective of the organization are to:

- Obtain excellence through engineering academic programs, research and training
- Create an academic niche in South Asia
- Become established as an icon to contribute national development process of Nepal through program innovation and quality education
- Perform research and development so as to strengthen national engineering capabilities and development issues
- Offer academic and professional training, sponsored professional courses, problem-based research, engineering consultancy services and more

IOE/TU strategy

In order to improve the effectiveness of the engineering education offered under IOE/TU, the following strategies has been envisioned:

- Finalize the establishment of a Centralized Visualization System (CVS) lab based on PBL setup and to develop an implementation guideline for the effective use of the lab in different courses offered by different departments of IOE/TU
- Pilot test the use of the CVS lab in existing courses and evaluate feedback
- Integrate CVS lab use in existing or new courses in the Bachelor and Master programs
- Conduct capacity building activities for faculty and staff towards using the lab

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PBL Lab

Features:

- The administrator can decide whether to display a single video source or all the video sources to the Central Visualization System
- The media server and central visualization system is connected and the video sources are chosen using the IP addresses of the machine
- The administrator has full privileges to customize the display themes, size of the display and settings
- Supported video sources include VGA, DVI, HDMI, SDI, BNC, S-video, Composite Video, TV Tuner and IP camera
- The lab supports network streamed video sources
- The lab supports audio
- The lab offers complete control of the entire display through a controller application running on a multi touch tablet or iPad
- The lab offers capabilities for review and control of video sources, including resizing, movement, transparency, refreshing

Figure 36: Installation and commissioning testing of Centralized Visualization System

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Equipment

A Central Visualization System will be developed. It will be based on the PBL learning approach and will consist of the following:

Video sources

This includes all the Input Video Sources that a user may want to display to the Central Visualization System. A video source refers to any video data fed to the system, be it a PC output, DVD player output, camera output or TV input

Central Visualization System

This system will be used to view all the input video sources. This could be a single desktop monitor, a dual monitor computer display, a video wall of various display cubes or a large seamless, multichannel edge blended projection wall. The display surface could be curved or flat.

Media server

Media server is the system that controls and manages all video sources. This includes tasks such as dynamically identifying video sources to be displayed on the Central Visualization System where they will be displayed and defining their sizes.

Controller application

This application will run on a simple PC, laptop, iPad or multi touch table. The controller application will be user friendly and allow easy management of video sources by the administrator.

Figure 37 below demonstrated the suggested architecture:

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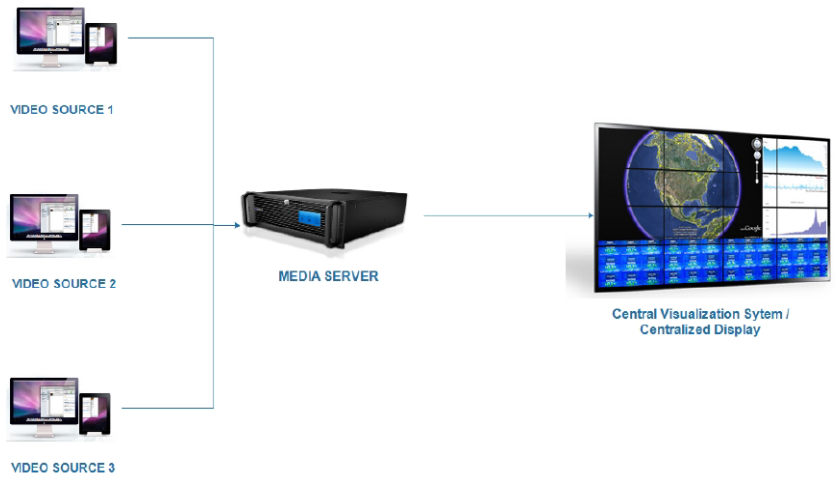

Figure 37: Centralize Visualization System

How the equipment will be used for active/problem-based learning

Implementation

Though there is no dedicated PBL laboratory established at IOE/TU, some courses offered by Department of Electronics and Communication use PBL approaches in limited subjects. There is large potential for using PBL in other engineering discipline, provided that a dedicated specialized laboratory is available. PBL can be integrated effectively in courses related to multi-criteria design analysis, operation research and management science, dynamic and complex problem simulation and solving and others. It will ultimately contribute to improved effectiveness of the courses delivered.

Scenario of ALIEN AL/PBL lab use in a course

Course title: Operation Research and Management Science

Engineering curriculum where it belongs:

The course is a 1th year elective in the curriculum of the MSc. Engineering in Energy Systems Planning and Management (MSESPM) of the Department of Mechanical Engineering.

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Course description

Operations Research/Management Science (OR/MS) is the use of mathematical models and quantitative approaches for decision-making. It originated some 70 years ago in military applications in the 2nd Great World War. OR/MS is now being profusely used in managerial decision-making especially with the widespread application of personal computing in business, industrial and household sectors since the 1990s. This course aims to introduce concepts and application of OR/MS for engineer-managers with the help of spreadsheet software such as Microsoft EXCEL and its add-in software like SOLVER, CRYSTAL BALL and more. The course also deals with solving problems under real world conditions involving multi-stakeholders' involvement, multi-criteria solutions and more. It is application-oriented, rather than lecture-based solving with mathematical models.

Number of students to be engaged

60 students from 3 Master programs are typically enrolled in the course each year.

