D3.1 Evaluation

of the implementation phase

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INTRODUCTION

Project ALIEN introduced an active- and problem-based learning intervention that aimed to establish problem-based methodologies a strategic choice for engineering higher education institutions that can help build the foundational knowledge and soft skills that young engineers today need to become tomorrow's problem solvers addressing the pressing needs of the 21st century.

The ALIEN learning intervention aimed to address the challenges that inhibit the deployment of problem-based learning in engineering higher education, which, based on the ALIEN state of the art analysis, include the lack of physical infrastructures, the lack of open digital educational content, and the need for building instructor capacity towards the adoption of problem-based learning.

To alleviate these challenges, ALIEN introduced an active- and problem-based learning intervention that involved the establishments of physical laboratories at 12 universities in Asia, the development of a digital problem-based learning platform and content for problem-based learning, and instructor training.

This document summarizes the results of the evaluation of the implementation phase of project ALIEN.

Part A of the report summarizes the experiences of the deployment of the ALIEN learning intervention in courses at all 17 partner sites in Asia and Europe. Notably, ALIEN was deployed in over 130 courses in which over 12.000 students were enrolled over 2 years.

Part B summarizes instructor training activities. Over 65 instructor training events took place at all 17 partner sites engaging over 1.200 individuals. Instructor training was conducted through a series of 4 - 5 sessions at each partner site to ensure an on-going process.

Part C analyses the results of a questionnaire-based evaluation in which close to 500 students from all 17 partner sites participated providing positive feedback on their experiences stemming from participation in the project.

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PART A. USE OF THE ALIEN LEARNING INTERVENTION IN COURSES

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A0. Introduction on the use of ALIEN in courses

This section describes the active and problem-based learning activities that took place at each ALIEN partner site in Europe and Asia. The activities took place in the context of the ALIEN implementation aiming to expose students to emerging active and problem-based learning design deploying the ALIEN learning intervention, which includes the physical laboratories and the ALIEN digital problem-based learning platform and active learning problems that are based on digital tools. In terms of physical infrastructures, the activities deployed the ALIEN problem-based learning laboratories developed at Asian partner universities. Correspondingly, activities in Europe deployed existing laboratories at partner sites. The activities took place in the 2nd half of the project implementation period from spring 2019 to spring 2021.

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A1. University of Thessaly

A1.1 Course ECE329: Educational Technologies

A1.1.1 Description of the course

The course focuses on the deployment of technology as an educational tool in lifelong learning contexts that target the needs of specific groups including school learners, higher education students, adult learners, vocational learners, professionals, and others. The course analyses traditional and emerging learning methodologies including collaborative learning, explorative learning, active learning, mobile learning, problem-based learning, project-based learning, active learning, game-based learning, and more. It focuses on how technology, and most importantly information technology, can be combined with emerging pedagogies towards the enhancement of learning processes and experiences in formal, informal, and non-formal learning. The course furthermore focuses on how technology can contribute, in combination with pedagogical models, towards the development of basic, transversal skills including analytical thinking, critical thinking, entrepreneurial thinking, problem solving, ability to work in a team, etc.

A1.1.2 Description of the participants

The course is an elective in the formal curriculum of the Department of Electrical and Computer Engineering of the University of Thessaly.

ALIEN was deployed in this course in two academic years, 2019 - 2020 and 2020 - 2021. The following groups of students were engaged:

- 140 students in the 2019 - 2020 academic year.
- 120 students in the 2020 - 2021 academic year.

The students were enrolled in the 3rd, 4th, and 5th year of studies in the Department of Electrical and Computer Engineering.

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A1.1.3 Description of active learning deploying ALIEN methodologies and tools

During the course of Education Technologies, students were exposed to active and problem-based learning in the contexts of formal projects leading to credits. In academic year 2019 - 2020 the activities took place in the classroom. In academic year 2020 - 2021 the activities took place virtually due to the COVID-19 situation.

In the 1st of these projects, students designed educational scenarios for integration into a learning game that targets engineering higher education and aims at building skills for the real-world through a city builder framework. This project was assigned in both academic years, 2019 - 2020 and 2021-2021. For each scenario, students described the educational objectives, the skills expected to be developed, and the gameplay and experience of the users that aims to contribute to the achievement of educational goals.

Students introduced a plethora of scenarios, a total of 30 for the two academic years, on topics, such as (please note that scenarios on similar topics have been combined):

- Designing an internet provider service for a city, including fiber optics solutions.
- Integrating green energy production for covering everyday energy needs.
- Monitoring of the work of large corporations.
- Reserving energy in public buildings.
- Making a city more livable.
- Designing earthquake protection interventions in a city.
- Design a car sharing service for reducing emissions from traffic.
- Designing a platform that simulates electrical circuits.
- Design a water service for islands.
- Designing interventions for avoiding traffic congestion.
- Designing interventions for flood prevention.
- Designing fault tolerant energy grids.
- Designing interventions for fire protection.
- Designing a mobile learning service.

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- Designing a startup network in a city.
- Designing a pandemic response system.
- Designing an ecological waste management factory.

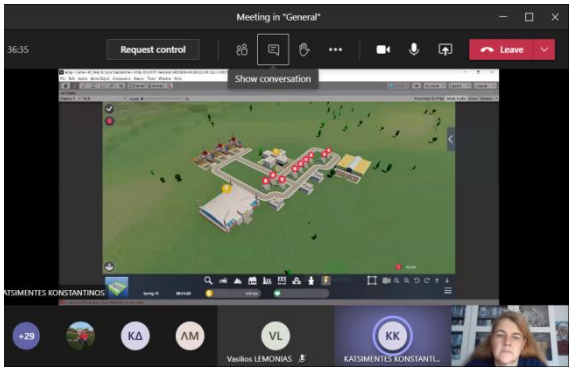

Figure 1. Students virtually explore a city builder application for building problem-solving skills in the context of the Technologies in Education course.

In the 2020 - 2021 academic year students further integrated their scenarios into the educational game, enriching the game functionality. Engaging in game design activities is a problem-based learning approach, in which students are not only players but also designers. The activity provided students with an opportunity to both identify problems and to become problem solvers by introducing potential implementations for addressing today' challenges.

In the second of these projects the students designed problem-based learning activities for engineering education that deploy digital technology to promote exploration, experimentation, and collaboration. The project was also assigned in both academic years. The students worked in teams and published the scenarios on the ALIEN platform. A total of 50 problems were published in the ALIEN platform by students in the two academic years. The problems cover a broad range of engineering activities, such as database design, electronic circuit design, agile software management, programming, machine learning, logic, and more. The students furthermore were active in the ALIEN community, researching and posting information of interest in the ALIEN forums on topics, such as problem-based learning methodologies and tools, problem-based learning in software engineering,

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problem-based learning and gamification, problem-based learning and artificial intelligence, and problem-based learning activities in Greece.

Figure 2. Students in the Technology in Education class participate in a videoconference with the University of Malaya, Malaysia, during which the see the TEALS laboratory installed through the ALIEN project at the latter.

In the third of these projects, students researched topics related to: a) digital services for educational purposes and b) research activities related to technology in education. Students worked in teams and delivered the presentations in the class. Finally, during the class the students had the opportunity to connect through videoconferencing to the TEALS laboratory

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at the University of Malaya, Malaysia and to see how the laboratory is used in problem-based learning contexts.

The active learning activities allow students to engage in practical application of digital technologies used in actual educational contexts, helping link education to needs in the real-world. They allowed students to be directly engaged in the ALIEN project by designing problems for engineering education and by being exposed to active learning practices in Asian and European countries.

To complete their work, students were challenged to deploy active learning for understanding the needs of the target groups in relation to specific educational objectives ant themes, designing a learning solution that involved digital technology for enriching student experiences and contributing to the achievement of learning goals, and proposing methods for validating the scaffolding of knowledge.

Figure 3. Students in the Technology in Education class presenting learning solutions that are based on robotics.

A1.2 Course ECE311: Database Management Systems

A1.2.1 Description of the course

The course focuses on database management theory and practices. Learning is delivered through lectures and through practical hands-on activities that take place in the computer laboratory. The practical activities encourage students to apply new knowledge on Database Management Systems in practice in a manner that simulates related operations in the business world. The activity exposes students to Database Management System

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architectures, data modeling, entity-relationship models, relational models, relational algebra and relational calculus, the SQL language for data definition and manipulation, physical organization of a database, normalization of content, storage media, file organization, and indexes.

A1.2.2 Description of the participants

The course is obligatory in the 3rd year of undergraduate studies at the Department of Electrical and Computer Engineering of the University of Thessaly. The following groups of students were engaged in the 2019 - 2020 and 2020 - 2021 academic years:

- 180 students in the 2019 - 2020 academic year.
- 150 students in the 2020 - 2021 academic year.

A1.2.3 Description of active learning deploying ALIEN methodologies and tools

In both academic years students were exposed to active learning in a context of laboratory work that takes place weekly.

In academic year 2019 - 2020 the activities were implemented in the 2 computer laboratories of the Department of Electrical and Computer Engineering that have a capacity for 35 and 20 students respectively. Students were divided in working groups according to the capacity of the laboratories.

During the weekly workshops students followed specific steps in order to solve an exercise given by the teacher. For example, students had to create an inventory manager. The goal of this exercise was to create an inventory manager that will be digitally administered. The learner were challenged to create a schema for managing the necessary information, design and enter into the schema characteristic content, and perform basic operations that extract desirable information.

In the 2020 - 2021 academic year due to the COVID-19 situation the implementation of the laboratories was a challenge. The laboratories took place virtually with an on-line organization. Students continued to work in groups, similarly to the previous academic year.

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The educator provided explanations in a virtual classroom on the activities that the students engaged in during the regular laboratory hours. Students furthermore engaged in in-class exercises, although these took place virtually. Finally, the educator assigned homework exercises that the students completed over a period of 24 days.

Figure 4. Students in the Database Management Systems course are exposed to data mining exercises, which are also available through the ALIEN digital problem-based learning platform.

The ALIEN project provided a platform for the publication of database practical exercises for the benefit of wider engineering higher education audiences.

A1.3 Course ECE211: Circuit Analysis

A1.3.1 Description of the course

This course is fundamental and introduces students to the concepts of circuit elements, simple linear circuits, and methods of analysis. It aims at better understanding and consolidation from the students of concepts, such as circuit components, data connections, sinusoidal steady state, complex impedance and principles or methods, such as laws of Kirchhoff, circuit theorems and analysis methods.

A1.3.2 Description of the participants

The course is obligatory in the 1st year of undergraduate studies of the Department of Electrical and Computer Engineering of the University of Thessaly. The following groups of students were engaged:

- 180 students in the 2019 - 2020 academic year.

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- 150 students in the 2020 - 2021 academic year.

A1.3.3 Description of active learning deploying ALIEN methodologies and tools

The laboratory activities of the course were based on problem-based learning and were performed on workbenches with instrumentation and breadboards. The activities led to better understanding of basic principles of linear circuits and to their familiarization with instrumentation.

Figure 5. Students in the Digital Circuits course develop electrical circuits in laboratory practical work.

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In academic year 2019 - 2020 the practical exercises took place in the Electrical Circuits laboratory of the Department of Electrical and Computer Engineering.

In academic year 2020 - 2021 the activities took place virtually due to the COVID-19 situation. Students worked in a single group, which is feasible due to on-line delivery. Students deployed virtual simulation environments for circuit analysis. Mostly, students used the Multisim® tool by National Instruments® and related Multisim® Live tool. They also used the Modelism® compiler and the Icarus® compiler by Verilog®. Students submitted their computations electronically, which were automatically corrected.

Practical activities are published through the ALIEN problem-based learning platform as good practices for the benefit of engineering students and educators. The COVID-19 situation demonstrated the added-value of deploying digital simulations in learning, which allowed class activities to continue from a distance.

A1.4 Course ECE115: Programming I

A1.4.1 Description of the course

The main objective of the course is to provide first-year students with first-hand knowledge of the basic principles of programming and of computer-assisted problem solving in general. Students are introduced to C programming language, a classic, powerful procedural programming language. The course is accompanied by a mandatory laboratory in which the participants apply in series of tasks what they have learned in the course in order to deepen their understanding of the concepts and techniques.

A1.4.2 Description of the participants

The course is obligatory in the 1st year of undergraduate studies at the Department of Electrical and Computer Engineering of the University of Thessaly. The following groups of students were engaged:

- 180 students in the 2019 - 2020 academic year.
- 150 students in the 2020 - 2021 academic year.

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A1.4.3 Description of active learning deploying ALIEN methodologies and tools

The course had a weekly laboratory work that took place in the computer laboratories of the Department of Electrical and Computer Engineering that have a capacity of 35 and 20 students respectively. Students worked in groups according to the capacity of the laboratories.

The laboratory part of the Programming I course was based on problem-based learning and was performed on Linux environment. It involved analyzing the requirements of problems which were to be solved with a computer, basic data types and operators, functions and variables and complex data types. Students developed projects individually, which constituted a significant part of their grade.



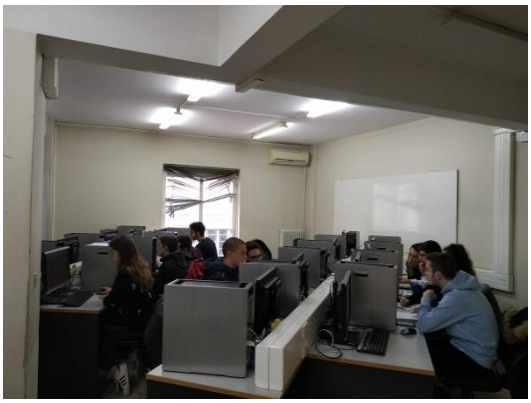


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Figure 6. Students in the Programming I course program solutions to data extraction problems in the computer laboratory of the Department of Electrical and Computer Engineering.

The practical course activities took place in the computer laboratory of the department in academic semester 2019 - 2020. In academic semester 2020 - 2021, practical application of programming took place virtually. Students worked as one single large group. The educator provided students with activities at the beginning of each session, presenting the objectives of each exercise. Students programmed locally on their own computers and submitted the results of their work for evaluation through the department on-line learning management system.

The ALIEN platform is used for publishing activities that the students work on. Examples of activities include programming lists, data structures, and data objects.

A1.5 Course ECE118: Discrete Mathematics

A1.5.1 Description of the course

The course is a basic introduction course in discrete mathematics concepts of objects and their relationships. This course aims to introduce students to the basic concepts of mathematical structures that are fundamentally discrete. The objects studied in discrete mathematics, such as logic, sets, functions, number theory, induction, combinations and permutations, graphs, recurrence relations, theoretical principles of cryptography, and trees.

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A1.5.2 Description of the participants

The course is obligatory in the 1st year of undergraduate studies at the Department of Electrical and Computer Engineering of the University of Thessaly. The following groups of students were engaged:

- 180 students in the 2019 - 2020 academic year.
- 150 students in the 2020 - 2021 academic year.

A1.5.3 Description of active learning deploying ALIEN methodologies and tools

The course took place virtually in both academic years due to the COVID-19 situation. Discrete Mathematics is a completely problem-based learning course. Students solved problems in the class in all lectures. Most of the activities were solved through pen and paper. However, in the context of the ALIEN project some activities, such as the classic "The Tower of Hanoi puzzle" that students are exposed to in the context of recurrence relations were implemented in digital form. The digital application allowed students to explore potential solutions to the puzzle through experimentation before introducing a formal mathematical solution. This application aimed at demonstrating links between discrete mathematics and programming. It may be used more generally in activities aimed to build problem solving capacity. It challenged students to analyze a problem and experiment with potential solutions while striving to arrive to a solution formula. It furthermore addressed issues related to solution optimization. As second step, students may be called to program a solution to the puzzle, which typically takes place in the context of programming courses.

Other classic problems introduced in the course that demonstrate links with other curriculum courses, such as programming, include the finding a recurrence relation for the Fibonacci sequence, counting the number of paths in the classic travelling salesman problem, counting available internet addresses, calculating shortest paths in graphs (a problem related to programming and algorithms), and more.

The ALIEN project has provided an opportunity to publish well-known problems through the problem-based learning platform for the benefit of all. In addition, it provided an

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opportunity to implement digital solutions to problems, such as the Tower of Hanoi, also published the problem-based learning platform.

A1.6 Course ECE422: Data Mining

A1.6.1 Description of the course

The course introduces students to basic data mining principles of organizing and extracting data from large databases. It further encourages students to apply these principles in practice by using them for designing and implementing a basic data mining system in a manner that simulates related programming and data management activities in industry.

A1.6.2 Description of the participants

The course is an elective in the 4th year of undergraduate studies at the Department of Electrical and Computer Engineering of the University of Thessaly. The following groups of students were engaged:

- 60 students in the 2019 - 2020 academic year.
- 60 students in the 2020 - 2021 academic year.

A1.6.3 Description of active learning deploying ALIEN methodologies and tools

The exercises used in the course were meant to be executed in the context of broader introductory data mining activities that expose students to data mining principles, such as data preprocessing, data mining primitives, languages, and system architectures.

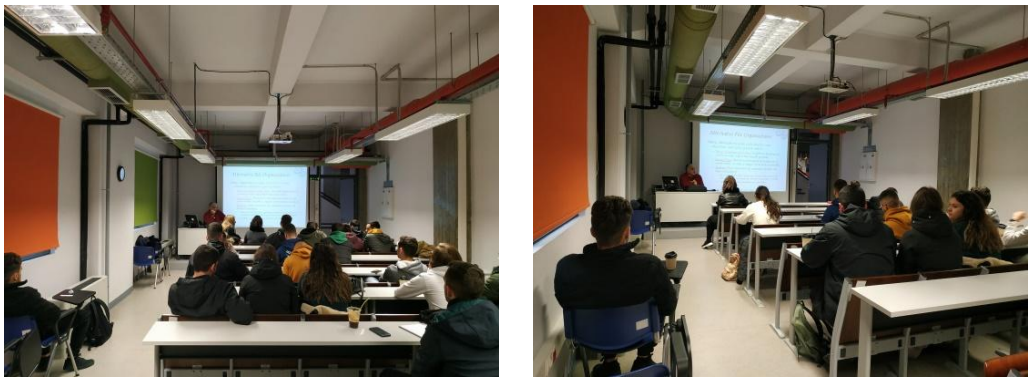

Figure 7. Students in the Data Mining course follow presentations on effective data extraction algorithms.

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More specifically, the activities were part of broader curricula that are related to mining association rules in large databases, classification and prediction, clustering, mining data of complex types, mining big datasets using parallel and distributed frameworks, implementing and managing data warehouses, and more.

The course took place in the classroom in the 2019 - 2020 academic year and virtually in the 2020 - 2021 academic year.

During the course students engaged in exercises for data extraction and data mining that took place in each class session. Students engaged in classic problem-solving activities that were built around basic algorithms of data mining described above. Students were given an exercise which they solved during the course of the lecture at home and discussed the results with the educator. Data mining activities were published on the ALIEN problem-based learning platform.

A1.7 Course ECE516: Design and Implementation of Digital Games

A1.7.1 Description of the course

The course focuses on the design and implementation of digital games and covers subjects that include: what is the definition of games and play, characteristics of digital games, game taxonomies and game genres, understanding different groups of users, designing a game concept, elements of game worlds, designing a game story, designing game characters, what are the core mechanics of games, typical game dynamics and the experience of users, game balancing, elements of chance, characteristics of on-line games, creative play, marketing principles, and more.

A1.7.2 Description of the participants

The course is an elective in the 4th year of undergraduate studies at the Department of Electrical and Computer Engineering of the University of Thessaly. The following groups of students were engaged:

- 130 students in the 2019 - 2020 academic year.

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- 120 students in the 2020 - 2021 academic year.

A1.7.3 Description of active learning deploying ALIEN methodologies and tools

The course was balanced between theory and practice. A significant part of the course work was on the design and implementation of a digital game. Upon completing the course, the students were able to apply game design principles to implement further games and applications. The course had a weekly laboratory work that took place in the computer laboratories of the Department of Electrical and Computer Engineering. At the beginning of the course students followed tutorial examples as well as practical presentations of the functionality of popular game design platforms, such as Unity®. Upon completion of this segment of the work, which spanned a couple of weeks, students used the laboratory to design and implement their own games in teams. During laboratory sessions students had the opportunity to collaborate with their peers towards game implementation, to get help on technical questions, and to receive guidance for a smooth implementation.

The games that students develop each year have a theme. In the 2020 - 2021 academic year, the focus was on learning games for engineering higher education, although students had the option of selecting a different target group.

Before implementing their game, students were called to present their game concept in class and receive feedback from their peers. At the end of the course students demonstrated in class their working games.

Some of the game ideas introduced by students include for both academic years:

- Mathematics game in the form of platform games that include quizzes.
- Games that promote hand-eye coordination.
- Puzzle games that promote critical thinking.
- Strategy games.
- Games for managing emotions, such as grief.

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- Games that challenge players to solve a mystery by putting together bits of information that they discover.
- Adventure games.
- And more …

Figure 8. Students in the Game Design and Implementation class learn the basic principles of the popular Unity game development environment.

The most successful games that were well linked to educational objectives were published through the ALIEN platform and made public for all to use.

A1.8 Course ECE9251: Serious Games

A1.8.1 Description of the course

The course focuses on the design and implementation of serious games, namely games that are being design from the beginning for educational purposes. This is in contrast with games that have been designed for entertainment but are deployed in educational contexts. Serious games offer advantages in learning, because their educational design means that

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learning does not have to be adjusted to the game features; rather the game is developed for seamless integration into learning. Serious games are used to build skills and competencies, training for crisis management, health, as well as promoting positive attitudes and perceptions. Popular sectors in which serious games are used include formal education, business training, and health.

Serious games use game elements, such as clear missions and objectives, rewards, recognition, feedback, avoidance of penalties, and more to promote learner engagement, to motivate learners, and to reinforce knowledge. When designed well and in lines with educational objectives, serious games offer complementary digital channels for knowledge development that exploit exploration, experimentation, and learning by doing.

Serious games are particularly useful as initial training in cases when physical training may be too expensive or involve risk. Examples of the former is the need to train employees in factory facilities that are in operation; using the facilities for training would result in lessening production, which has a significant cost. An example of the latter is pilot training, surgeon training, and more; initial training in a virtual environment may contribute to the development of skills before individuals actually practice them in real life conditions.

A1.8.2 Description of the participants

The course is an elective in the second year of studies of the master's programme "Applied Informatics" of the Department of Electrical and Computer Engineering of the University of Thessaly. The following groups of students were engaged:

- 31 students in the 2019 - 2020 academic year.
- 20 students in the 2020 - 2021 academic year.

Course participants are professionals with diverse backgrounds, including educators, military professionals, and more.

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A1.8.3 Description of active learning deploying ALIEN methodologies and tools

The course activities balanced theoretical and practical work. The theoretical work involved game design concepts similar to those described for above for course ECE516: Design and Implementation of Digital Games. Theoretical work also included pedagogical principles, such as the benefits of active, experiential, and problem-based learning and supporting research work of well-known researchers including Papert, who introduced the concept of microworlds, namely simplified representations of the real-world that are relevant in game design, and Piaget, a psychologist that worked on the cognitive development of individuals among topics.

Practical work involved the design and development of a serious game with educational objectives that address specific educational or training needs of a well-defined target group. Students began the work by building a game concept, which they presented to the class. Given the background of the participants, game development could take place through digital tools, such as Unit®, JavaScript®, or the simple to use Scratch® and AppInventor® environments that are appropriate for non-developers. It could also take place in the form of physical, non-digital prototypes. At the end of the course students demoed their games to the class. The best designed games were published on the ALIEN problem-based learning platform.

Figure 9. Games developed by students in the context of the Serious Games course: a history board game (on the left) and a quiz game with an astrophysics background (on the right).

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Originally, the plan was for the development of the digital games to take place in the computer laboratories of the Department of Electrical and Computer Engineering. However, in both academic years the class took virtually due to the COVID-19 situation.

A1.9 Course ECE439: Special Subjects

A1.9.1 Description of the course

This course provides an opportunity for students to engage in research and explorative activities. The course is in the form of a full semester project, which may be inspired by any subject in the curriculum of the Department of Electrical and Computer Engineering. Examples of activities that students may engage in include:

- Development of a software application.
- Bibliographical research on specific topics.
- Evaluation of software tools through the engagement of user groups.
- And more.

A1.9.2 Description of the participants

The course is an elective for students in the 3rd, 4th, or 5th year of their studies. Typically, each instructor may engage a limited number of students in special projects. The following groups of students were engaged:

- 30 students in the 2019 - 2020 academic year.
- 25 individuals in the 2020 - 2021 academic year.

A1.9.3 Description of active learning deploying ALIEN methodologies and tools

Students were assigned a high-level research activity according to their interests and educational aspirations. Approximately 10 students engaged fully on the development of educational activities published on the ALIEN platform. Another group of students developed games and simulations that are also published through the ALIEN platform in the

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context of broader activities. Some examples of software simulations and games developed by students that are now open available to all through ALIEN include:

- Fractals. This is an on-line simulator that allows users to experiment with fractals, including Mandelbrot and Julia, by exploring the graphical presentations with various input parameters.
- Falling words. This game helps students build their dictation skills by challenging them to correctly write words under time pressure. In addition, the tool may be used by individuals that need to build their typing skills as well as individuals that are visually impaired and need additional practice in writing and spelling.
- Portal. This game allows students to explore physics concepts, such as gravity, by striving to have an object go through a portal that teleports it to a different space. Students must estimate the object trajectory and reflect on the laws of physics in real-life and in the game environment.

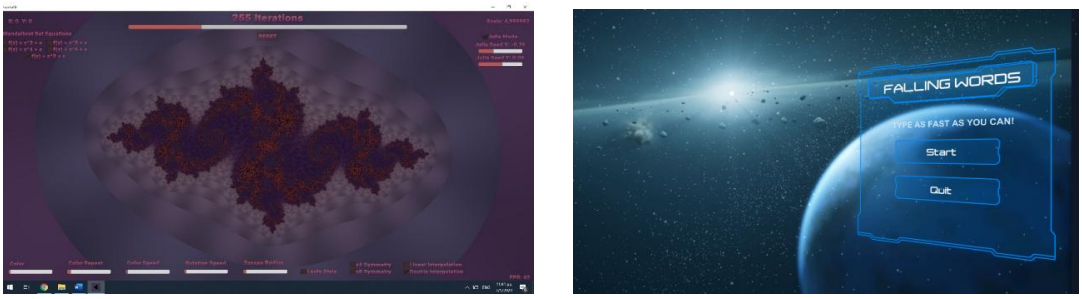

Figure 10. Software games and simulations developed by students in the Special Subjects course and published on the ALIEN platform in the context of Special Subject projects: fractal exploration (on the left) and spelling games (on the right).

- Solar system. This simulator allows students to view our solar system and gain information for each of the planets.
- Tower of Hanoi. This game allows students to experiment with the well-known mathematical puzzle in which the user is challenged to move disks of different sizes from an initial to a destination peg using an interim peg and observing the restriction that no larger disk is allowed to be placed over a smaller one.

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- Visual programming game. Through this game students may explore programming structures, such as lists, trees, and more.
- And more.

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A2. Instituto Politécnico do Porto

A2.1 Course: Serious Games

A2.1.1 Description of the course

This course introduces games and serious games as paradigms of graphics and multimedia applications. This course provides the concepts and practice necessary to understand, analyse, design, develop, test, and evaluate games and serious games.

Upon completing the course students are able to understand and implement concepts, methods, and processes for game idealization, design, and development; understand, identify, and compare concepts, methods and processes for serious game idealization, design, and development; select, use, and evaluate specific environments and tools for game and serious game development; conceive, design, implement, test, and evaluate a serious game. Other competences relate to project planning and execution, team forming and leading, decision making and problem solving and final product presentation.

A2.1.2 Description of the participants

This course is part of the MSC in Computer Engineering of the School of Engineering of the Porto Polytechnic. The following groups of students were engaged:

- 35 students in the 2018 - 2019 academic year.
- 24 students in the 2019 - 2020 academic year.

A2.1.3 Description of active learning deploying ALIEN methodologies and tools

This course pedagogical methodology was based on active learning and project-based learning and currently it followed ALIEN's methodological approach. Students started by evaluating existing serious games, following a predetermined method that had to be adjusted to the game they selected. Then they reported their findings. Collectively, the concept of serious games was discussed as a result of all contributions. Then, students were asked to form small teams of 2 - 3 members to design, develop, and evaluate a serious game

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therefore following the entire cycle from the idea till the tested product. In the end, the groups presented and defended their products. Students then completed a group evaluation where every team member's individual contribution was assessed.

Figure 11. Students collaborate in the Serious Game course.

A2.2 Course: Multimedia Applications Architecture

A2.2.1 Description of the course

This course provides knowledge and competences related to specific graphics and multimedia systems software development methodologies and their practical applications. Upon completion of the course, students are able to understand concepts and apply the technologies related to the manipulation of multimedia information including the production, transmission, storage, standardization, integration, synchronization, and protection of that information. They can apply methods and processes for multimedia design and development. They can analyse and use tools, APIs, and technologies for

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multimedia development. They can analyse and use development environments for multimedia applications. They can develop a multimedia project using specific tools.

A2.2.2 Description of the participants

This is an elective course, part of the Master's Degree in Computer Engineering Program of the School of Engineering of the Porto Polytechnic. The following groups of students were engaged:

- 15 students in the 2018-2019 academic year.
- 14 students in the 2019 - 2020 academic year.
- 7 students in the 2020 - 2021 academic year.

A2.2.3 Description of active learning deploying ALIEN methodologies and tools

This course followed a flipped classroom and project-based learning strategies towards the design, development, and evaluation of multimedia applications.

Figure 12. Students work in groups in the Multimedia Applications Architecture course.

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Material for the theoretical lectures was prepared beforehand and given to students. Classes were used to discuss those contents and relate them with practical implementation. Based on those classes students were asked to conceive, design, develop, and evaluate a multimedia application using specific tools. Over an 8-week period students investigated users' needs, identified suitable technologies, and applied appropriate development methods to create a prototype system. The project-based learning approach challenged students to think about what data they needed to capture and on how they would then analyse the data and infer conclusions for improving their prototype. The problem-based learning approach was based on ALIEN's pedagogical methodology.

A2.3 Course: Multimedia Authoring and Development

A2.3.1 Description of the course

The Multimedia Authoring and Development course focuses on the development of multimedia applications using the most common methodologies and technologies. The course includes requirements analysis and management, presentation of examples related to specific multimedia areas, quality assurance, and testing. The following skills and competences are expected from students: analysis and design, programming and testing, video and audio processing. Agile methodologies for software development are deployed. Upon completion of the course, students are able to apply the principles and steps of multimedia design methodologies. They can analyse and understand the specific requirements of design and multimedia authoring. They can apply a project methodology in multimedia design and development of collaborative or individual projects. They can create elements from various media. They can evaluate and apply effectively authoring tools and multimedia design suitable for a particular project.

A2.3.2 Description of the participants

This course is part of the Master's Degree in Computer Engineering Program of the School of Engineering of the Porto Polytechnic. 26 students were engaged in the 2019 - 2020 academic year.

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A2.3.3 Description of active learning deploying ALIEN methodologies and tools

Students were presented with the methodological process of conceiving, designing, developing, testing, and evaluating a multimedia application using an authoring tool. As this process is very close to project-based learning combined with agile and rapid prototyping development methods, ALIEN's problem-based methodological design was used in the course. Students were asked to develop an efficient multimedia approach to solve a problem. Students worked in groups. The solution of every group was discussed with the whole class. The teacher presented some potential improvements. After that, students used an agile development method to create a prototype that was demonstrated again to the class. Class members assumed the role of potential users to evaluate the functionality and usability of the solution.

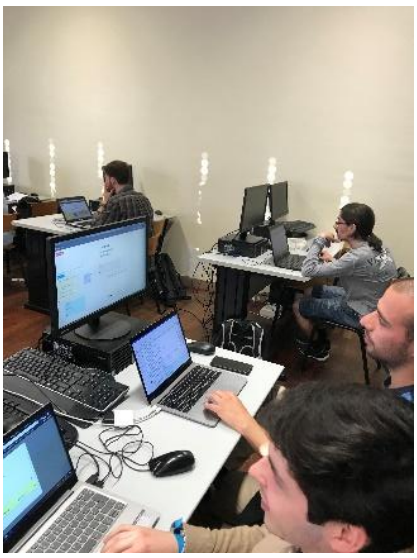

Figure 13. Students work on projects in the Multimedia Authoring and Development course.

A2.4 Course: Advanced Graphical Applications

A2.4.1 Description of the course

This course provides the integration of a set of technologies and development techniques in the field of computer systems and multimedia in the development of advanced applications and innovative. Upon completion of the course, students are able to understand the most

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common applications and the business models of multimedia technologies. They can apply effectively a project methodology in multimedia design and development of a new product. They can understand a business plan of a new product or service to a set of investors; argue the most common applications and the business models of multimedia technologies and business models. They can analyse the problem to be solved, adopting engineering sciences and best practices. They can evaluate different approaches for solving the problem by adopting appropriate engineering sciences and best practices. They can design a solution to the problem by adopting appropriate engineering sciences and best practices. They can lead the developing process of a product and/or system supported by multidisciplinary teams. They can write the processes and results, adopting appropriate engineering sciences and best practices. They can evaluate the designed and implemented solution by applying appropriate engine.

A2.4.2 Description of the participants

This course is part of the MSC in Computer Engineering of the School of Engineering of the Porto Polytechnic. The following groups of students were engaged:

- 17 students in the 2019 - 2020 academic year.
- 19 students in the 2020 - 2021 academic year.

A2.4.3 Description of active learning deploying ALIEN methodologies and tools

This course presented advanced concepts to the students and prepared them for working in professional environments. The class was divided in two groups which were given the same project. The groups then followed a complete project-based learning approached combined with agile development with 2-week sprint cycles. Each group alpha, beta, and pilot tested the solution of the other group. The active learning approach allowed students to incorporate professional development skills during their studies so that they prepared for their future work life as software engineers.

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Figure 14. Students collaborate in groups in the Advanced Graphical Applications course.