PBL activities that will be integrated in the course

The students will be asked to solve multi-criteria decision-making problem under different scenarios as following:

- Use equal weights for each criterion
- Use different weights as per the importance to different criteria without consulting other groups
- Use different weight average as per the importance to different criteria with consulting other groups
- Present results to their peers
- Explain the importance of multi stakeholder's participation in the decision making process

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Equipment, software and educational material to be deployed

Hardware

- 3 workstations
- Internet connectivity
- 4 display screens

Software

- MS Excel with solver add-in software like SOLVER, CRYSTAL BALL and more.

Educational material (books, scenarios, etc. and sources)

- Wayne Winston and S. Christian Albright, "Practical Management Science: Spreadsheet modeling and applications", Thompson Learning, 2009
- Winston, Wayne L., "Operations Research: Applications and Algorithms", International Thompson Publishing, 1994
- Camm, Jeffrey D. and James R. Evans, "Management Science & Decision Technology", South – Western College Publishing, A Division of Thompson Learning, USA, 2000
- Hillier, Frederick S., Mark S. Hillier and Gerald J. Lieberman, "Introduction to Management Science: A Modeling and Case Studies Approach with Spreadsheets", McGraw-Hill International Editions, 2000
- Evans, James R. and David L. Olson, "Introduction to Simulation and Risk Analysis", Prentice Hall, Upper Saddle River, New Jersey 07458, 1998

How the ALIEN equipment will be used

Students will be working in teams of 4-6 individuals on designing and implementing solutions to multi-criteria decision making problems. They will allocate weights to the criteria based on varying conditions representing different stakeholders. They will be asked

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to make a decision working as independent teams in two scenarios: in the first they will not be allowed to consult with other teams; in the second they will be allowed. Students will use the PBL lab installed at the Center for Energy Studies, IOE, TU.

Students will also be exposed to concepts related to the judgment method, game theory, goal programming, multi-objective programming, genetic algorithms and more.

Course title: Image Processing

Engineering curriculum where it belongs

The course is a 2nd Semester elective course offered in the MSc in Computer System and Knowledge Engineering program of the Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University.

Course description

The objective of this course is to provide the knowledge of image processing and pattern recognition and apply the concept in research applications. The course aims to:

- Develop a theoretical foundation of fundamental digital image processing concepts
- Provide mathematical foundations for digital manipulation of images, image acquisition, preprocessing, segmentation, Fourier domain processing and compression
- Gain experience and practical techniques to develop programs for the digital manipulation of images, image acquisition, preprocessing, segmentation Fourier domain processing and compression

Number of students to be engaged

20 students are typically enrolled in the course each year.

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PBL activities that will be integrated in the course

The instructor will divide students in five groups, each consisting of 4 students. The instructor will assign one common problem inspired by current research on image processing or real-life problems to all groups. An example of a problem statement is the following: “applicants’ photos are being manually rejected in the entrance examination. Design a solution for solving this problem autonomously using image processing and pattern recognition”. Each student in a group will search the Internet using lab equipment and present ideas to peers. The instructor will select the best idea based on the presentations. Then, the instructor will ask students to write a research paper based on the best idea. One student will write the introduction part, one will write the methodology part, one will write the results and discussion part and one will write the abstract and conclusion part. This process will lead to the design of a first draft of a research paper.

Equipment, software and educational material to be deployed

Hardware

- Workstations with centralized display
- Internet connectivity
- Projection hardware required to display each screen

Software

- The built-in software with hardware required for projections
- MATLAB

Educational material (books, scenarios, etc. and sources)

- Related research articles, available on the internet
- Fundamentals of Image Processing using MATLAB, available on the internet
- Related Books on Image Processing and Pattern Recognition, available in the library

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The ALIEN equipment will be used

Students will be working in groups of 4 individuals towards introducing solutions to a given image processing problem. In the beginning of the course students will use the workstations and lab connectivity to research the related scientific articles. The students will further download tutorials and articles over the internet and use them in synthesizing solutions to a given problem. Subsequently, the students will use the MATLAB software that will be available on the lab workstations to develop the software code for a solution of their choice. Each student will present their idea on the main display screen available in the lab. The best idea will be selected by the subject teacher. Finally, one group of 4 students will write a research article based on the best idea and present it to the rest of the class on the main display screen.

Course title: Knowledge Engineering

Engineering curriculum where it belongs

The course is a 1st semester introductory core course offered in the MSc in Computer System and Knowledge Engineering program of the Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University.

Course description

The objectives of this course are:

- To familiarize students with basic concepts of knowledge engineering
- To teach the basics of knowledge acquisition methods, IR, NLP and machine learning techniques
- To teach concepts related to knowledge representation, logic and reasoning
- To introduce students to the semantic web and ontology engineering

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Number of students to be engaged

20 students are typically enrolled in the course each year.

PBL activities that will be integrated in the course

The instructor will divide students in five groups, each consisting of 4 students. Each group of students will be assigned a mini-project in which they will perform a case study and develop a simple knowledge-based system that would be useful for the institute. As an example, a sample mini-project may be to develop a system for performance analysis of students in semester exams and correlating this to the entrance exam score and high school score of the students.

Each group of students will collect and review material from the web through the campus intranet. Students will hold meetings and interact with experts and contact persons in the concerned knowledge domain. Through the internet research and the meetings with experts students will collect information of interest. They will further explore existing solutions from the web. Based on the results of their research students will propose a knowledge-based system for the project. Students will deliver group presentations and receive feedback by other groups, the instructor and the domain expert. Based on this feedback, each group will develop a solution prototype and will present it to all other groups, the instructor and the domain expert.