A2.5 Course: Interaction and Graphical Systems

A2.5.1 Description of the course

Computer graphics, 2D and 3D, and human-computer interaction are very important areas of Computer Science, with applications on several human activity domains, such as education, medicine, scientific data visualization, computer-aided design, geographic information systems, and entertainment (movies, videogames, etc.). The course is an intermediate level unit that aims at establishing a solid foundation for more advanced study of specific topics in the scientific area of Computer Science. Upon completion of the course, students are able to understand the fundamental role that interaction processes between human beings and machines play in the success of informatics applications. They can understand the growing importance of computer graphics in many human activities. They can understand concepts related to computer graphics and interaction. They can understand the necessary knowledge to develop interactive 3D graphics systems with OpenGL or any other API. They can analyse, evaluate, and create interactive graphics systems. They can apply standard graphics development tools. They can apply the concept

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of teamwork. They can prepare a report and a presentation to defend a project before an evaluation jury.

A2.5.2 Description of the participants

This course is part of the Bachelor Degree in Computer Engineering of the School of Engineering of the Porto Polytechnic. This course is part of the 1st semester, 3rd year curriculum of Informatics Engineering. 219 students were engaged in the 2021-2021 academic year.

A2.5.3 Description of active learning deploying ALIEN methodologies and tools

This course followed the project-based learning educational strategy. Students were asked to group in teams of 4 or 5 individuals in order to complete projects related to 3D modelling, user-interfaces, and computer graphics. The challenges were the same for all the teams. The course's methodology was adapted to use ALIEN's concept in a more systematic way.

A2.6 Course: Laboratory / Project I, II, III, IV, V

A2.6.1 Description of the course

This set of 5 courses integrates the knowledge of all previous courses in a complex project paying special attention to subjects being lectured in the courses of the same semester. Students exercise their implementation skills and teamwork realizing an integrated project of significant complexity, working as a team, and simulating the context of a business project. Teams develop a software system composed of several applications based on an open specification and simulate a request for proposals. Students gain understanding and sensitivity that a software system is more than one application but a collection of different elements, such as database engine, several applications, web server, etc., most of the time running on heterogeneous environments and hardware. Students practice iterative development methods and processes as well as project management techniques previously learned.

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A2.6.2 Description of the participants

Theses 5 courses are part of the Bachelor Degree in Computer Engineering of the School of Engineering of the Porto Polytechnic. A total of 750 students in the 5 courses in the 2019 - 2020 academic year.

A2.6.3 Description of active learning deploying ALIEN methodologies and tools

This is a laboratory course. It is expected to allow students to integrate the knowledge acquired in a semester in a project. Each laboratory run in a specific semester and had specific objectives related to the other semester courses. However, the pedagogical methodology of all the laboratory courses was the same and based on project-based learning, implemented through agile development methods. First, the need or the problem was introduced and students researched the information required to produce a more concrete problem statement. Then students presented potential solutions which were analysed by the teachers. Then, students teamed up in groups of up to 6 members to develop and test the solution. The course ended with testing and evaluation.

Figure 15. Students present their work in the Lab / Project course.

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A2.7 Course: Electrical Engineering Project

A2.7.1 Description of the course

The study of engineering should be accompanied by the development of soft skills that allow engineers to develop integrated work in teams and with appropriate working methodologies. The curricular unit of the Electrical Engineering Project builds soft skills that will be used by students throughout their studies as well as during in professional activities. The course helps integrate newly admitted students into the environment of ISEP and the Department of Electrotechnical Engineering. It further aims at making known the regulations and services available at ISEP, such as email, portal, Moodle, library, etc. It conveys important concepts, such as ethics and plagiarism. It develops soft skills relevant for the activity of an engineer, such as teamwork, project and work management, reporting, communication, research methods, organization and synthesis of information, etc. It applies soft skills in the scientific discussion of a theme related to the course and launched in the first week of classes.

A2.7.2 Description of the participants

This course is part of the Bachelor Degree in Electrical Engineering Program of the School of Engineering of the Porto Polytechnic. It is part of the 1st semester of the 1st year curriculum. The following groups of students were engaged:

- 125 students in the 2019 - 2020 academic year.
- 131 students in the 2020 - 2021 academic year.

A2.7.3 Description of active learning deploying ALIEN methodologies and tools

This course introduced students that have recently entered higher education to problem-based learning. The course was adapted to use ALIEN's methodological approach. The course followed a problem-based learning approach from start. A problem in the electrical engineering domain was proposed to the teams of up to 5 students who were challenged to study the problem, find the necessary resources, prepare a presentation on the problem,

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and identify potential solutions. The goal of the course was to develop personal and social skills, foster the integration of the students in higher education, and prepare them to effectively engage in other courses that adopt problem-based learning.

Figure 16. Students collaborate in the Electrical Engineering Project course.

A2.8 Course: Integrated Project

A2.8.1 Description of the course

Integrated Project is an aggregative discipline that allows the completion of a degree and integrates the knowledge and skills acquired in the other course disciplines. As a prerequisite, students are required to have participated in basic science courses across different areas of engineering, as subjects of expertise, to obtain the required knowledge and the foundations for the project. The project can be developed in a group of 2 students supervised by an ISEP teacher or be individual and conducted in a company with the guidance of an ISEP teacher and a company supervisor. The course aims to expose students to a team environment and a specific problem that is inspired by the real-world and simulates activities that students will be engaged in the future in as professionals. Students carry out the application, study, and synthesis of knowledge domains that characterize the course towards building greater added-value techniques. Students further build skills in

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communication, autonomy, and teamwork. The work is developed in areas as diverse as the board, management and supervision of works, planning and project management, quality management, environment and security, the preparation of studies and projects in various specialties civil engineering structures, such as, building physics, geotechnics, hydraulics, and roads.

A2.8.2 Description of the participants

This course is part of the Bachelor Degree in Civil Engineering of the School of Engineering of the Porto Polytechnic. 35 students were engaged in the course in the 2019 - 2020 academic year.

A2.8.3 Description of active learning deploying ALIEN methodologies and tools

This course allowed students to integrate all the knowledge acquired in the programme in a single project. The pedagogical methodology was project-based learning. First, the need or the problem was introduced and students researched the information required for producing a more concrete problem statement. Then students presented potential solutions which were analysed by teachers. Students then developed their solutions. This activity could actually take place outside of the school, in a professional environment. The course ended with the students presenting their solutions.

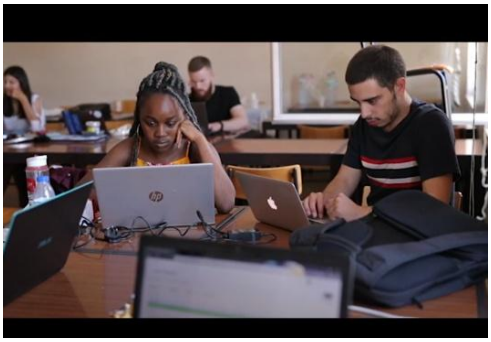

Figure 17. Students prepare their presentations in the Integrated Project course.

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A2.9 Course: Social Network Management

A2.9.1 Description of the course

This course aims at raising awareness on the growing importance of on-line communications, to describe the importance of two-way vs. one-way communications, and to develop a critical attitude on the production of on-line content management. The frequency of the course allows its participants build knowledge on tools used in the management of current social networks, possibly to be used in their own workplaces.

A2.9.2 Description of the participants

This course is part of the Bachelor Degree in Corporate Communication Program of the School of Management of the Porto Polytechnic. The following groups of students were engaged:

- 34 students in the 2019 - 2020 academic year.
- 28 students in the 2020 - 2021 academic year.

A2.9.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active and problem-based learning in the context of a team project. Teams became familiar with the resources provided by the teacher related to the problem. Each team selected a problem and discussed potential solutions in the form of a media campaign. Then, the teams chose the most appropriate tool and used it to solve the problem. Finally, the teams analysed their results and presented them to the class.

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Figure 18. Students engage in group work in the Social Network Management course.

A2.10 Course: Management of Research Projects

A2.10.1 Description of the course

Technical project management skills related to the management of the scope, time, risks, communication, and quality of a project have been developed for 50 years and are currently recognized as useful for the planning and control of projects or programs that people or organizations develop in the market. The vision of a project as a way to generate knowledge, design solutions, produce new products, introduce innovation, and earn competitive advantage has been disseminated globally. In this course students increase their knowledge on the critical areas of project management, methodologies and management tools, and technical and behavioural skills that the project manager must mobilize to reach the end of a successful project. Based on a case study, students develop a project plan, a useful planning tool at any stage of a Master's or PhD activity. In parallel, a space is created for discussion of various issues related to the success of a project.

A2.10.2 Description of the participants

This course is part of the Master's Degree in Biostatistics Program of the Health School of the Porto Polytechnic. 34 students were engaged in the 2019 - 2020 academic year.

A2.10.3 Description of active learning deploying ALIEN methodologies and tools

This course allowed students to integrate knowledge acquired in the programme in a project they manage. The pedagogical methodology of the course was project-based learning. As part of an active learning methodology students were asked to design projects that solve a certain problem. The students were asked to do the task independently. With the pandemic restrictions, students used on-line tools including ALIEN's problem-based learning platform to conduct discussions and make progress through the different stages of the project.

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Figure 19. Students engage in research in the Research Projects course.

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A3. University of Central Lancashire

A3.1 Course CO2509: Mobile Computing

A3.1.1 Description of the course

Mobile devices are increasingly becoming a large part of work and daily lives with an associated increasing demand and marketplace for mobile apps. Improvements in wireless networks, hardware technology, and protocols for the provision of distributed services have rapidly increased the capability and popularity of personal ICT, including mobile phones, personal digital assistants, and mobile PCs. The enabling technologies provide both technical and user-interface challenges for software developers. This module explores key underlying technologies used to support mobile applications and extends development skills to produce software for mobile devices, along with skills to understand how to design successful mobile applications.

A3.1.2 Description of the participants

The course is compulsory for students on the Software Engineering Degree and is an option in the Bachelor Degree in Computer Science and Bachelor Degree in Games Development. The following groups of students were engaged:

- 27 students in the 2019 - 2020 academic year.
- 34 students in the 2020 - 2021 academic year.

A3.1.3 Description of active learning deploying ALIEN methodologies and tools

Students were required to develop a mobile based application and evaluate the product. They were tasked with evaluating an existing mobile application, having to select an appropriate method, they then had to try and establish how to use the method and report their findings. This use of problem-based learning challenged the students to think about what data they needed to capture and on how they would then analyse the data and infer conclusions.

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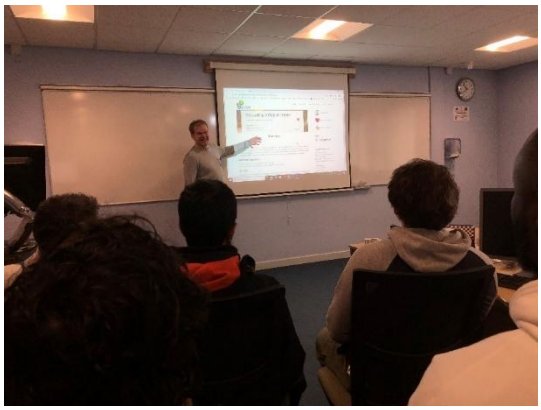

Figure 20. Students evaluate mobile games in the context of the Mobile Computing course.

The learning from course activities was applied to the assessment for the module.

A3.2 Course CO2519: Interacting with the internet of Things

A3.2.1 Description of the course

This course aims to teach students about prototyping and the internet of things. The aims are to develop an understanding of the technologies underpinning the internet of things and how they communicate, to develop the skills necessary to design, develop, test, and evaluate secure applications created within the scope of the internet of things, to explore legal, ethical, social, and user experience issues relating to the internet of things, and to enhance the student's ability to select appropriate hardware and software for devices used within the internet of things.

A3.2.2 Description of the participants

The course is an option for students on the Bachelor Degree in Computer Networking and the Bachelor Degree in Computer Science. The following groups of students were engaged:

- 34 students in the 2019 - 2020 academic year.
- 53 students in the 2020 - 2021 academic year.

A3.2.3 Description of active learning deploying ALIEN methodologies and tools

The students were tasked with trying to respond to a funding call, based around a real-life scenario. According to the scenario, the University of Central Lancashire has recently set up

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a Research Centre for Digital Life and they is looking to fund a small number of innovative projects that use internet of things to improve the lives of people in Lancashire. The students were told that the call is open and were asked to clearly identify the user group, which could be children, the elderly, farmers, commuters, and more. Furthermore, they were asked to clearly describe the benefit of their proposed system to the user. Students were challenged to create an annotated storyboard that clearly demonstrates their internet of Things system. Through annotations clearly explained how the system worked with respect to the internet of Things, the sensing layer, network layer, data processing layer, and application layer. The storyboard and annotations should clearly demonstrate how data was to be captured, transferred, processed, and how the end user would interact with the data.

The students were required to investigate regional problems, understand communities and identify hardware which would be feasible to use, and then design a system. They then used Arduino® technology and sensors to prototype parts of this system. Weekly laboratories were used to facilitate the task and enable students to ask questions about their proposal.

A3.3 Course CO3717: Games for the internet

A3.3.1 Description of the course

This course provides students with the skills and background necessary to develop internet-based games, examining the technology that is utilised for the development of on-line games and their distribution. Psychological aspects, including playability and usability, particular to internet games are evaluated. Emphasis is placed upon the multimedia concepts relevant to on-line game implementation.

A3.3.2 Description of the participants

The course is compulsory for students on the BComp Games Development Degree and is optional on the Bachelor Degree in Computer Science degree. 42 students were enrolled in the course in the 2020 - 2021 academic year.

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A3.3.3 Description of active learning deploying ALIEN methodologies and tools

As the module was about games design and evaluation within the context of the internet the task involved the evaluation of a mobile game as per the activity described in CO2509: Mobile Computing. These were a different cohort of students and therefore the same exercise was judged to be appropriate.

Figure 21. Students discuss a problem in the context of the Games for the internet course.

A3.4 Course CO4753: Design Away from the Desktop

A3.4.1 Description of the course

This module introduces students to user experience design in the context of possibilities enabled by the use of new and novel technologies that depart from the typical desktop metaphor and into the realms of the ubicomp vision. Students learn to design, build, and critically reflect on interactive applications using technologies, such as embedded, tangible, and surface. Students also learn how these technologies impact and are influenced by existing research.

A3.4.2 Description of the participants

The course is compulsory for students on the Master's Degree in User Experience Design and an option for students on the Master's Degree in Computing. The following groups of students were engaged:

- 19 students in the 2019 - 2020 academic year.

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- 24 students in the 2020 - 2021 academic year.

A3.4.3 Description of active learning deploying ALIEN methodologies and tools

The students were tasked with developing a prototype application using Arduino® input over the course of a 10-week period. Students needed to investigate how to program the device taking into account the capabilities and limitation of the hardware and demonstrate weekly progress on their learning. At the end of the period students demonstrated to the class the prototype explaining how it works and reflecting on their learning.

Figure 22. Students build a digital egg and spoon technology following an idea they formed from considering how sports days might work in the context of the Design Away from the Desktop course.

A3.5 Course CO4732: User-Centred Design and Evaluation

A3.5.1 Description of the course

This is an inherently practical module that introduces the principles of user-centered design and evaluation. The module is delivered in two halves. The first half considers design and supports the learning of students to carry out a group design project. The second section focuses on evaluation.

A3.5.2 Description of the participants

The course is compulsory for students on the Master's Degree in User Experience Design and the Master's Degree in Computing. The following groups of students were engaged:

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- 143 students in the 2019 - 2020 academic year.
- 154 students in the 2020 - 2021 academic year.

A3.5.3 Description of active learning deploying ALIEN methodologies and tools

The students had to learn about user-centered design methods to create a prototype. This was a group-based activity. The students had to roll a dice to create a unique scenario, with different user groups and technologies, which they would design for. Over 5-week period students investigated the users and applied appropriate methods to create a prototype system. For example, they were informed about the usefulness of personas in a taught class but then had to go away and create these for their unique scenario.

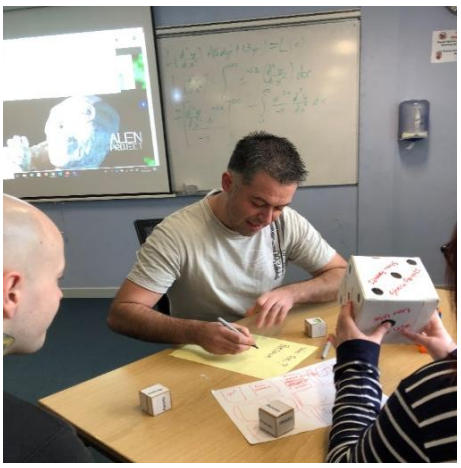

Figure 23. Students roll the dice to generate a design brief in the context of the User-Centred Design and Evaluation course.

To complete this task, they had to investigate ways of creating personas, collect data, and synthesize a set of personas to aid their design.

A3.6 Course CO4820: Critical Analysis

A3.6.1 Description of the course

This is a research methods course that is intended to equip students with problem-solving skills, research skills, writing skills, and statistical skills in order for them to succeed in a master's programme. Students are expected to be able to describe, run, experiment,

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design, and administer a survey and to be able to write up their research in a standard way as if for publication.

A3.6.2 Description of the participants

The course is compulsory for students on the Master's Degree in User Experience Design, MSc Computing, and MSc IT Security. The following groups of students were engaged:

- 143 students in the 2019 - 2020 academic year.
- 249 students in the 2020 - 2021 academic year.