Equipment, software and educational material to be deployed

Hardware

- Workstations with centralized display
- Internet connectivity
- Projection hardware required to display each screen

Software

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- The built-in software with hardware required for projections
- Microsoft PowerPoint
- Software development environment and database/knowledge-based platforms required by each group

Educational material (books, scenarios, etc. and sources)

- Material and datasets related to the mini-project domain
- Fundamentals of knowledge engineering, available on the internet
- Related Books on knowledge engineering and AI, available in the library

The ALIEN equipment will be used

Students will work in groups of 4 individuals towards exploring the domain and applicable solutions for the assigned mini-project. In the beginning of the course the students will use the workstations and lab connectivity to explore material on the selected domain and collect required data and documents. The students will download tutorials and articles over the internet and propose a feasible solution for the problem assigned. Subsequently, the students will setup the required development environments on the lab workstations to develop the knowledge-based software solution. Students will present their solutions in at least two rounds. The first presentation will take place at design time and will aim to generate feedback from the domain expert, other groups and the instructor. The second presentation will focus on the final prototype developed by the group and will take place at the end of the activity. The groups will be evaluated based on these presentations.

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P15. Kathmandu University (KU)

Institutional mission, vision and strategy

Vision

KU's mission is to become a world class university devoted to bringing knowledge and technology to the service of mankind.

Mission

KU aims to provide quality education for leadership.

Institution initiatives towards AL

- KU has implemented the concept of community-based Learning in association with Himal Partner for Second Year Engineering Student
- The organization has implemented the Combined Engineering Project (COMP 302) under the Supervision of Mr. Dhiraj Shrestha. The project involved using the Engaged Learning method 3rd year students of Computer Engineering in collaboration with UNAPCICT
- Professor Dr. James M. Widmann from California Polytechnic State University and Fulbright Scholar in association with Mr. Binay KC offered the Strength of Materials course at the Department of Mechanical Engineering to 2nd year undergraduate AL in the fall semester of 2012
- The School of Medical Science has been using AL as a mode of teaching and learning in their curriculum since 2011

Strategy for implementation

The strategy of implementing AL involves the following principles:

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- Use the test results of previous work to demonstrate the effectiveness of AL
- Establish a PBL lab for deploying AL
- Pilot AL in some subjects for creating a foundation for establishing AL as the main organizational learning methodology of the institution

PBL Lab

AL using PBL will be implemented starting in September 2019. Following is a demonstration of the lab installation (see Figure 38).

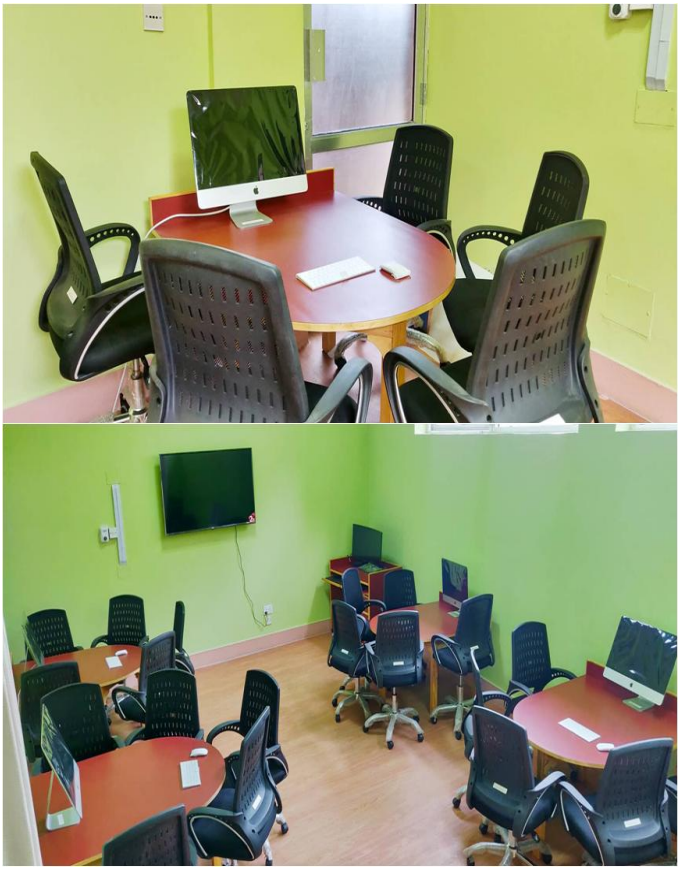

Figure 38: The PBL lab in KU

Equipment

The lab includes the following equipment:

- 1 all in One PC - HP EliteOne 1000 GZ

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- 1 workstation - HP Z4 Gr with 27'' Monitor
- 1 Optoma W341 Multimedia Projector with WI-FI
- 1 LG UK6320 55'' Smart TV
- 4 Mac All in One PC

How the equipment will be used for active/problem-based learning

Following are examples of courses in which AL and PBL will offer benefits:

Undergraduate courses

- Computer graphics
- System analysis and design
- Computer programming
- Software dependability
- Embedded systems
- Algorithms and complexity

Graduate courses

- Emerging technology
- Data mining

Kathmandu University has purchased the equipment in three batches.

1st batch

The 1st batch of equipment was bought depending upon the results of needs analysis performed by faculty members involved in the project. Apple products were brought in this batch as Apple vendors are different from others.

2nd batch

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The 2nd batch of equipment was bought based on the results of needs analysis performed by the faculty members involved in the project interested to deliver their subjects in PBL mode. All products were other than Apple.

3rd batch

A 3rd batch of items was bought based on the requirements set by new subjects integrated into the ALIEN PBL learning intervention.

Faculty support

The following initiatives were introduced to support PBL:

- An AL faculty group was established. 4 faculties currently deliver learning activities in the AL lab
- Faculty workshops for the Department of Computer Science and Engineering have been organized, highlighting the importance of AL and presenting test cases. The workshops took place in September and October 2019
- PBL lab members support other faculties for the proper utilization of resources
- A National Workshop is being organized in collaboration with IOE for disseminating the organization's experiences to other universities of Nepal

Scenario of ALIEN AL/PBL lab use in a course

Course title: Computer Graphics (Comp 342)

Engineering curriculum where it belongs

This is 3rd year undergraduate course offered to students of Bachelor of Computer Engineering and Computer Science.

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Course description

The course covers the basic concepts, mathematical foundations, fundamental theory and algorithms, software techniques, hardware and system issues and application examples on computer graphics.

Number of students to be engaged

60.

PBL activities that will be integrated in the course

Students will be developing mini-projects in groups of 3-4. Students will select the topics that whey will work on. The selected projects must include concepts from computer graphics.

Equipment, software and educational material to be used

Equipment

- Multimedia projector
- Smart TV
- 6 workstations and 2 laptops

Software

- C / C++, Python compiler
- OpenGL

Educational material (books, scenarios, etc. and sources)

- Computer graphics by Donald Hearn and M. Pauline Baker
- Computer graphics: Principles and Practices by James Foley, S.K Feiner and J.F Hughes
- OpenGL tutorials available on Internet

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How the ALIEN equipment will be used

Multimedia projector, Smart TV

The projector and Smart TV will be used by students for discussion and conducting brainstorming sessions among team members. The equipment will also be used by students for the presentation of their project progress and final work.

6 workstations and 2 laptops

The 6 workstations will be used by students working in groups for collaboration on their project work and for programming.

The laptops will be used by students for the presentation of their work.

C / C++, Python compiler, OpenGL

This open source software will be used for the development of student mini-projects.

Course title: Operating System (Comp 307)

Engineering curriculum where it belongs

This is a 3rd year undergraduate course offered to students enrolled in the Bachelor of Computer Engineering, Computer Science and Computational Mathematics programs.

Course description

The course objectives are to build knowledge on:

- Fundamentals of operating systems
- The mechanisms of operating systems on handling processes, threads and communication
- The mechanisms involved in memory management in contemporary operating systems

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- Distributed operating system concepts including architecture, mutual exclusion algorithms, deadlock detection algorithms and agreement protocols
- Components and aspects of concurrency management
- Programming simple operating system mechanisms

Number of students to be engaged

75.

PBL activities that will be integrated in the course

Students will be given a problem based on the concepts of operating systems and be asked to solve it in groups through simulations. Simulations will be implemented using the C/C++, Python or Java programming languages.

Equipment, software and educational material to be used

Equipment

- Multimedia projector
- Smart TV
- 6 workstations and 2 laptops

Software

- C / C++, Python compiler

Educational material (books, scenarios, etc. and sources)

- Andrew Tanenbaum, “Modern Operating Systems”, 3rd edition, Pearson/Prentice Hall, 2008
- Avi Silberschatz, Peter Baer Galvin, Greg Gagne, Operating System Concepts, 9th Edition, John wiley & Sons, Inc.

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How the ALIEN equipment will be used

Multimedia projector, Smart TV

The projector and Smart TV will be used by students for discussion and conducting brainstorming sessions among team members. The equipment will also be used by students for the presentation of their project progress and final work.

6 workstations and 2 laptops

The 6 workstations will be used by students working in groups for collaboration on their project work and for programming.

The laptops will be used by students for the presentation of their work.

C / C++, Python, Java Compiler

This open source software will be used for programming simulations.

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P16. National University of Computer and Emerging Sciences (NUCES)

Institutional mission, vision and strategy

Founded as a Federally Chartered University in July 2000, the National University of Computer and Emerging Sciences is a premiere University of Pakistan, renowned for quality and impact of its students in the development of local software and other industries. The university has five modern campuses at Karachi, Lahore, Islamabad, Peshawar and Chiniot-Faisalabad. These campuses provide world class educational environment and recreational facilities to about over 11,000 students, around one quarter are female and over 500 skilled faculty members.

In line with the thrust of faith and the glory of Pakistan's national heritage, the organization shall try its best to play an effective and meaningful role in creating a knowledge-based society in Pakistan. This avenue would naturally and seamlessly lead to a civil society with knowledge driven economy.

In furtherance of these general objectives, we shall focus upon acquisition and propagation of cutting-edge science and technologies. Recognizing the fact that Information Technology is having a profound impact upon almost every aspect of human activity and changing the shape of the nation's future. The organization shall retain its focus, for the time being, on producing graduates in Computer Science, Engineering, Business Management and Basic Sciences as well as managers of the highest order who may act as vanguard of the IT Revolution in Pakistan.

The highly qualified, deeply committed and professionally inspired faculty gives to the university an academic character. Faculty not only excels in their teaching abilities but also keep themselves abreast of the latest trends and developments in science and technology. They are also accomplished researchers, contributors and developers in their respective

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areas of interest. Research projects are carried out at the Campus range from Bio-Informatics, Agro-Informatics, Machine Intelligence and Neural Networks to IT consulting. The Islamabad Campus is steadily expanding both in terms of its area and study programs.

Department of Computer Science Mission statement

To provide students of Computer Science with sound technical knowledge and practical skills of relevance to the contemporary industry, together with the spirit of teamwork, ability to communicate effectively and inculcating professional ethics leading to a successful career with lifelong learning.