A3.6.3 Description of active learning deploying ALIEN methodologies and tools

Students were asked to determine if there was a difference between entering text on a keyboard or on a tablet. They were asked to provide evidence of any claim made. Prior to being given this challenge students had learned about experimental design and about research paper writing but for the problem-based learning activity they had to design and carry out an investigation. In the first cohort, around 70% of the students chose to take an experimental approach with many using the metrics from Mackenzie's work at York University. In running their own experiments, the students learned by doing about the need for instructions, the need to control order effects, and the need to be specific about technologies used. Over 50% of the students realised their first attempts were in need of modification.

Figure 24. Students work on projects in the context of the Critical Analysis course.

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Because of COVID-19, in the second cohort most of the students used a survey and thus only gathered opinions. But again, many realised having built one survey that they were not asking useful questions or that they had answer choices that did not match what the respondents wanted to say so they learned a lot about surveys as they had to redo this activity to be able to offer evidence. In the exam for the course the students were asked to reflect on what they had learned.

A3.7 Course MSC065: Foundation Maths

A3.7.1 Description of the course

This is an entry level mathematics course intended for students who come to the University without a classic maths qualification. It covers all aspects of mathematics, including numeracy, trigonometry, algebra, geometry, and statistics. The course is evaluated by coursework and by an exam.

A3.7.2 Description of the participants

The course is compulsory for students on the FdSc. 41 students were enrolled in the 2019 - 2020 academic year.

A3.7.3 Description of active learning deploying ALIEN methodologies and tools

Students were asked to design a snakes and ladders game with some accompanying dice that would ensure that every time they played a partner they could guarantee to win. To complete this challenge, students had to consider the numbers that would be placed on the dice and the positioning of snakes and ladders on the board.

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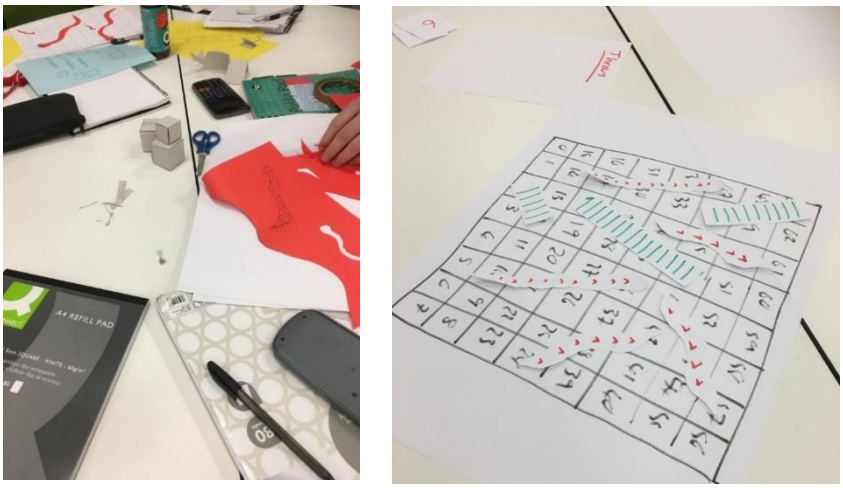

Figure 25. Students work on math exercises and a snakes and ladders activity in the context of the Foundation Maths course.

Through these activities, students learned about probability but also about how to describe game instructions.

A3.8 Course CO1111: Computing Skills

A3.8.1 Description of the course

In this module, students work in teams to create, evaluate, market on-line, and present a sophisticated computing-related product through a series of intensively supported exercises and guided discovery.

A3.8.2 Description of the participants

The course is compulsory for students all students of computing undergraduate courses degrees in computing and is the 1st module they complete in year 1 of their studies. The following groups of students were engaged:

- 177 students in the 2019 - 2020 academic year.
- 242 students in the 2020 - 2021 academic year.

A3.8.3 Description of active learning deploying ALIEN methodologies and tools

The students were placed into groups and worked over 4 weeks to design, develop, and market a mobile treasure hunt application.

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Figure 26 Students showcase their mobile app in the context of the Computing Skills course.

Each week they were required to complete a specific task within their groups, for example connect their phone to a server to extract data to be used in the app, investigate, and market the app. At the end of the 4 weeks, they produced a marketing stall to showcase their work.

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A4. University of Malaya

A4.1 Course WIF3008: Real-Time Systems

A4.1.1 Description of the course

This course introduces real-time systems. The differences between soft and hard real-time systems are explained. Issues related to system decomposition and scheduling techniques are discussed. These include Timed Petri Net, clock-driven scheduling, as well as priority-driven scheduling of periodic, a-periodic, and sporadic tasks. The course also covers issues, such as multiprocessor scheduling and resource access control, fault tolerance, and real time communication.

A4.1.2 Description of the participants

This course targets undergraduate students in the Department of Software Engineering, Faculty of Computer Science and Information Technology. Approximately 52 students enrolled on the course. Most of them were 3rd year students. The course was delivered in semester 1 of the 2019 - 2020 academic year.

A4.1.3 Description of active learning deploying ALIEN methodologies and tools

The purpose of the course was to develop student experience through a basic design-build project. Through the course students were challenged to explore a given problem in the Faculty of Computer Science and Information Technology surroundings or within the University of Malaya. The problem was designed to be solved using a real-time system. Students implemented the following problem-based learning steps:

- Elaborated on an issue with specific focus using a real-time systems-based solution.
- Designed the real-time system architecture.
- Analyzed the real-time systems of the proposed solution.
- Applied ethical principles and discipline.
- Functioned effectively in a team.

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- Communicated effectively on complex computer science activities through presentations.

The course included project and problem-based learning. Students were required to choose a problem that exists in the Faculty of Computer Science and Information Technology or within the University Malaya that could be solved by applying real-time systems using Arduino, Raspberry Pie, drones, or the Anonymous Car platform. Students were asked to create real-time system architectures and analyze real-time systems. Students were further asked to explain how their system addressed the identified problem. Students presented their work in class by week 13 of the course.

Students were divided into groups of 9 - 10 individuals. Each group appointed a leader. Team members discussed the group rules, developed a group contract, and assigned roles to each team member.

The activities were implemented in the TEALS laboratory that was developed through the ALIEN project using the equipment purchased.

Students implemented the following activities:

Step 1: Draft a group contract

Each team created the first draft of the group contract and agreed on the rules that underlined team member collaboration.

Expectation: to prepare the first draft of a team group contract.

Step 2: Explore the TEALS problem-based learning laboratory equipment

Each team explored the IoT problem-based learning equipment available in the TEALS laboratory. Team members helped each other understand the functionality of the equipment and exchange knowledge and findings. Team members were asked to perform the following tasks:

- Fly the drone, 2 students.

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- Light up LED using Arduino®, 2 students.
- Light up LED using Raspberry Pie®, 2 students.
- Set up the Anonymous Car®, 2 students.
- Design and print a small object using 3D printer, 2 students.

Through this activity, students developed good psychomotor skills in operating the IoT equipment.

Expectation: to become familiar with the TEALS laboratory problem-based learning equipment.

Step 3: Identify a problem

Students identified problems in the Faculty of Computer Science and Information Technology or in the University of Malaya's environment that could be solved using real-time systems. Students were encouraged to hold discussions outside of the class for selecting a problem from a pool of options, drawing a real-time architecture, and interviewing potential users informally. The result of this activity was the definition of the problem by the students, namely the title and the general description.
Expectation: to identify a problem to work on.

Step 4: Design the architecture

Students discussed the architecture, analyzed issues, and reassigned team member roles. Students filled out the FILA form and updated the group contract with a particular focus on team member roles.

Expectation: to generate an updated group contract.

Step 5: Identify required changes and implement them

Students were challenged to decide if any changes needed to take place on the initial architecture design.

Expectation: to generate an updated FILA form, if necessary.

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Step 6: Solve problems related to ethics

Students focused on and addressed the ethical issues of the project implementation.

Expectation: to generate an updated FILA form. To be able to solve problems related to ethics and discipline.

Step 7: Present solution to class

Students presented and demonstrated their respective IoT implementation to the class. Each student presented their task in the context of the group project in the span of 1 - 2 minutes. Students were encouraged to use power points, video, acting, and other means to deliver the presentation. This approach fostered student creativity.

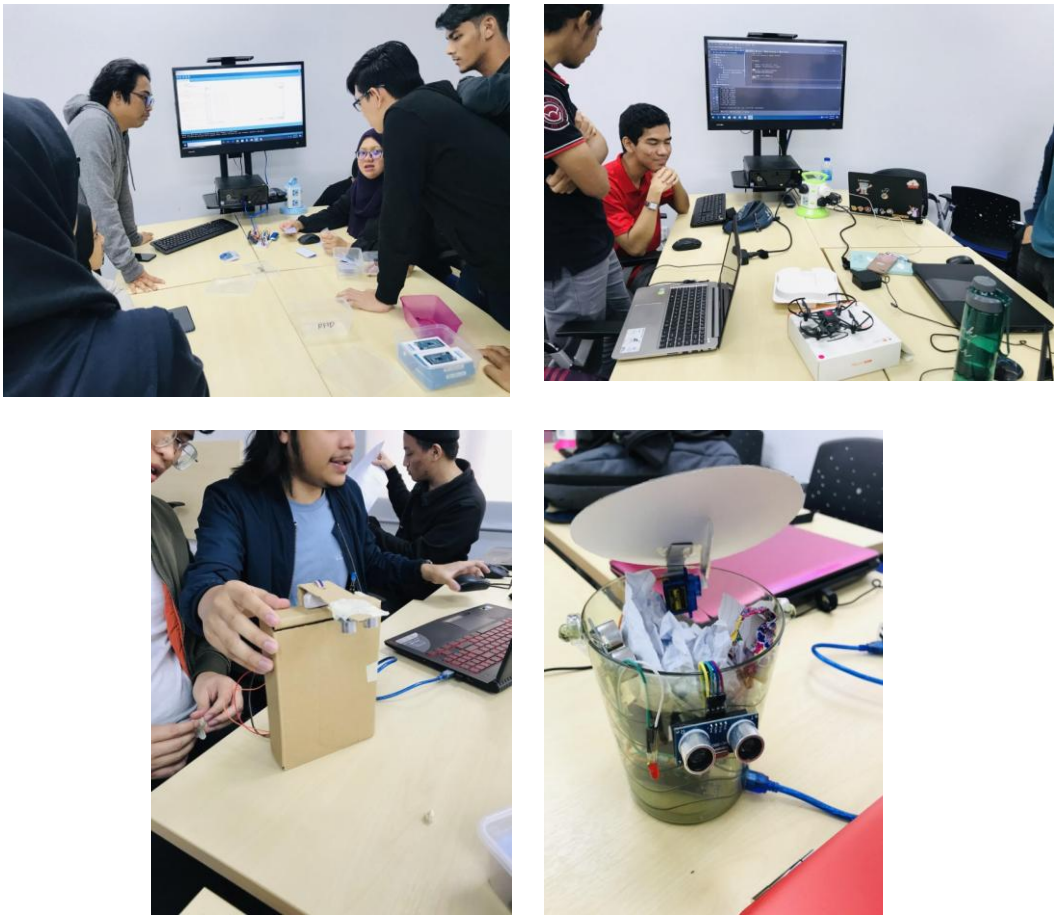

Figure 27. Students discuss, configure, and test in the TEALS laboratory in the context of the Real-Time Systems course.

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A4.2 Course WIF2001: Human-Computer Interaction

A4.2.1 Description of the course

This course covers both human factors and the technical methods for the design and evaluation of interactive systems. It addresses 4 main topics, namely overview of human-computer interaction, essential interaction design principles, user-interface development process, and interface design and programming.

The course introduces computers, humans, and their interactions. It further discusses user-interface and user-experience issues. It further introduces essential interaction design principles, such as 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.

More specifically, the discussion on user-interface development processes includes topics on iterative design, user-centered design, design discovery, design exploration, and evaluation of user-interfaces. The interface design and programming section of the course includes 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.

A4.2.2 Description of the participants

This course was conducted to undergraduate students from the Department of Software Engineering, Faculty of Computer Science and Information Technology. Approximately 120 students were enrolled. Most of them were 2nd year students. The course took place in semester 2 of the 2018 - 2019 academic year.

A4.2.3 Description of active learning deploying ALIEN methodologies and tools

Students were assigned a human-computer interaction project, which was conducted through active learning, and more specifically project-based learning, with the intention of covering the following topics: design principles, conceptual design method, storyboarding,

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personas, and usability testing. The context of application of these topics was embedded in the following objectives of the project:

- Designing, prototyping, and evaluating an interactive game.
- Applying the knowledge and content of the HCI course in real-life situations using Arduino®/Raspberry Pi®, 3D printer, and a writable surface.

The Human-Computer Interaction course student project website is available at http://alien.fsktm.um.edu.my. The web page illustrates the use of TEALS, the equipment, the outcomes of student projects project. The web site presents:

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

Figure 28. The TEALS laboratory equipment.

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The course took place in the Technology-Enabled Active Learning Space (TEALS), a learning space designed through the ALIEN project for conducting active learning classes in the Software Engineering Department, Faculty of Computer Science and Information Technology, University of Malaya.

TEALS consists of seven islands with 7 - 8 students per island. The laboratory can accommodate of 49 - 56 students at a given time. Each island is equipped with movable workstations, monitors, casters, writable surface, drones, Arduino®, and Raspberry Pi® kits.

TEALS is equipped with 1 unit of Autonomous Car® and a 3D printer used in the active learning process. The laboratory also offers one Samsung Galaxy® Tablet for the lecturer to use.

Figure 29. The TEALS laboratory in use during the Human-Computer Interaction course (WIF 2001).

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A4.3 Course WQC7003: Systems Modeling

A4.3.1 Description of the course

This course covers topics such as systems development roles, systems development building blocks, systems development processes, systems development project management, systems analysis, fact-finding techniques for requirements discovery, modeling system requirements with use cases, data modeling and analysis, process modeling, feasibility analysis and the system proposal, object-oriented analysis and modeling using UML, systems design, application architecture and modeling, database design, output design and prototyping, input design and prototyping, user-interface design, object-oriented design and modeling using UML, systems construction and implementation and systems operations and support.

A4.3.2 Description of the participants

The course enrolled 8 final year students of the Master's in Information Technology Management program, for semester 1 of the 2019 - 2020 academic year. The Master's in Information Technology Management is a program that provides opportunities for candidates who do not have any degree related to Computer Science to meet the needs for information technology management knowledge and skills in the organizations. Therefore, the students have different backgrounds, such as business and dentistry. Being close to the completion of their studies, the participants are well familiar with the fundamentals of information technology, such as web commerce, multimedia system development, management statistic, data mining, database management, and web development. In this course they need to model a software system to resolve a real-life problem that requires understanding of the relation between software requirements, software modeling and the concept of programming.

A4.3.3 Description of active learning deploying ALIEN methodologies and tools

The students were required to draw a UML activity diagram that controlled the activities of a drone as well as the drone flight plan. Course activities were organized as follows:

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Step 1: Pre-activity questionnaire

The educator prepared a questionnaire for students to fill-in. The questionnaire was designed for collecting data on the understanding of the students on specific subjects. It further aimed at documenting student prior knowledge before engaging in the activity, informing the teaching method to be deployed.

Step 2: Base source code

The educator prepared a simple source code that allowed students to observe the relation between their project source code and the behavior of the software that they produced. The educator provided clear guidelines on how to edit the source code. The educator introduced the concept of UML activity diagrams through active learning. The educator was advised to not introduce UML concepts before the related active learning session took place.

Step 3: Active learning session for Systems Modeling

The educator engaged students in active learning on Systems Modeling. During the active learning session students were required to draw a UML activity diagram that displayed the drone activities and the control flow of a drone flight plan.

Students implemented the following tasks:

- Students answered the active learning pre-activity questionnaire.
- Students run a simple drone flight plan without control flow. The plan consisted of 4 activities: take-off, moving forward, turning 90 degree clockwise, and landing.

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Figure 30. Students discuss, configure, and test in the TEALS laboratory in the context of the Systems Modelling course.

- Students discussed and drew the UML activity diagram for the simple flight plan on a writable surface. In this stage, students are instructed to use formal UML notation. The educator checks the diagram and gives guidance if required.
- Students run the flight plan once more with control flow.
- Students were required to discuss and draw the UML activity diagram for the complex flight plan on the writable surface. The educator checked the diagram and gave guidance where required.

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Figure 31. Casual photo after the class.

- Students designed a new flight plan by drawing a new UML activity diagram. Then, they edited the source code. In this stage, students run their drone program to check if their source code matched with their designed flight plan. The educator checked the diagram and provided guidance where required.
- Students presented their work to their peers.
- Students answered a post-activity questionnaire.

A4.4 Short-term mobility (inbound) student exchange program module: Understanding Control Flow through Drone Programming

A4.4.1 Description of the course

The faculty of Computer Science and Information Technology (FCSIT), University of Malaya often receives a group of international students to participate in their short-term mobility student exchange program. In 2019, the student exchange program included a module that incorporated active learning methods to build knowledge on programming concepts using the Tello® EDU drones. The module adopted the gamification and simulation approach to build student skills on control flow concepts related to programming. The programming languages used for this module were Python® and DroneBlocks®. Each module session took 4 - 6 hours to complete.

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A4.4.2 Description of the participants

The module is designed to address the needs of undergraduate 1st year Computer Science and Engineering students. It was delivered in the 2019 - 2020 academic year. The following groups of students were engaged:

- 12 undergraduate and postgraduate students from the University of Cardiff, United Kingdom.
- 30 Computer Science undergraduate students from the University of Lanzhou, China.
- 15 undergraduate Computer Science and Engineering students from Telkom University, Bandung, Indonesia.