Learning outcomes of Department of Computer Science

Upon completing a Computer Science degree students will:

- Possess advanced knowledge of Computer Science field
- Be able to think creatively and critically; to solve non-trivial problems
- Be able to use computing knowledge to develop efficient solutions for real life problems
- Be able to design solutions and can conduct research related activities and development

Masters of Science (Computer Science) mission statement

The MS in Computer Science program comprises of both course work as well as a research component. The curriculum includes 4 ‘core courses’ aimed at strengthening the understanding and competence of students in computer science fundamentals. The university expects its MS graduates to pursue careers either as ‘Computer Science Faculty Members’ or as ‘Software Development Managers’ in the industry. The faculty has recently introduced MS Data Science, MS Cyber Security and MS Software Engineering programs.

Bachelor of Science in Computer Science mission statement

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The program mission is to:

- Impart in-depth understanding of Computer Science field according to international standards
- Convert understanding to innovation
- Build diverse careers in Computer Science as productive IT professionals and entrepreneurs for the socio-economic development
- Prepare students for the graduate level studies and research
- Develop effective communication, management and leadership skills
- Impart professional ethics and collaborative team player abilities.

Bachelor of Science in Computer Science objectives

The objectives of the program are to:

- Provide graduates with a thorough understanding of the key principles and practices of computing
- Provide graduates with firm foundations in the scientific, mathematical and engineering principles that support the computing disciplines
- Develop intellectual curiosity, mature judgment and a commitment to the betterment of society in students
- Prepare students to contribute to the computing profession

PBL Lab

A dedicated classroom/lab has been allocated for the project. Since, the equipment has been purchased. The furniture is designed in order to accommodate the purchased equipment and is currently being procured. Meanwhile, the VR equipment is being installed in the Software Engineering and Automation Lab (SEAL) headed by the Co PI of this project where two research associates are exploring the use this equipment in multiple projects. As

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soon as the lab will be ready for use, an initial hands-on training on PBL will be imparted to the faculty members of CS dept.

As soon as the furniture is in place the equipment will be installed in the lab along with the ALIEN platform. Hands-on training on the ALIEN platform and the equipment purchased will be conducted with the faculty members of CS and EE department. Then the lab will be used to conduct training of faculty members from other universities interested to use AL as a part of their study manifesto. At the same time, the faculty plans to practically use the lab in upcoming courses. Following is an demonstration of the lab configuration (see Figure 39).

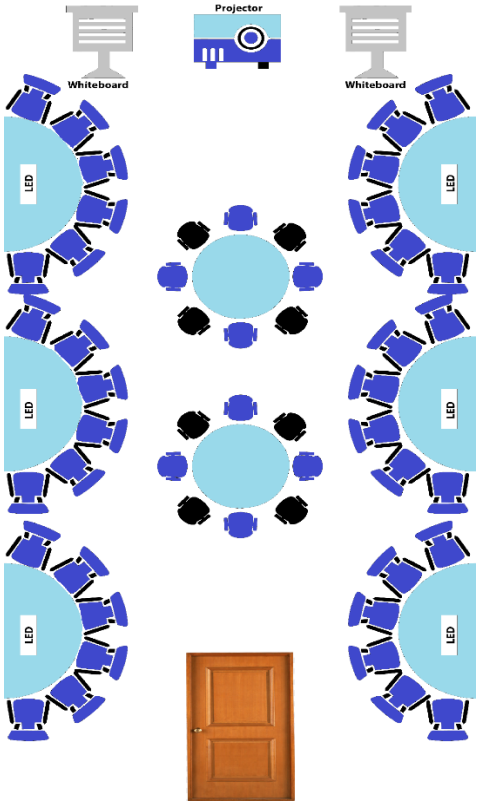

Figure 39: Blueprint of the design of ALIEN PBL lab in NUCES

Equipment

- 2 Oculus Rift + Touch Virtual Reality System Oculus

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- 2 LEAP Motion VR development bundle
- 11 Windows 10 professional
- 3 PCs for development, Ci7 8700, ASUS ROG Motherboard 8360, 1 32GB DDR4 RAM, 2 TB SATA HDD, 500GB SSD, GeFORCE GTX1080 8GB, DVD RW, Corsair Casing, Corsair 750W Supply, HP27F 27" LED Display, 2.5" Passport Drive 4TB, Keyboard and Mouse
- 5 PCs for gaming, Ci7 8700, ASUS ROG Motherboard 8360, 16GB DDR4 RAM, 1 TB SATA HDD, 128GB SSD, NVIDIA GTX1050Ti 4GB, DVD RW, HP27F 27" LED Display, Keyboard and Mouse
- 2 Acer projectors model X118H

How the equipment will be used for active/problem-based learning

3 pilot courses will be initially transformed for delivery through AL and PBL using the ALIEN lab and digital learning platform. The details of the courses are provided below:

Subject	**Number of students**	**Number of teachers**	**Equipment**	**Semester**
Software engineering for Industrial Automation systems	Expected students: 15	1 teacher	Virtual reality	August 2019
Object oriented analysis and design	Expected students: 60 2 section 30 each	2 teachers and 1 lab instructor	Virtual reality	August 2019
Software	Expected	1 teacher and 1	Augmented	March 2020

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engineering	students: 30	lab instructor	reality	

Table 11: Pilot courses in NUCES

Faculty support

Higher education commission (HEC), Pakistan has established a quality assurance agency (QAA) with a vision "to promote, enhance and assure the quality of higher education across higher education institutes (HEIs) in Pakistan." QAA goals include:

- Policy making and development of practical guidelines of quality assurance related to the degree programs offered at HEIs
- Guidelines to develop, monitor and evaluate quality enhancement cells (QEC) at each HEI
- Capacity building to enhance the quality assurance in higher education at national level
- Monitor and regulate HEIs for implementation of policies to improve quality and standard of higher education in Pakistan

Based on HEC's QAA, a QEC has been established at each HEI of Pakistan. QEC timely organizes workshops for the faculty members to improve their teaching skills and provide quality education to their students. The use of AL in different universities of Pakistan has increased over the last decade. During the search on AL in the HEIs of Pakistan, it was found that AL has been highly used in the medical education compare to other fields like engineering, business among others. Therefore, to support teachers in AL and PBL a number of workshops would be conducted in collaboration with QEC at the NUCES where teachers would be trained in using both AL and PBL in their courses. Three different types of workshops would be conducted as described below:

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- Problem design workshops: First the organizations need to educate faculty members on how to transform their usual lecturing into a PBL course through collaboration among students and the teacher. To achieve this goal, preliminary workshops of not more than 2-3 days are being organized to demonstrate examples on how to design problems based on the lessons or contents of the course. These workshops will also demonstrate the use of AL and PBL and what the principles of both to the faculty
- PBL Platform demonstration workshops: A 2-3 days session is being organized on training teachers and lab instructors on how to use PBL platform and how they can merge it with existing systems. In this workshop, faculty will be able to use the platform for mock activities and report their experiences through post-activity questionnaires. The organization aims to conduct this workshop before the start of the new semester so the tentative schedule falls somewhere in August 2019. Tentative schedule is shown below.

Subject	**Number of students**	**Number of teachers**	**Equipment**	**Semester**
Object oriented analysis and design	Expected students: 10-15	1 teacher and 1 lab instructor	Virtual reality	August 2019
Software engineering	Expected students: 20-30	1 teacher and 1 lab instructor	Augmented reality	August 2019

Table 12: Tentative schedule

Scenario of ALIEN AL/PBL lab use in a course

Course Title: SE593- Software Engineering in Industrial Automation

Engineering curriculum where it belongs

School of Computing, MS Software Engineering/MS Computer science, MS Cyber security.

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Course description

The main objectives of this course are:

- To develop understanding on the concepts of industrial automation and control systems
- To develop the ability to use software engineering lifecycle steps for industrial automation and control systems
- To build knowledge on risk assessment techniques for Industrial automation systems
- To build knowledge on cyber security of SCADA systems
- To build knowledge on cyber security standards and functional safety in industrial automation

The course content includes:

- Introduction to Software Engineering principles
- Industrial automation systems: programmable logic controllers (PLC), motion control systems, computer numerical controls (CNC), AC drives, human machine interface (HMI) software, supervisory control and data acquisition (SCADA), PXI and PC based systems automation software
    - Categories: software tools, manufacturing systems, resources, planning, real-time systems
- Industrial software standards: IEC 61131-3, ISA 88/95, IEC 61499, IEC 61804, IEC 61850
- Requirements engineering for industrial automation systems
    - Quality requirements industrial automation systems
    - Requirements patterns for industrial automation systems
- Risk management in industrial automation systems analysis, security failure analysis, safely failure analysis, STPA, FMEA, HAZOP, FTA

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- Industrial software design practices: model-driven engineering (MDE), component-based software engineering (CBSE), design based on formal models, multi-agent architectures, service-oriented architectures (SOA), OO approach for industrial automation software development
- Industrial software testing, management and validation: software testing, software maintenance and evolution, software configuration and engineering management, software processes and tools, software quality
- SCADA systems, DCS and cyber security in SCADA systems cyber security, SCADA systems, attack models, mitigation techniques, security constraints

Number of students to be engaged

57.

PBL activities that will take place in the course

Flipped classroom.

Equipment, software and educational material to be deployed

Hardware

- PCs
- Projectors
- VR Headsets

Software

- OpenPLC
- AdvancedHMI
- JSON API for plant automation
- SteamVR
- OpenVR

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Educational material (books, scenarios, etc. and sources)

- Industrial Cloud-Based Cyber-Physical Systems, Editors Armando W. Colombo, Springer, Cham
- Title of Book Advanced Industrial Control Technology, By Peng Zhang

How ALIEN equipment will be used

As a general-purpose Classroom for multiple PBL enabled courses

The Lab is designed in such a way that it has all 8 PCs settled in a big room with moveable semi-circular tables and chairs as shown below in Figure 39. The tables and chairs can be adjusted into any design required by the instructor to solve the problem. There are no fixed LEDs so the computers can be kept in any required fashion. There is a projector installed to disseminate the instructions and share material with the students. This lab can also be used for teacher training on PBL.

In Software Engineering in Industrial Automation

A project was assigned to the students to use AL principles to lower the barrier of malicious entry into the industrial control system. The students were asked to practice common attacks like including command injection, man-in-the-middle and buffer overflows, on the PCs and visually see the impact of their attacks in the 3D visualization through the VR headsets as shown the following figure.

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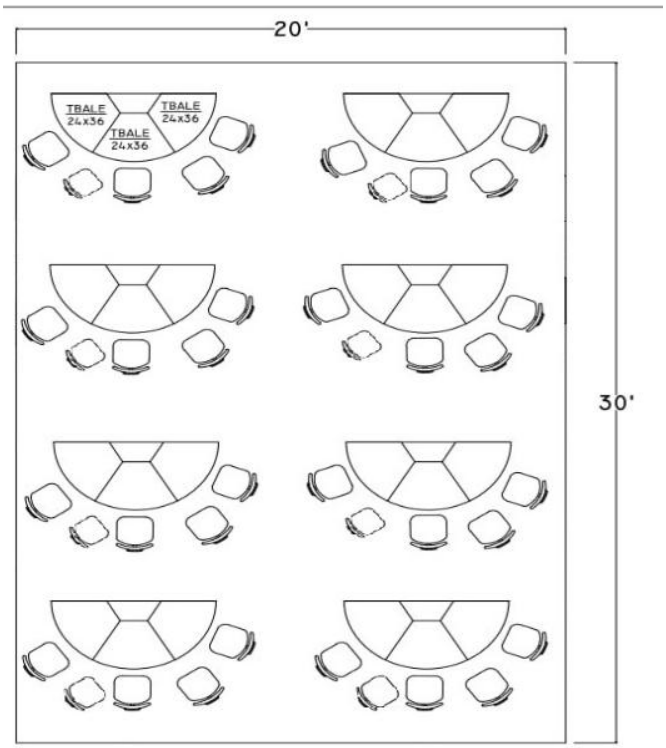

Figure 40: Floor plan of the PBL lab in NUCES

Users can also practice their defensive skills by properly segmenting the network with strong firewall rules, or writing intrusion detection rules.

The outcomes of the project will be:

- ICS simulation
- Attack simulation
- Attack results

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Figure 41: Simulation of ICS

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P17. Hanoi University of Science and technology (HUST)

Institutional mission, vision and strategy

As a technical university, the training goal of the HUST is that graduate students must be able to solve problems themselves, propose solutions, make decisions, evaluate solutions effectively and be able to present and write a report.

Students develop abilities of self-learning, self-study, critical thinking, problem solving skills, teamwork and presentation skills.

Vision

In order to achieve the above goals, the initiative learning of students is very important. At the time a new student enter the university, they are required to take part in courses built on AL methods. In contrast to high school studies in which students follow a pre-defined program, at HUST students must be proactive in planning learning schedules, selecting courses, choosing teachers and choosing narrow majors. In each course, teachers only introduce the theory. Students must actively execute exercises, practice, projects. Through exercises and projects, students build problem solving skills.

AL implementation

At HUST, AL methods have been implemented through curriculum design and delivery. The training program for engineers at HUST lasts 5 years and includes more than 60 courses, including 3 PBLs courses in the 3rd and 4th years. In these PBL courses the teacher raises an issue and students choose a problem in the given context and solve it. In the 5th year students do an internship at a company and implement graduation projects. Normally a student's graduation project addresses a real problem at the company in which the student works as an intern.

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In addition, each course is usually structured to include 60% of total time on theoretical work and 40% of total time on practice, exercises, problems and projects in which students solve problems themselves under the guidance of the lecturer or TA.

Strategy

Although the PBL method has been applied in HUST, the number of PBL courses is still small, so it is only effective for good students. In recent years, HUST has been implementing a reform of learning and teaching methods in the following directions:

- Enhancing the initiative of students in learning, organizing seminars on active learning methods for students
- Redesigning training programs
- Increasing the number of courses taught under the PBL model
- Reducing the theoretical work and increasing practice time
- Strengthening cooperation with businesses and enterprises, inviting them to participate in teaching or guiding students. This initiative provides students with more opportunities to do internship at enterprises through which they are exposed to practical problems and become more competitive in high quality labor market right after graduation
- Applying blended learning to reduce teaching time for teachers and increase AL for students

PBL Lab

The organization has 5 labs that support PBL learning. These labs are funded by ODA project from Japan. The labs include self-study space for students. They are equipped with all equipment needed by students. Depending on the major, the labs are equipped with tables,

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network, computers, laptops, projectors, servers and other practice equipment and material. Students can study in these labs overnight or in the weekend.

Currently HUST is building an AL classroom. The equipment is funded by ALIEN project. The organization is setting up the space and furniture.

Equipment

- 4 laptops MacBook Pro, accessories, extension guarantee
- 2 laptops DELL, accessories, extension guarantee
- 2 Smart TVs Samsung 4k 65
- 1 project Panasonic PT-LB383-LCD-ortion wireless
- 1 projector screen
- 2 portable Wi-Fi 4G TP-Link M7370

Table 13: HUST's equipment for ALIEN PBL Lab

How the equipment will be used for active/problem-based learning

5 lecturers have registered to apply AL method in their courses in the next academic semester starting in September 2019. The courses are:

- Parallel programming
- Game development
- Website design
- Mobile programming
- AI

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After this initial pilot phase, the organization plans to increase the number of courses that apply the AL model.

In AL classes, the number of students is about 40. Each class has one lecturer and one or several TAs. Lecturers teach theory and assess students. TAs can be PhD students or young lecturers. TAs help students in practical time.

Faculty support

Teacher training course about AL

Currently, HUST is working with USAID to organize a teacher training course on AL, Problem Oriented Learning (POL) and PBL for lecturers. The course is divided into 2 stages. Phase 1 was implemented in January 2019. During this period HUST invited experts to introduce and implement pilot AL, POL and PBL courses.

Phase 2 was implemented in the spring and fall of 2019. Each teacher chooses a subject that he or she is teaching to apply the AL method. After one semester teachers will share experiences on how to apply AL, what are the advantages of AL, what are the challenges, what needs to be improved and what needs to supplemented.