A4.4.3 Description of active learning deploying ALIEN methodologies and tools

The goal of the module was to understand and develop the ability of students to use control flow concepts in programming by integrating them into the software code of a programmable drone. Once students became familiar with the concepts, they deployed them in a final mission in which they competed in teams.

The session plan for the module was as follows:

- Students filled in a pre-activity questionnaire that aimed to establish their level of knowledge on control flow concepts.
- Students were introduced to the concept of control flow, notation for representing control flow, basic programming notation using the Python® or DroneBlocks® programming languages, which was directly used in control flow design, and the Tello EDU® programmable drone.
- Students engaged in a demonstration of flights implementing control flow concepts. For this step students were grouped in teams of 4 - 5 individuals. Each team was allocated a drone and writable surface. Each student in the team was assigned a role, mainly for the purposes of enforcing safety during flight:
    - Pilot, who was responsible for launching the mission.
    - Co-pilot, who was responsible for positioning the drone.

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- Control tower, who handled requests for take-off.
- Engineer, who charged the battery when it reached 60% of capacity or after every mission.
- Safety officer, who ensured that the flight area was clear.

- Students were given a series of short flight missions. They were required to implement and simulate each control flow concept through programming using either Python® (used by students from the University of Cardiff and Lanzhou University) or DroneBlocks® (used by students from Telkom University) in to the Tello EDU® drone.
- Students engaged in a challenge / competition. After they completed the activities, students were assigned a special flight mission to implement using the control flow concept. The mission was either a time-based or creativity-based challenge.

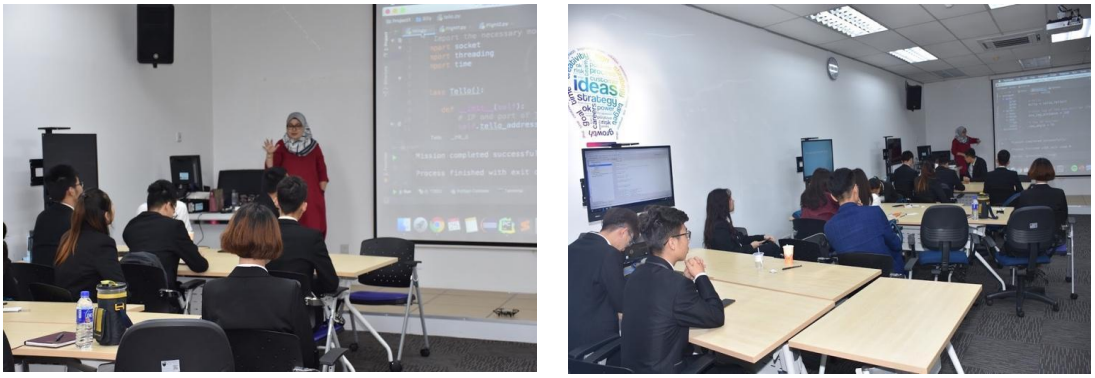

Figure 32. Students from the University of Lanzhou engage in the student exchange module.

- Students filled-in a post-activity questionnaire that included the same questions as the pre-activity one and aimed to establish the increase of student understanding on control flow concepts as a result of the activity.
- Students answered reflective questions related to the concepts learned.

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Figure 33. Students from the University of Cardiff, United Kingdom work on projects in the context of the Control Flow module.

Figure 34. Students from Telkom University work on projects in the context of the Control Flow module.

A4.5 Course WIA2005: Algorithm Design and Analysis

A4.5.1 Description of the course

The course introduces students to the analysis and design of computer algorithms. Students build knowledge on basic design techniques, important classic algorithms, and advanced

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data structures as well as their implementation in modern programming environments. The course includes an active learning session which focuses on one topic, and specifically sorting algorithms. Hands on activities deploy the kinestatic and buzzgroup approach for understanding the concept. The session takes 120 minutes to complete.

A4.5.2 Description of the participants

This course is a 4th semester obligatory course for the Bachelor of Computer Science Program at the Faculty of Computer Science and Information Technology, University of Malaya. It is attended by all 2nd year students enrolled in the Bachelor of Computer Science Program. The 1st session of active learning for this course was conducted in semester 2 of the 2019 - 2020 academic year. The course engaged 2 tutorial groups that enrolled a total of 80 students.

A4.5.3 Description of active learning deploying ALIEN methodologies and tools

The goal of this active learning session was to develop student understanding and skills on using the sorting algorithm learned during lecture. The session aimed to ensure that students effectively understand the algorithm by engaging them in additional active learning tasks. Students worked in groups. They presented their findings on the algorithm to the class. Students were asked to apply the algorithm to a set of given input elements. They were also asked to classify the algorithm in one of several categories as well as to discover its advantages and limitations. This session deployed the writable surface of the TEALS problem-based learning laboratory built through the ALIEN project as the main tool for the activity.

The session plan for the module was as follows:

- Students filled in a pre-activity questionnaire that aimed to establish understanding on algorithm design.
- Students are divided into groups of 4 - 5 individuals to work on a buzzgroup activity.
- Each team was allocated several writable surfaces to use.

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- Each team was randomly assigned 2 algorithms to prepare. A particular algorithm was examined by 2 teams in a single session.
- Each team was allocated 1 hour to discover information on the algorithm based on the following:
    - Applying the algorithm to an input element.
    - Discussing the running time complexity for all possible conditions.
    - Classifying the algorithm into the following categories:
        - In-place vs. not in-place.
        - Online vs. offline.
        - Stable vs. not stable.
        - Adaptive vs. non-adaptive.
- Each team presented the algorithm to the class. Since 2 teams worked on each algorithm, they checked each other's presentation.
- Students filled-in a post-activity questionnaire that included the same questions as the pre-activity one and aimed to establish the increase of student understanding on control flow concepts as a result of the activity.
- Students answered reflective questions related to the concepts learned.

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Figure 35. Students collaborate in the Algorithm Design and Analysis course.

A4.6 Student's Final Year Project: Drone Guide

A4.6.1 Description of the course

Final year students of Faculty of Computer Science and Information Technology implement 2 projects titled Final Year Project 1 and Final Year Project 2 in semesters 6 and 7 of their study. In the 2020 - 2021 session, semester 1, one student is developing a Drone Guide as his Final Year Project. He has applied inquiry-based learning throughout his project in order to complete the drone guide prototype.

A4.6.2 Description of the participants

The participant is a final year student undertaking Final Year Project 1 and Final Year Project 2 under the supervision of Dr. Asmiza Abdul Sani.

A4.6.3 Description of active learning deploying ALIEN methodologies and tools

The goal of this module was to understand and be able to apply requirements for developing a drone guide for the purpose of guiding a guest to their specific destination based on a pre-defined layout. The topic was proposed by the supervisor. The students applied inquiry-based learning techniques. They identified and conducted several data gathering methods to identify the requirements for designing the drone guide as well as independent learning for building the technical skills required for the implementation.

The foreseen activities for Final Year Project implementation were:

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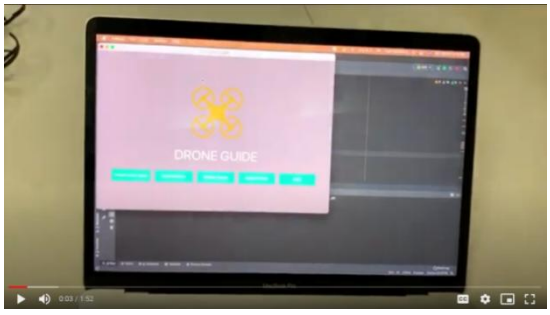
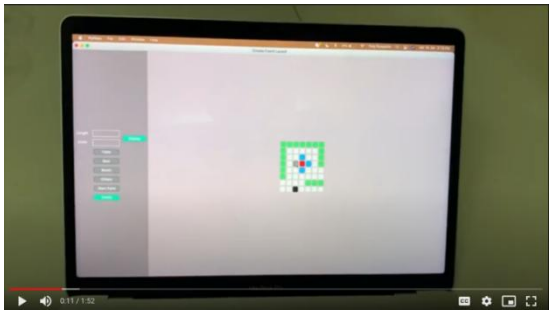
- Students analysed implementation requirements using requirements elicitation methodologies.
- Students developed a software requirements document for their application.
- Students developed a design and specification document for their application.
- Students identified possible implementation approaches and independently acquired the necessary implementation skills.
- At the end of Final Year Project 1 students performed a viva session to present their findings to a pair of panels. They further submitted a report to their supervisor.
- During the viva of Final Year Project 1, students demonstrated parts of drone guide prototypes.
- In Final Year Project 2, students continued the development of their application.
- Students tested the completed application.
- At the end of Final Year Project 2, students performed a viva session to present their findings to a pair of panels. They further submitted a report to their supervisor.
- During the viva of Final Year Project 2, students demonstrated a complete drone guide prototype.

The figures below demonstrate screenshots from the drone flight demonstration video. Since this is conducted during the Movement Control Order due to COVID-19 pandemic, the students demonstrated the prototype using their kitchen and dining table layout.





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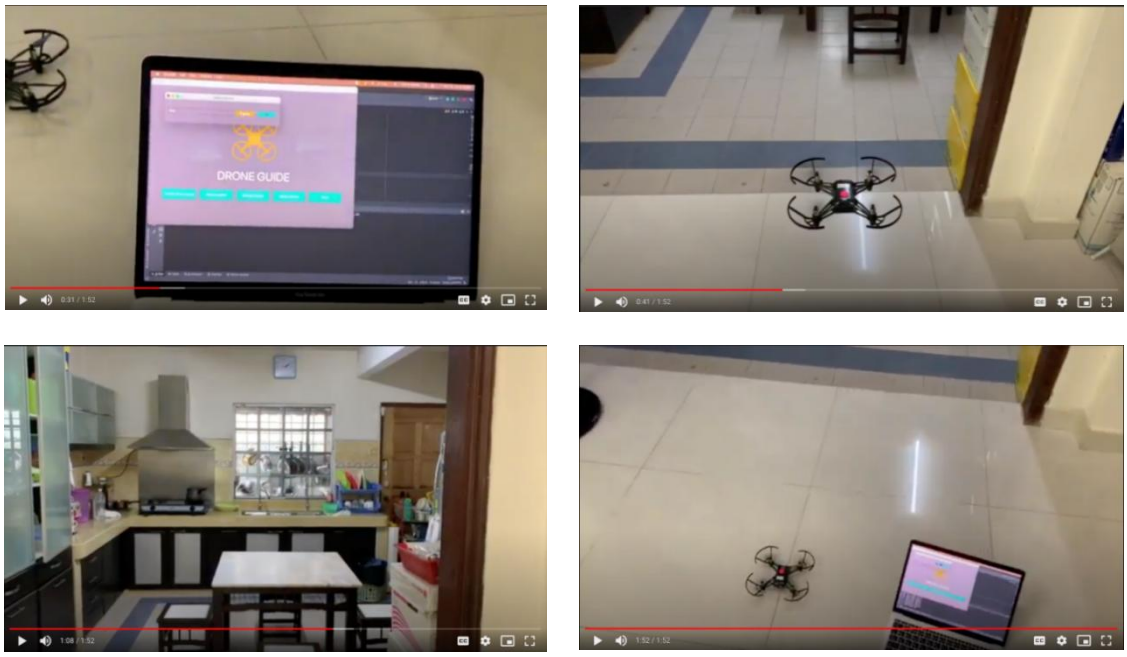

Figure 36. Students demonstrate their drone in the Final Year Project activities.

The evaluation for this module was divided into 2 parts. As stated above, evaluation was based on viva presentations and a written report. Evaluation criteria included the ability of the students to prepare the documentation, identify the appropriate development methodologies, and complete and correct implementations. Furthermore, evaluation addressed soft skills. The results of the student work were reflected on the marks given by the panels and supervisor, which demonstrated that the student was able to develop a drone guide prototype according to the identified user requirements.

A4.7 Course WOC7010: Agile Software Development

A4.7.1 Description of the course

The course examines agile methods, including extreme programming (XP), SCRUM, lean, Kanban, Crystal, dynamic systems development methods, test-driven development, and feature-driven development. The course aims at building understanding on how rapid realization of software can most effectively be achieved. The ability of agile development teams to rapidly develop high quality, customer-valued software is examined and contrasted with teams following more traditional methodologies that emphasize planning

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and documentation. Students build knowledge on agile development principles and techniques covering the entire software development process from problem conception through development, testing, and deployment. Issues of adopting agile methods are also discussed.

A4.7.2 Description of the participants

The course is an elective for Masters of Software Engineering students in the Faculty of Computer Science and Information Technology of the University of Malaya. 14 students enrolled in the course in semester 1 of the 2019 - 2020 academic year. Half of the students were Malaysian while the other half were from Bangladesh and Afghanistan.

A4.7.3 Description of active learning deploying ALIEN methodologies and tools

The main focus of the course was on project-based active learning, while jigsaw active learning techniques were also deployed. The course took place in the TEALS laboratory. Students were divided in groups. Each group was seated in a different island. Students used the workstations on the islands to display discussion ideas. At the same time, most students also use their own laptops for performing individual work. Students also used the writable surface of the laboratory to sketch ideas. Furthermore, students used the laboratory drones, which were part of the project deliverable. More specifically, the drones were deployed in the following activities:

- Applying agile, SCRUM methodologies for project development
- Selecting the applicable gesture for a predefined thematic area development.
- Designing a prototype for a gesture recognition system using drone.
- Identifying the platform to output the response from the drone.
- Displaying the outcomes on selected social media platforms.

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Figure 37. Students program drones in the TEALS laboratory in the Agile Software Development course.

In the context of active learning students implemented a project. The project brief was introduced on week 9 of the course. Students were allocated 4 weeks to complete their work. The objectives of the project were to demonstrate agile development practices in a software design, and more specifically the SCRUM model. Students engaged in practical work under weekly monitoring and submitted a report at the end of the project. The project allowed students to design, implement, and test an agile software product, and specifically a gesture recognition system involving the use of programmable drones and social media accounts. Students had the opportunity to present their work upon completion.

Assessment took place through FILA forms, a group contract, reflection, presentations, reports, and the comparisons of pre- and post-activity tests.

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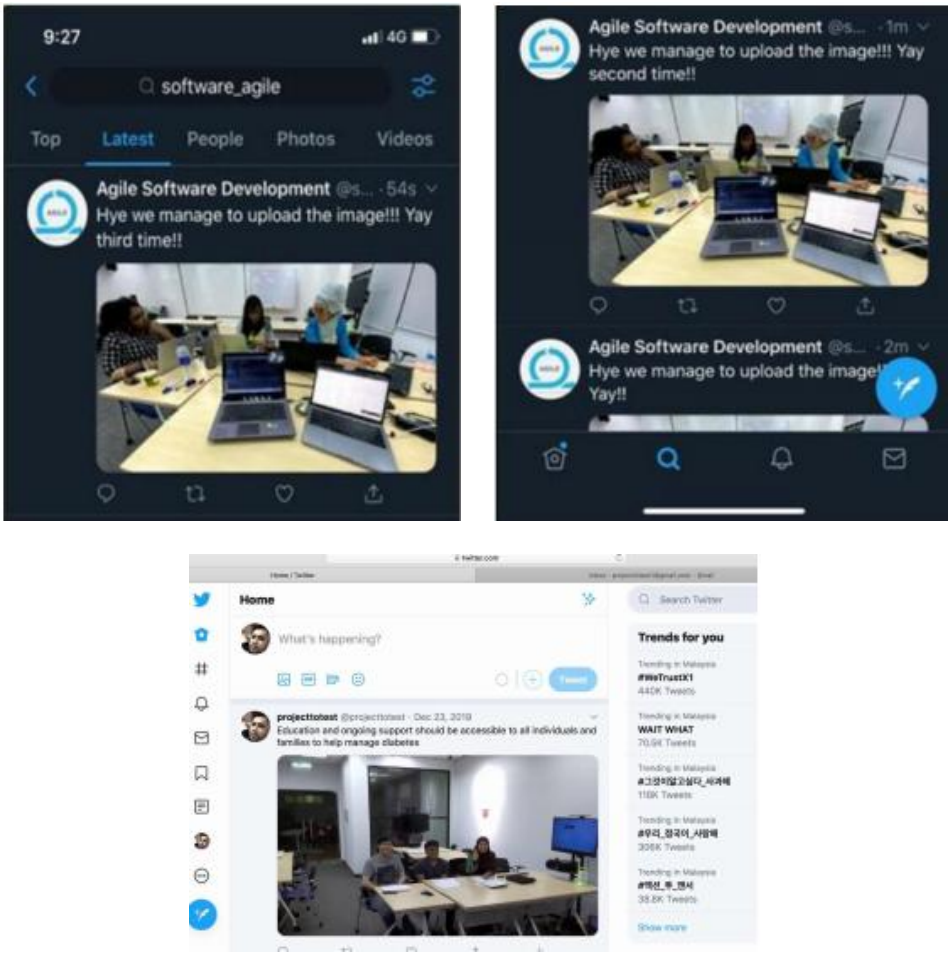

Figure 38. Students use drones to take pictures and send them to social media pages in the Agile Software Development course.