In addition, HUST is implementing the blended learning method. According to this method, the amount of class sessions will be reduced. Students will become more proactive in learning actively exploring a problem and introducing solutions.

Re-design curriculum and syllabus

The organization is redesigning the curriculum and syllabus in the direction of reducing the amount of theoretical teaching time, increasing the amount of practice, increasing PBL subjects and organizing classes according to the AL model. The goal of the new program is to strengthen the initiative of students in learning and to ensure that graduates are able to solve practical problems and to compete in the high-quality labor market.

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So far, at HUST teachers must teach both theory and practice. This consumes a lot of time of teachers. In fact, teachers only focus on teaching theory and put less emphasis on teaching practice. In order to organize teaching according to the AL model HUST introduce policies to pay fees for hiring TAs that will undertake practical teaching. TAs may be PhD students or young teachers. This not only saves time for teachers but also enhances instruction and support for students during practice time.

Scenario of ALIEN AL/PBL lab use in a course

Course title: Parallel Programming

Engineering curriculum where it belongs

Computer Science.

Course description

This course is intended for students who are interested in learning how to take advantage of parallel and distributed computing with a focus of writing parallel code for processor intensive applications to be run on clusters, the grid, the cloud, etc. The objectives of the course are to give the students an understanding of how they can use parallel computing in their research and enable them to write parallel code for their high-performance computing applications. The programming languages used are MATLAB, Maple, sage, python, Fortran or C.

Number of students to be engaged

>= 50.

PBL activities that will be integrated in the course

Projects and exercises on parallel programming.

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Equipment, software and educational material to be used

Hardware

Equipment	Detail Description	Purpose
iOS Programming Computer Set	- Laptop Apple MacBook Pro MPXQ2 128Gb (2018) Core i5 / Ram 8GB/ 128 SSD/ 13,3"/ Mac OSX with UGREEN 9-1 HUB	Simulated Computing Environment for Project-based Learning
Android and Windows Programming Computer Set	- Laptop Dell Inspiron 3476 (2018) CPU Intel® Core™ i7 8550U (1.80GHz Upto 4.00GHz, 4 nhân 8 luồng, 8MB Cache)	Simulated Computing Environment for Project-based Learning
Smart TV	- Smart TV 4K 65 inch, 4K Ultra HD	Seminar, Group Discussion
Projector	- Panasonic PT-LB383 Projector	Seminar, Group Discussion
Audio	- Sony BDVN9200W/BMSP1	Seminar, Group Discussion, Final Presentation
Wi-Fi Router	4G TP-Link M7350	Internet connection outside the Lab

Table 14: Equipment used in the Parallel Programming course of HUST

Software

The following software is used. It is downloadable from the internet.

- MATLAB, Maple, sage, python, Fortran, or C
- XCode, Swift
- React Native, React JS
- 3D Studio to print 3D object

Educational material (books, scenarios, etc. and sources)

The following materials are being used. They are downloadable from the internet.

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- On AL and project-based learning
    - Active learning in an ICT-enhanced blended learning environment: A case study of Vietnamese students in Australian higher education (https://www.semanticscholar.org/paper/Active-learning-in-an-ICT-enhanced-blended-learning-Vu/a0d4bcbab581e0b211c97dea8efe5f4759fbc540)
    - Active learning practices in the classroom using ICT (https://www.researchgate.net/publication/323847571_ACTIVE_LEARNING_STRATEGIES_IN_CLASSROOM_USING_ICT_TOOL)

Learning materials will be delivered to students through the LMS platform http://lms.hust.edu.vn .

How the ALIEN equipment will be used

The AL lab will be set up at the Innovation Centre of the School of Information and Communication Technology, Hanoi University of Science and Technology. The Innovation Center supports HUST in the following tasks:

- Support SoICT in the management of research laboratories and facilities for research
- Support the implementation of R&D activities associated with practice, creating conditions for bringing scientific research products to market
- Support collaboration of ICT companies, lecturers and students
- Find funding sources for scientific research, technology transfer and scholarships from businesses and domestic and foreign organizations for staff and students
- Support and advise staff and students to ensure intellectual property rights, establish innovative businesses, "spin-offs" and "startups", in connection with the university's policies and provisions of law.

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Setting up the AL lab inside the Innovation Center will allow students to implement projects with mentors from ICT companies, to be involved in R&D projects and to learn how to do research and achieve technology transfer. An important part of AL by project-based approaches is allowing students to work on a project on a topic of their choice that is closely related to the course content. Students work in groups of up to 3 individuals. Examples of eligible projects include review papers, tutorials and software in a relevant programming language or problem-solving environment.

Smart TV and projectors are used for seminars and group work. The computers, PCs and laptops are used to set up a simulated cluster computing environment for students. The School of ICT has set up an online platform through which lecturers and students can book the lab for their work. Meetings are held every 2 weeks for progress checking. Final presentations are delivered at the end of the semester. Students are graded individually depending on their contribution to the group.

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CONCLUSIONS

This document presented the institutional strategy of the ALIEN project towards promoting Active Learning and Problem-based Learning as strategic educational approaches in engineering HE. The document presented an overall educational framework that is based on Active Learning and Problem-based Learning, which is the basis for the ALIEN learning intervention. This overall framework is individualized for each ALIEN partner organization based on its organizational vision and mission, the everyday practices, educational needs, current and necessary infrastructure and curricula organization. The individualized institutional strategies aim to provide the basis for the deployment and adoption of ALIEN methodologies and tools towards enriching the educational experiences of students and building skills that are in line with industry and societal needs.

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