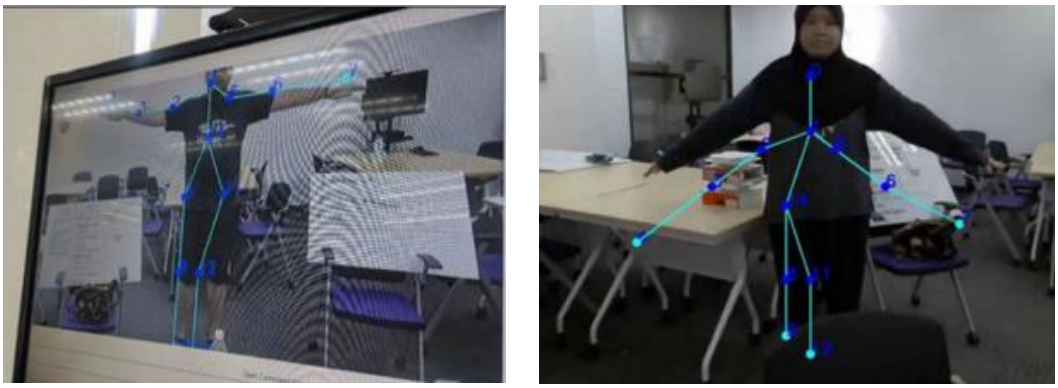

Figure 39. Students program drones to recognize gestures in the Agile Software Development course.

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The software that was deployed in the context of the course includes the Python® programming language, the Pycharm IDE for Python®, a Python® Interpreter, Python® packages for accessing social media, and gesture recognition libraries.

A4.8 Course WOA7001: Advanced Algorithms

A4.8.1 Description of the course

The course is offered in the Master's in Computer Science program. It introduces students to the analysis and design of computer algorithms. Students build knowledge on advanced design techniques, important classical algorithms and data structures, and their implementation in modern programming environments. Upon completion of the course, students are able to demonstrate familiarity with major advanced algorithms, apply advanced design and analysis techniques, and analyse the performance of algorithms.

A4.8.2 Description of the participants

Students that attend this course are enrolled in the Master's of Computer Science programme. 15 students were enrolled in the course in semester 2 of the 2019 - 2020 year. The student body was very international, including students from China, Iran, the Netherlands, Africa, the Middle East, as well as Malaysia. Some students were already employed in a software company while others were enrolled in the Master's program full-time. Students attended a few physical face-to-face classes before the COVID-19 lockdown order in Malaysia. After that, classes continued on-line.

A4.8.3 Description of active learning deploying ALIEN methodologies and tools

Active learning was the predominant methodology deployed in the course. Two different active learning methods were used, jigsaw and project-based group activities.

Before the COVID-19 restrictions were enforced, active learning took place in the TEALS laboratory. The jigsaw activity focused on sorting algorithms and involved the following steps:

- Students formed groups of 2 - 3 individuals.

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- Students selected a sorting algorithm, such as radix sort, count sort, shell sort, and bucket sort.
- Each group member studied the function of the algorithm and practiced coding it in a 2-hour session. This activity took place in the TEALS working islands using the workstations installed in each.
- In the last hour of the activity each group split in 2 subgroups. The 1st of those stayed on the island while the 2nd explained their algorithm to another group. This process continued until all teams visited all others explaining their work. The advantage of the activity lied in the students' repeatedly explaining their assignment, which contributed to the understanding of the algorithm and the improvement of communication skills.

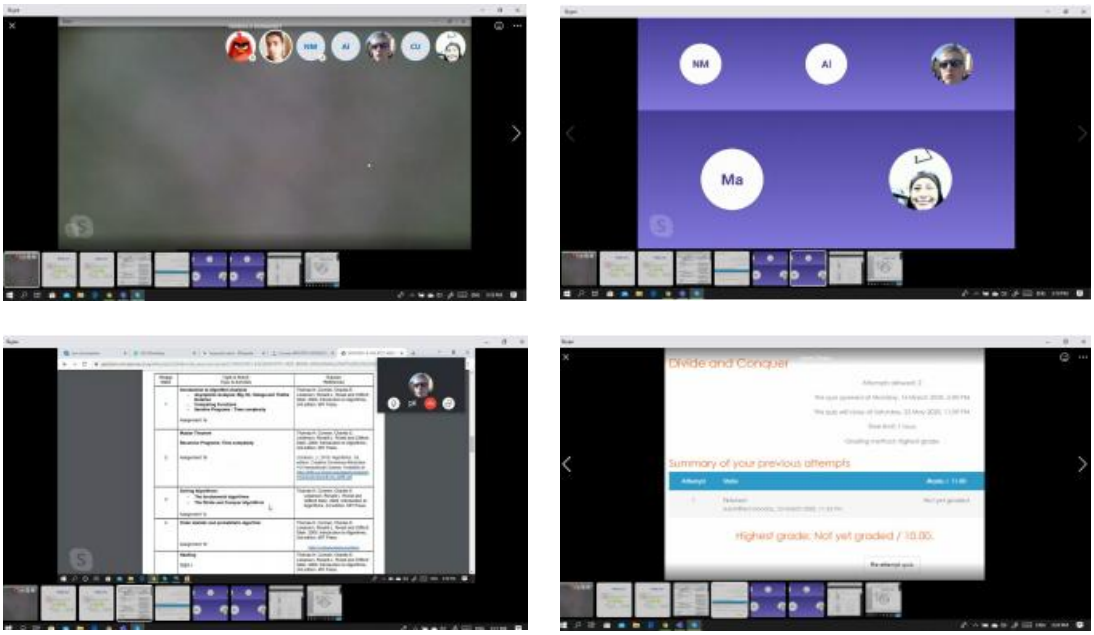

Figure 40. Students collaborate on-line via in project-based active learning activities in the Advanced Algorithms course.

The team-based project activity took place entirely during the COVID-19 lockdown. Students were given instructions in tutorial sessions in which study questions were introduced. Students worked in groups to answer the questions in focus and present their findings in slides, video presentations, and video interviews. Evaluation took place through FILA forms that helped monitor team dynamics and contribution.

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A4.9 Course WIF3001: Software Modelling

A4.9.1 Description of the course

This is a hands-on software modelling activity that allows students to develop understanding of theoretical concepts and their practical application. In software development it is critical for software analysts to capture dynamic system behaviour for understanding all the possibilities of how the system will behave in certain circumstances or states. UML state machine diagrams are dynamic models that show the different states that a single class passes through during its life in response to events. The single class must be dynamic and enters a variety of states over the course of its existence. The course uses a problem-oriented problem-based active learning method (POPBL). The instructor presents students with 5 different existing real-life software systems, from which students select one for performing an activity in groups. The instructor kick-starts the activity by introducing a topic. The instructor explains the objectives of the project, the input, output, and implementation steps, and the forms to fill in. The students are asked to execute existing system software for developing understanding on how it behaves in real-time. Subsequently, students are asked to pick 2 main classes of the system software, of which one is an external object and the other is an interface object. They have to consider all the alternative events that might take place and capture the different behaviour of the objects as a result of these events. The activity ends by students presenting the state machine diagram while running the system software to check consistency of the design. The activity is completed in 60 minutes.

A4.9.2 Description of the participants

The course is obligatory in the 2nd year of undergraduate studies at the Faculty of Computer Science and Information Technology of the University of Malaya. Approximately 80 students enrolled in the course in semester 1 of the 2019 - 2020 academic year. This is an entry-level course in software modelling. Participants had been exposed to case-based learning through 1st year courses.

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A4.9.3 Description of active learning deploying ALIEN methodologies and tools

The objective of the activity was to design a complete state machine diagram to model system behaviour. Students engaged in active learning for the modelling software related exercises linked to actual world practices.

Students implemented the following:

- Students selected a software system from a machine operating around them. For example, a vending machine, a microwave, or an electronic bicycle.
- Students executed the system of the machine to understand the operation of the system.
- Students decided which 2 classes of the system are predominant.
- Students studied the state changes of the classes. They were encouraged to consider all methods and guards that might affect the change of the states.
- Students drew 2 complete state machine diagrams to represent the 2 selected classes.

These activities were implemented by using the writable surfaces of the TEALS laboratory.

Figure 41. Students build finite state machines in the Software Modelling course.

The timeline of the activities was as follows:

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- Running the system (suggested duration 6 min).
- Discussing and determining the significant classes of the system (10 min).
- Dividing the group into 2 for each class (1 min).
- Running again the system if clarification is necessary (6 min).
- Deciding which states are involved for each class and determining transitions (10 min).
- Including complete transitions by documenting events, conditions, and actions (10 min).
- Finalizing the diagram (3 min).
- Presenting the diagram (5 min).

A4.10 Course WIF3001: Software Testing

A4.10.1 Description of the course

This course is fundamental and introduces students to the concepts of review of static testing. It aims at developing understanding of the process of review testing, including conducting the artefact examination of review testing.

A4.10.2 Description of the participants

The course is an elective course in the 3rd year of undergraduate studies of the Department of Software Engineering of the University of Malaya. Approximately 56 students were enrolled in the course in semester 2, of the 2018 - 2019 academic year. Participants had limited exposure to active learning. Through this course they built hands-on knowledge in an active manner on review testing.

A4.10.3 Description of active learning deploying ALIEN methodologies and tools

The active learning part of the course was based on the flipped classroom method and is performed using Dropbox® technology for synchronous reporting among team members. Students worked in groups to perform review testing. More specifically, students performed examination and reporting exercises for building better understanding on the basic

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principles of the review tests on a given artefact. Team members were assigned a role based on the review process and acted accordingly. At the end of the activity students submitted forms documenting their decision on the defect status of the artefact. The activity took place in the TEALS laboratory, where students used the writable surfaces.

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A5. Universiti Tenaga Nasional

A5.1 Course CSEB453: Software Quality

A5.1.1 Description of the course

The course introduces students to the fundamental concepts and principles of software quality. It further emphasizes the importance of ensuring quality in software products and services for being competitive in the software services industry. Topics covered include quality management systems, quality assurance plans, product and process quality models, inspection and walkthrough, software testing, software metrics, and common software quality standards. Upon completion of the course, students are able to explain the fundamental concepts associated with quality and software quality, apply appropriate techniques and processes in solving issues related to software quality assurance implementation, and work effectively in a team exercising quality assurance activities.

A5.1.2 Description of the participants

The course is compulsory for students enrolled in the Bachelor in Computer Science Bachelor in Computer Science (Software Engineering) (Hons.) Program at Universiti Tenaga Nasional. The course is included in 2nd year of studies curriculum. On average, a total of 50 - 100 students take the course each semester. It bears 3 credit units, which correspond to a 3 hour lecture each week.

A5.1.3 Description of active learning deploying ALIEN methodologies and tools

Active learning was deployed in the course for building knowledge on software inspection and walkthrough. For this activity, students were assigned a problem to be solved in groups. Each group was comprised of 5 - 6 students. The problem was also uploaded onto the ALIEN problem-based learning platform for easy access by participating students. The ALIEN problem-based learning platform further allowed the sharing of the problem among instructors.

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Figure 42. A problem uploaded onto the ALIEN PBL Platform in the context of the Software Quality course.

The learning objective of this activity was to build knowledge on the roles involved in an inspection process and the responsibilities of each role. Students were assigned into groups of 4 - 6 individuals. At the beginning of the session each group was asked to search for an inspection report template used by any software company that they can use to report the inspection activity that they would perform. This activity allowed students to understand the expectations from an inspection process and the important elements to look for in an inspection activity. In each group, students assigned amongst themselves the roles of moderator, author, reviewer, and scriber. In a group of more than 4 individuals, team members were allowed to allocate an additional reviewer and author in descending priority order. Each student was required to discover the responsibilities of the role she undertook during the inspection activity.

Each group was then given a sample program to inspect and the inspection session begins. Each member of the group played their role to ensure the delivery of each responsibility. Depending on the inspection templates that they had chosen students were required to complete the template with the required information that was obtained by conducting the inspection session. At the end of the activity they were required to submit the inspection report, the inspection meeting minutes, and the full description of each role assumed during the activity. In their submission they were asked to provide complete descriptions of the

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tasks that they performed according the roles assigned. The descriptions of the roles were used by the instructor to assess students' understanding of the topic and to facilitate discussion during the wrap-up session.

Due to the COVID-19 pandemic, the activity was slightly modified. Students were asked to submit a recording of their inspection session instead. This spared students from preparing a lengthy report and allowed the instructor to assess their understanding of the topic.

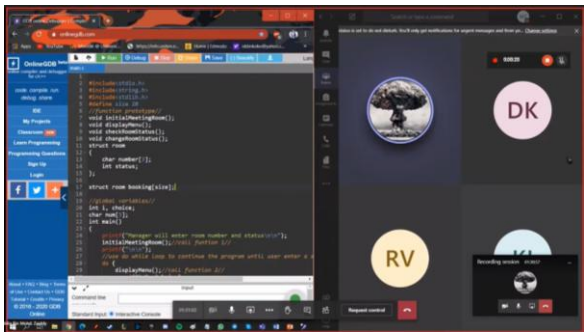

Figure 43. Students perform inspection activities on-line in the Software Quality course.

A5.2 Course CSEB334: Object-Oriented Programming

A5.2.1 Description of the course

The course introduces students to fundamental concepts and implementation of object-oriented programming in a pre-selected programming language. Topics covered include data types, variables, operators, objects, classes, methods, inheritance, polymorphism, string handling, regular expression, exception handling, arrays, abstraction, and interfaces. Upon completion of the course, students are able to describe object-oriented principles in system development, apply object-oriented concepts in system development, and produce a system to solve various problems using object-oriented approaches.

A5.2.2 Description of the participants

The course is compulsory for students enrolled in the Bachelor in Computer Science, Bachelor in Computer Science - Systems and Networking, and the Bachelor in Computer Science - Cyber Security programs at Universiti Tenaga Nasional. The course is part of the 2nd

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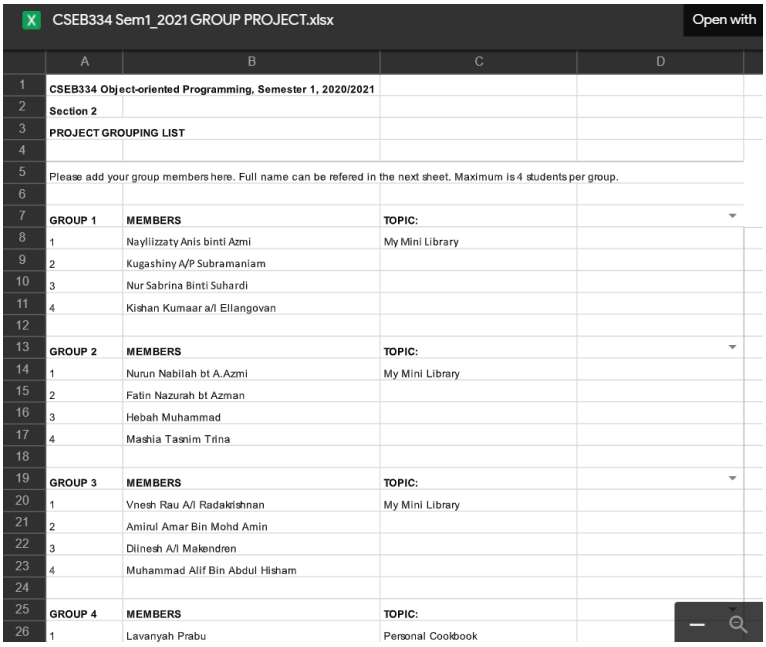
year curriculum of studies. It bears 4 credit points, which correspond to a 3-hour lecture and 2 hours of laboratory work each week. In semester 1 of academic year 2020 - 2021, which run from September 2020 to January 2021, 61 students were enrolled in the course.

A5.2.3 Description of active learning deploying ALIEN methodologies and tools

One of the active learning activities for this course was a systems development project. Students were given a problem to be solved in groups. Each group was comprised of 3 - 4 individuals. Students were required to register their group and choose a problem from a given list of choices in a Google® sheet. The activity took place on-line due to COVID-19 restrictions.



CSEB334 Sem1_2021 GROUP PROJECT.xlsx

	A	B	C	D
1	CSEB334 Object-oriented Programming, Semester 1, 2020/2021			
2	Section 2			
3	PROJECT GROUPING LIST			
4				
5	Please add your group members here. Full name can be refered in the next sheet. Maximum is 4 students per group.			
6				
7	GROUP 1	MEMBERS	TOPIC:	
8	1	Naylizzaty Anis binti Azmi	My Mini Library	
9	2	Kugashiny A/P Subramaniam		
10	3	Nur Sabrina Binti Suhardi		
11	4	Kishan Kumaar a/l Ellangovan		
12				
13	GROUP 2	MEMBERS	TOPIC:	
14	1	Nurun Nabilah bt A.Azmi	My Mini Library	
15	2	Fatin Nazurah bt Azman		
16	3	Hebah Muhammad		
17	4	Mashia Tasnim Trina		
18				
19	GROUP 3	MEMBERS	TOPIC:	
20	1	Vnesh Rau A/l Radakrishnan	My Mini Library	
21	2	Amirul Amar Bin Mohd Amin		
22	3	Dinesh A/l Makendren		
23	4	Muhammad Alif Bin Abdul Hisham		
24				
25	GROUP 4	MEMBERS	TOPIC:	
26	1	Lavanyah Prabu	Personal Cookbook	

Figure 44 Student registration form in the Object-Oriented Programming course.

The learning objective for this activity was for the students to produce a system that solved one of the problems using object-oriented design. Upon confirming a topic or problem, students were asked to identify the system requirements and integrate them with the basic requirements presented in the problem description. Students were allowed to refer to existing systems the requirements for which could be found on the internet. The system requirements were presented in the form of a use-case diagram and specifications. Each

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member of the group was required to contribute in all phases of the development process. Peer evaluation was used to measure group member involvement. Subsequently, group members developed a program that implemented the identified requirements to produce a system solution. At the end of the activity, students presented their solution to the lecturer and the class. They further submitted the system documentation including the source code. Evaluation of the project was based on a set of criteria and rubrics, with peer evaluation scores also incorporated into the individual grades.

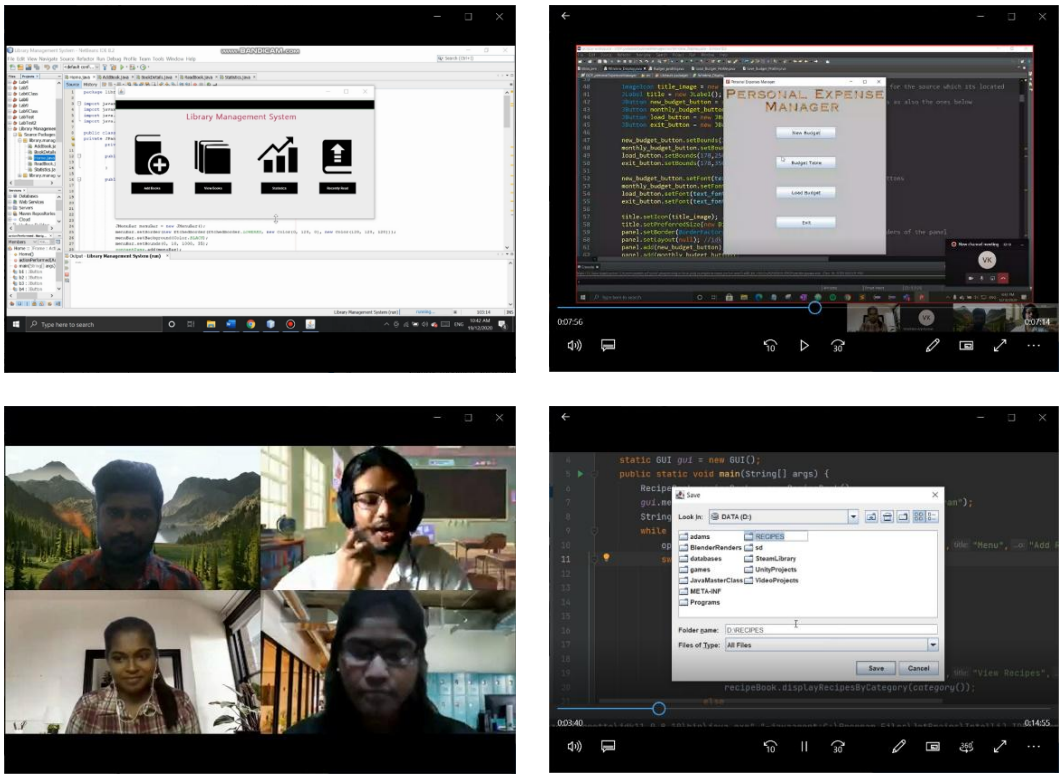

Figure 45. Students present their work in the Object-Oriented Programming course.

A5.3 Course CSEB233: Fundamentals of Software Engineering

A5.3.1 Description of the course

This course aims to equip students with fundamental knowledge on Software Engineering and to provide the necessary foundation before moving on to more detailed subjects on each concept at later stages of their studies. It discusses important concepts in the various types of common software processing and development models. The students also build

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knowledge on concepts and techniques used in each software development phase including requirements engineering, software design, and software testing. The course also exposes students to object-oriented design, for example UML models, and tools for analyzing and designing software. Upon completion of the course, students are able to appreciate most of the common software engineering concepts and techniques as well as produce various software artifacts and deliverables.

A5.3.2 Description of the participants

This course is part of the 1st year curriculum of studies in the Bachelor in Software Engineering, Bachelor in Information Technology - Graphics and Multimedia, and Bachelor in Information Technology - Visual Media programs at Universiti Tenaga Nasional. The main mode of delivery is lectures, which have duration of 3 hours weekly. For software engineering students this course is regarded as very important. For this reason, students are not allowed credit transfer for this course. 40 students were enrolled in the course in the 2020 - 2021 academic year.

A5.3.3 Description of active learning deploying ALIEN methodologies and tools

Active learning was deployed through digital serious games that address the requirements elicitation and analysis topic. Students assumed the role of a requirements analyst and were assigned a mission to gather the requirements of a system to be developed. Students collected information on the requirements from the non-playing game characters. A total of 7 non-playing characters existed in the proposed game, which could be categorized into 2 groups according to their roles. Firstly, there was the quest giver who assigned the quest to the player. The quest acted as a “pass” for the player to start gathering system requirements. A timer started once the quest was accepted. The 2nd category of non-playing characters was the stakeholders who were the sources of information for requirements gathering. Depending on the game scenarios, these non-playing characters could be clerks, administrative assistants, executives, project leaders, cashiers, managers, and directors. This category of non-playing characters could be further divided into 2

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categories, actual and dummy. Actual ones were the correct non-playing characters who could potentially provide correct information on requirements. Dummy non-playing characters were not relevant to the system to be developed and hence only suggested unrelated requirements.

The game included 3 different scenarios of 3 levels of increasing difficulty. In the 1st level, the player was asked to gather the requirements for a research assistant application system. The 2nd level was a car service center scenario in which the player gathered the requirements for an appointment booking system. The 3rd level was a supermarket scenario in which the player collected the requirements for a supermarket inventory system. The higher levels were harder in the sense that the scenarios had a larger scope with higher numbers of requirements to be gathered and analyzed. To meet the learning objectives of requirements elicitation and analysis, the requirements given by all non-playing characters were categorized based on their completeness, consistency, relevance, and practicality. The player was asked to label the categories correctly. In the 1st level, the player was asked for completeness and relevance of the requirements. Consistency was added from the 2nd level onwards. In the 3rd level, the player was further asked to evaluate the practicality of the requirements.

Activities took place in the ALIEN problem-based learning laboratory.

Figure 46. Students play the Software Requirements game in the ALIEN laboratory in the context of the Fundamentals of Software Engineering course.

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A5.4 Course MEFB121: Manufacturing Processes Laboratory

A5.4.1 Description of the course

This course builds fundamental skills for basic processes related to manufacturing technologies, including metal removal processes, such as lathe, milling, drilling, and grinding, and welding operations. The activities take place in a laboratory. Students engage in a basic workshop on safety practice. Upon completion of the course, students are familiar with safe manufacturing laboratory practices and regulations. They are further able to use hand and precision tools properly. Students are also able to use basic machining tools including lathe, drilling, milling, and grinding machines. In addition, students are exposed to basic welding processes. Topics covered include introduction to occupational safety and health issues related to workshop practices, workplace safety, metrology, drawing standards, lathe machines, milling machines, drilling, cutting, filing, and welding. At the end of the semester an open-ended project is assigned to students.

A5.4.2 Description of the participants

This course compulsory for 1st year students enrolled in the Mechanical Engineering Department at Universiti Tenaga Nasional. The course takes the form of a 4 hour laboratory session that corresponds to 1 hour of credit for each hour of laboratory work. The number of students enrolled varies from one semester to another. 92 students were enrolled in the course in the 2020 - 2020 academic year.

A5.4.3 Description of active learning deploying ALIEN methodologies and tools

At the end of the semester the students were asked to complete an open-ended group project. Each groups consisted of 4 - 5 individuals. Groups were given a briefing on the sample product model and then were asked to design and manufacture a new product by using the given raw materials, available machineries, instruments, and tools at the manufacturing process laboratory. The duration of the project was 3 weeks, and specifically 12 hours, and the final product was submitted along with a report for evaluation purposes on the 14th week of the semester. The sample of product assembly was demonstrated

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during the project briefing for the benefit of all groups. Based on the given materials with specified dimensions, students were required to design a new product based on a novel idea or concept and produce the product in 3 weeks' time. Students were asked to submit a preliminary project proposal report that clearly explains all the manufacturing steps involved in fabricating the new product in 2 weeks' time. The report was required to describe all materials and instruments that necessary in completing the project. Students were only allowed to start their project once their proposal report was approved by the lecturer.

The final report was required to include all steps involved in fabricating the product. It was also required to include details on the materials, tools, and equipment used for each process and each part. The report further included multiple views of the parts and assembly of the product based on appropriate drawing standards. Finally, the report was required to discuss the quality of the product, challenges, issues, shortcomings during the manufacturing process, and assembly operations.

The learning outcomes for the activities included the enriched capacity of students to explain the function of machines used, the procedures, and the process plan. Students built skills on using precision instruments for measurement, performing basic metal removal processes using conventional machines, such as lathe, milling and drilling, and performing welding procedures practiced in the context of the course project. Students were expected to be able to analyze and interpret data collected during the laboratory exercises. They were expected to be able to explain safety issues involved in completing the project while at the same time demonstrating commitment in following the laboratory rules. Their ability to work in a group was also measured as a desirable learning outcome. At the end of the project, students produced a report in written form.

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Figure 47. Students take measurements using the Vernier height gauge and drill in the Manufacturing Process Laboratory course.

A5.5 Course EEED283: Power Systems

A5.5.1 Description of the course

The course introduces students to the fundamental concepts and principles of AC circuits and power transformers. The course addresses topics on symmetrical components, per-unit systems, and transmission lines, including parameters and steady-state operation. The course also provides symmetrical faults and unsymmetrical faults analysis and the application of power system protection. Upon completion of the course, students are able to understand the basic concepts in electric power generation, transmission and distribution, and can apply the fundamentals of power system analysis, such as per-unit systems, 3-phase circuits, symmetrical or sequence components, and power systems protection.

A5.5.2 Description of the participants

This course is compulsory for students enrolled in the Diploma in Electrical Engineering Program at Universiti Tenaga Nasional. The course is part of the 3rd year curriculum. On average, a total of 20 - 30 students take this course each semester. It bears 3 credit points, which correspond to a 3 hour lecture each week.

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A5.5.3 Description of active learning deploying ALIEN methodologies and tools

Active learning methods were deployed in the course. An example is building per-unit diagrams. For this activity, students were given a problem to be solved in groups. Each group was comprised of 5 - 6 individuals. The problem has also been uploaded onto the ALIEN problem-based learning platform so that students could easily access it. The ALIEN problem-based learning platform further allows the problem to be shared among instructors.

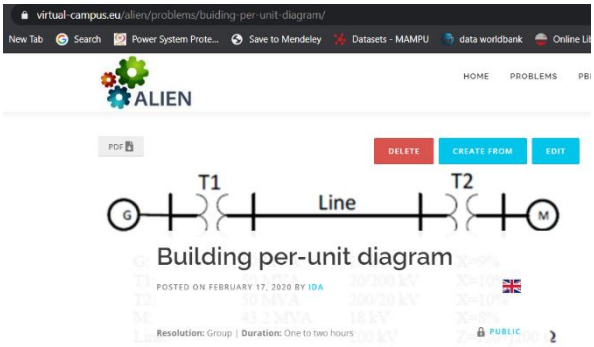

Figure 48. The problem uploaded onto the ALIEN PBL Platform.

The learning objective for this activity was for the students to build knowledge on building a per-unit diagram for a given circuit network given. Students were assigned into groups of 4 - 5 individuals. At the beginning of the session, students in each group assigned amongst themselves the roles of moderator, author, reviewer, and scriber to inculcate teamwork and collaborative learning.

Based on the circuit network that they had chosen to work on students were required to build a per-unit diagram with the specifications given. At the end of the activity, they were required to submit the per-unit diagram, the meeting minutes, and the full description of each role assumed by team members during the activity. In their submission, students were also asked to provide complete descriptions of the tasks that they had performed according to the roles assigned. The descriptions of the roles were used by the instructors to assess students' understanding of the topic and to facilitate discussion during the wrap-up session.

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Due to the COVID-19 pandemic the activity was slightly modified. Students were asked to submit a recording of their discussion session instead. This approach allowed the instructor to assess their understanding of the topic.

A5.6 Course COEB2014: Numerical Methods

A5.6.1 Description of the course

This course provides students with knowledge on basic algorithms in numerical methods, which allow them to solve practical engineering problems. The numerical methods covered include finding the roots of equation, linear algebra, regression and interpolation, differentiation and integration, ordinary differential equations, partial differential equations, and optimization. Mathematical software, such as MATLAB® and Microsoft® Excel is used for developing algorithms. Students are assigned a group project related to an engineering problem and synthesize a solution by applying numerical methods and using the software. Upon completion of the course, students are able to analyse related engineering problems and apply appropriate numerical methods towards their solution.

A5.6.2 Description of the participants

This is a core, compulsory course for students enrolled in the Bachelor in Electrical Power Engineering, the Bachelor in Electrical Electronics Engineering, the Bachelor in Computer and Communication Engineering, and the Bachelor in Mechanical Engineering programs at Universiti Tenaga Nasional. The course is part of the 2nd year curriculum. On average, a total of 200 - 300 students attend this course every semester. It bears 4 credit points that correspond to a 3 hour lecture and a 1 hour tutorial each week.

A5.1.3 Description of active learning deploying ALIEN methodologies and tools

Active learning was deployed throughout the semester. Each hour of learning time was divided into 5 - 6 segments. The first 10 minutes were allocated for students to prepare themselves for the topic to be covered by the course through warm-up exercises with open-ended questions. The questions were uploaded either on Facebook® or Telegram® groups

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usually 30 minutes before the class. In the 2nd segment students stood by for the lecture to start. They were exposed to a 2 minute song. The 3rd segment was a 15 - 20-minute lecture followed by a 3 minute quiz period during which students responded to the questions introduced at the beginning of the class. In the 4th segment students were exposed to a 2 minute song for releasing stress. The 5th segment was a 10 - 15 minute lecture divided into 2 sections. This division of work allowed students to maintain their interest and engagement and avoided congestion of knowledge. Finally, in the last segment students responded to a short quiz over a period of 10 minutes. The session was concluded with a discussion on the topic addressed.

The course further included a small group project during which active learning was deployed. Students were divided into groups of 5 - 6 individuals. They were assigned open-ended engineering problems that they solved using numerical methods and mathematical software. The learning objective for this activity was to encourage the application of theoretical knowledge and methods in real engineering applications. The activity further promoted group work and learning by teaching, where students researched a topic and presented it to the class.

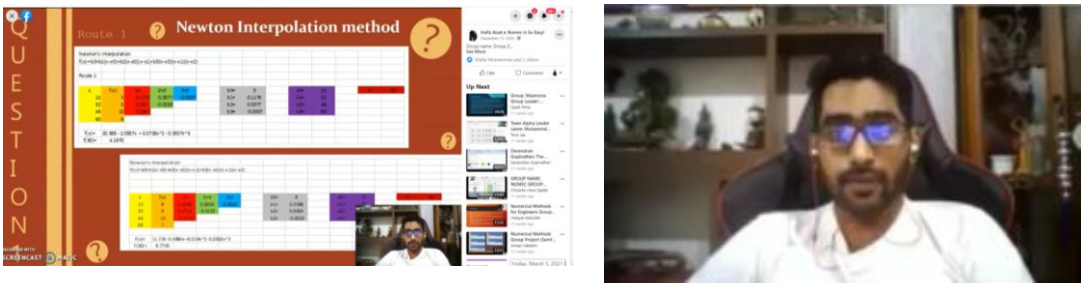

Figure 49. Students engage in learning by teaching activities in the Numerical Methods course.

A5.7 Course PHYD1013: Physics for Engineering

A5.7.1 Description of the course

In this course the students are introduced to the units used in measurement, principles, laws, and concepts of physics. The course aims at improving the physics background of students enrolled in engineering programs. It develops fundamental knowledge that is

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necessary in other subjects of engineering curricula. The course covers topics on mechanics, fluid mechanics, and thermodynamics. Upon completion of the course, students are able to understand the concepts of basics and vector quantities and to apply the new knowledge to related fields. Students further are able to understand and apply concepts related to kinematics, law of motion, rotational equilibrium, fluid mechanics, and thermodynamics.

A5.7.2 Description of the participants

This is a core, compulsory course for students enrolled in the Diploma in Electrical Engineering or Diploma in Mechanical Engineering programs at Universiti Tenaga Nasional. The course is part of the 1st year curriculum. On average, a total of 50 - 80 students attend this course every semester. It bears 3 credit points that correspond to a 3 hour lecture each week.

A5.7.3 Description of active learning deploying ALIEN methodologies and tools

One of the topics addressed through active learning methods was thermodynamics. For this activity, students were given learning resources in the form of lecture notes or lecture videos.

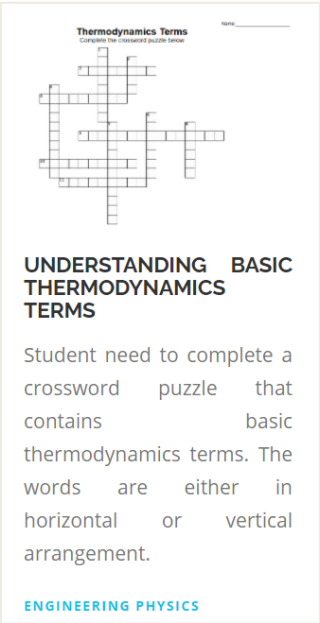

Figure 50. Problems uploaded onto the ALIEN problem-based learning platform for the Physics for Engineering course.

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The problems used in the course were also uploaded onto the ALIEN problem-based platform so that the students could easily access them. The ALIEN platform further allowed the sharing of problems among instructors.

The learning objective of the activity was to develop understanding on basic thermodynamic terms. The activity helped students build familiarity on the field of thermodynamics. It was particularly useful for students that attended thermodynamics learning activities for the first time, and so were not familiar with core related concepts. The activity took place at the end of the semester, when familiarity with the rest of the syllabus had already been developed.

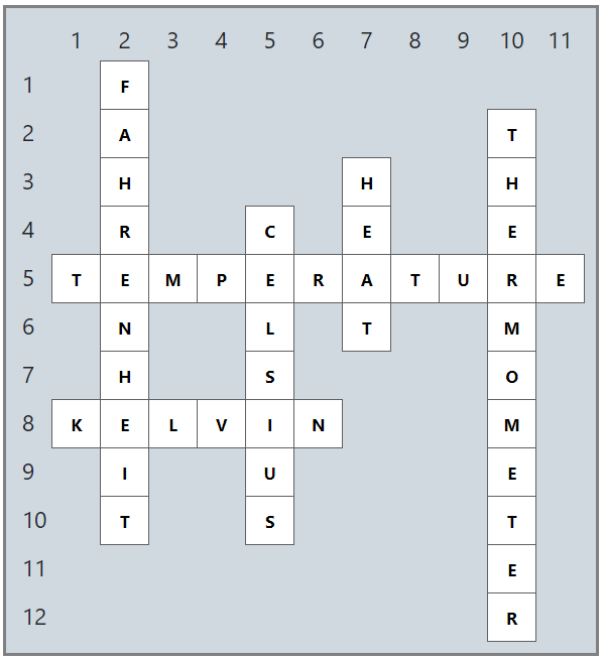

Figure 51. A crossword activity that uses scientific terms was implemented through the Moodle® learning management system in the Physics for Engineering course.

One of the challenges faced by students in engineering programs is to understand the different use of the term “system” in mechanics and in thermodynamics. In mechanics, the term system refers to mass, strings, and pulleys. In thermodynamics, it refers to gas, liquids, cylindrical containers, and pistons. For this activity, students were divided into groups of 3 - 4 individuals and were required to complete a crossword puzzle. At the beginning of the session, each group was asked to actively search for keywords or descriptions of terms in

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lecture notes or lecture videos. Students achieved this by skimming through lecture notes or skipping to time stamps in lecture videos. Team members took leadership in researching specific subtopics or terms. Students researching a specific topic became the group "experts" in this area. Group members were required to complete the crossword puzzle using the hints provided. At the end of the activity, they were required to self-evaluate by checking the number of correct words in their solution. Group members were further asked to discuss the scientific terms. Finally, the instructor explained in detail the definition of thermodynamic terms.

Due to COVID-19 restrictions, the activity took place on-line. Groups were allowed to record their discussions as proof of participation. Varieties of the activity may also be designed. For example, the activity may be implemented individually or in groups. It may also be untimed or timed activity with early finisher awards.

A5.8 Course EECB423/3053: Data Communications and Networks

A5.8.1 Description of the course

The course introduces students to fundamental concepts and principles of data communications and networks. It highlights the importance of network design in a networked world. Topics covered include basic data communication, the Open System Interconnect (OSI) and TCP/IP Protocol Suite reference models, Internet Protocol (IP) and addressing schemes, physical addressing, and popular applications, such as web browsing and e-mailing. Upon completion of the course, students are able to apply fundamental concepts associated with network planning, deploy appropriate techniques in troubleshooting network configurations, and solve issues related to real-life network scenarios.

A5.8.2 Description of the participants

This is a core, compulsory course for students enrolled in the Bachelor in Electrical and Electronics Engineering and Bachelor in Computer and Communication Engineering

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programs at Universiti Tenaga Nasional. The course is part of the 3rd year curriculum. On average, a total of 30 - 70 students attend this course every semester. It bears 3 credit points that correspond to a 3 hour lecture each week.

A5.8.3 Description of active learning deploying ALIEN methodologies and tools

The course included some challenging topics that would be best covered through active learning methods. One such topic was network planning for IPv4. For this activity, students were asked to design a network based on specific criteria and requirements. The problem was shared the Moodle® and Padlet® learning management systems. It was also uploaded onto the ALIEN problem-based learning platform allowing easy access.

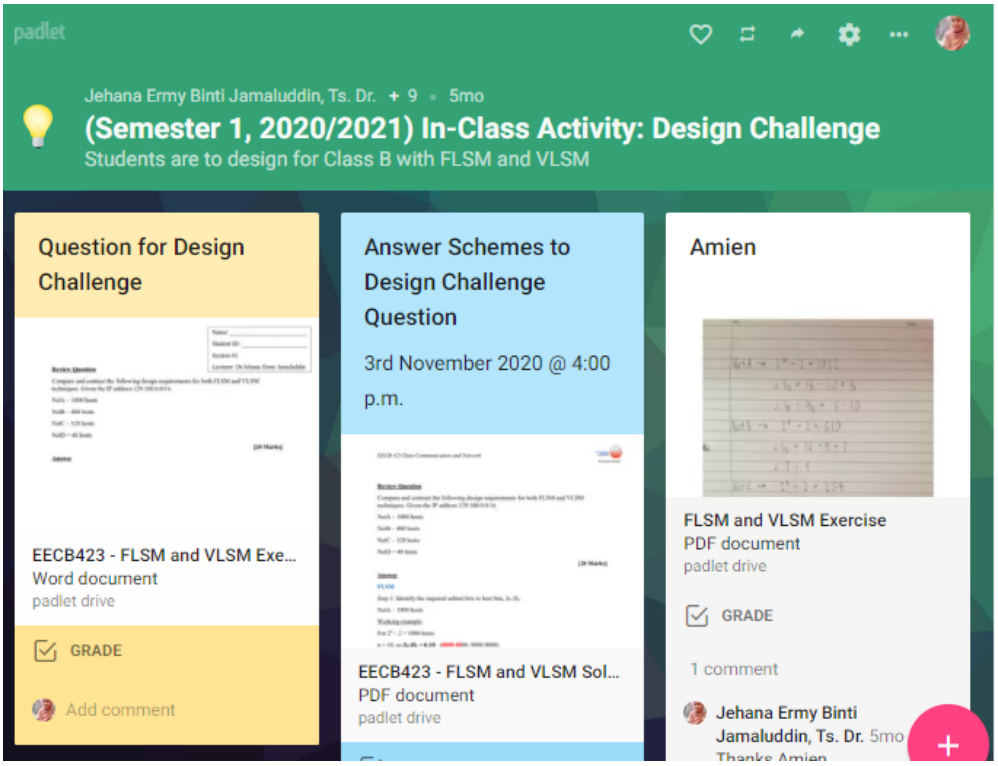

Figure 52. Problems uploaded onto the Padlet® learning management system for the Data Communications and Networks course.

The learning objective of the activity was to develop subnetting skills among students, allowing them to design a network based on specific requirements. Students were worked in groups of 4 - 5 individuals using the In-Class Teams approach. At the beginning of the session, each group was asked to analyze requirements before designing a network. This

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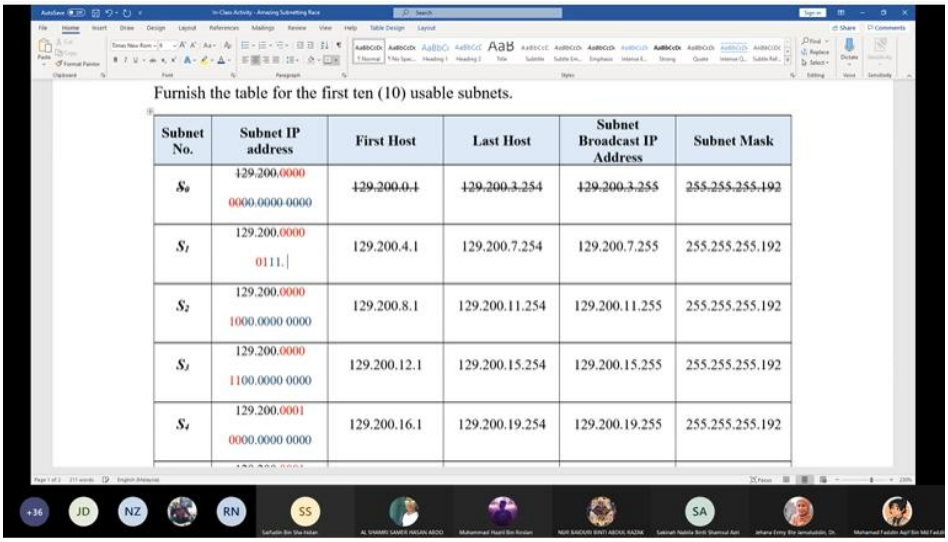
activity allowed students to develop a list of design criteria. It further challenged them consider aspects related to subnet tabulating. Next, team members assumed the roles of moderator, author, reviewer, scriber, reviewer, and author.

Subsequently, each group was given a sample subnet table and was asked to fill it with different criteria on the desirable number of subnets and hosts. Each group member ensured that the team's network design met the assigned criteria. Group members completed the subnet table with the required information, which included subnet number, host number, and subnet mask. At the end of the activity, teams uploaded their network design containing the subnet details to the Padlet® platform, including the full description of the network design. Each group presented their network design and supporting details and was later interviewed by the instructors to assess students' comprehension. The instructors then collected important network design criteria and discussed the outcome of the activity in the class at the end of the session.



Furnish the table for the first ten (10) usable subnets.

Subnet No.	Subnet IP address	First Host	Last Host	Subnet Broadcast IP Address	Subnet Mask
S_0	129.200.0000 0000.0000 0000	~~129.200.0.1~~	~~129.200.3.254~~	~~129.200.3.255~~	~~255.255.255.192~~
S_1	129.200.0000 0111.	129.200.4.1	129.200.7.254	129.200.7.255	255.255.255.192
S_2	129.200.0000 1000.0000 0000	129.200.8.1	129.200.11.254	129.200.11.255	255.255.255.192
S_3	129.200.0000 1100.0000 0000	129.200.12.1	129.200.15.254	129.200.15.255	255.255.255.192
S_4	129.200.0001 0000.0000 0000	129.200.16.1	129.200.19.254	129.200.19.255	255.255.255.192

Figure 53. Students collaborate virtually in the Data Communications and Networks course.

Due to COVID-19 restrictions, the activity took place virtually using the MSTeams® platform. The instructor had the opportunity to "visit" each group, observe discussions, and offer help when needed. The MSTeams® platform further allowed the recording of presentations for evaluation purposes.

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A5.9 Course CSEB2122: Algorithmic Problem Solving

A5.9.1 Description of the course

The course introduces students to fundamental concepts and problem-solving techniques that are prerequisites to programming courses. Topics covered include programming language environments, basic mathematics, algorithms, algorithm techniques, and basic understanding of data structures. Upon completion of the course, students are able to discuss various problem-solving techniques for different types of problems, apply suitable problem-solving techniques in solving a given problem, and adopt appropriate problem-solving techniques to solve a given problem in a working team.

Instead of focusing more on theoretical problem solving, this subject emphasizes basic algorithms and techniques in Computer Science, such as of graphs, search, and sorting algorithms as well as dynamic programming. The class activities involve mathematical games or puzzles, such as the tower of Hanoi, the travelling salesman, the gallery problem, and the poison problem.

A5.9.2 Description of the participants

This is a core, compulsory course for students enrolled in the Bachelor in Computer Science - Software Engineering at Universiti Tenaga Nasional. The course is part of the 1st year curriculum. On average, a total of 50 - 100 students attend this course every semester. It bears 2 credit points that correspond to a 2 hour lecture each week.

A5.9.3 Description of active learning deploying ALIEN methodologies and tools

One of the topics addressed through active learning methods was algorithms. The session started with a lecture on algorithm. Subsequently, students were assigned a problem and were asked to present it in pairs through a video. Students used game-based methods instead of a formal presentation. Students were assisted in this activity through a pre-recorded video that they could use as a reference on presentation techniques. The activity

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instructions were uploaded onto the Moodle® learning management system and the MSTeams® platform for easy access.

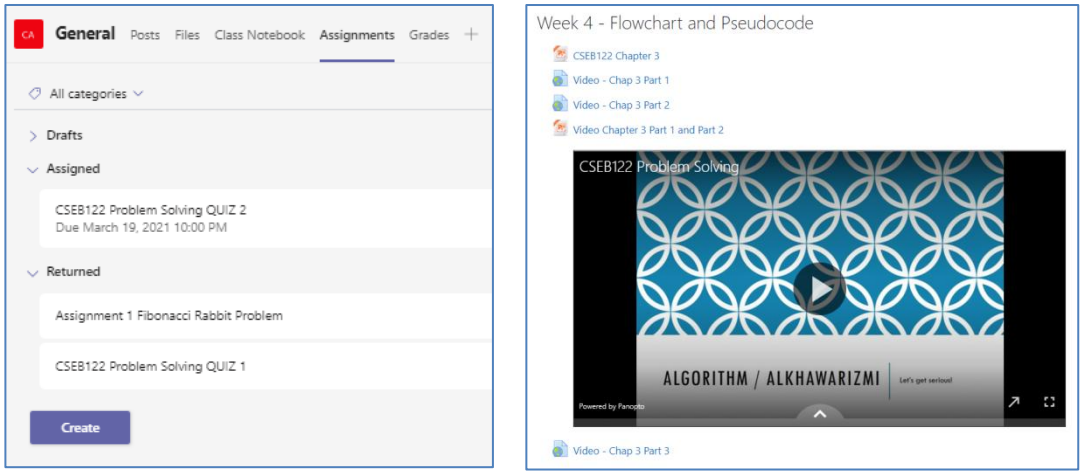

Figure 54. Activity descriptions uploaded onto the Moodle® and MSTeams® platforms in the Algorithmic Problem-Solving course.

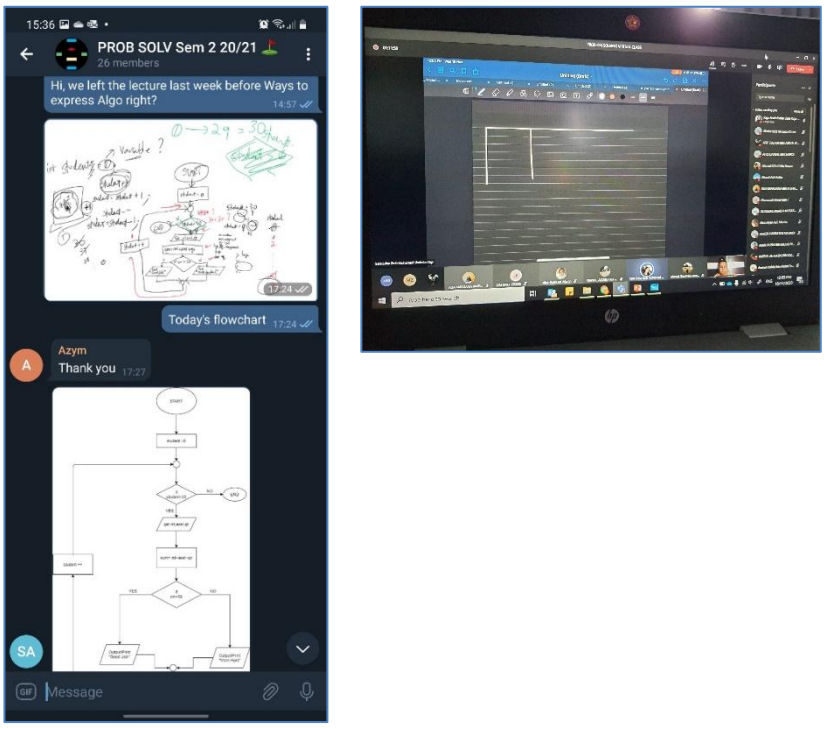

Figure 55. Students engaged in discussions and knowledge sharing through the MSTeams® platform in the Algorithmic Problem-Solving course.

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Students were free to use official communication channels to discuss their understanding on algorithm techniques before proceeding with their work in pairs. This method encouraged active learning virtually.

The objective of this active learning activity was to develop student understanding on algorithms and build their capacity to apply them in practical situations. Furthermore, the activity aimed to build student skills on selecting an appropriate algorithm for solving a given problem. Students were allowed to choose any game available (on earth), be it a traditional toy, board game, modern children's toy, or any new game that they could design by combining existing games. The activity encouraged originality through extra points. Students were free to get family members or roommates to join them in their video presentation, in which both team members had to be visible. Links to student videos were shared to the communication channels so that other students could also watch their classmates' presentations and perhaps to offer a "like" or two.

Figure 56. Students presented their work through videos in the Algorithmic Problem-Solving course.

Once the presentations were all submitted, inspection and evaluation were performed virtually. Students were evaluated for their presentation skills, the rules of the game they developed, the clarity of their presentation, creativity and originality, and the problem-solving technique applied. Results were published on the Moodle® learning management system for the benefit of the entire class.

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A5.10 Course CMPF134: Fundamentals of Data and Information

A5.10.1 Description of the course

The course builds fundamental knowledge on data representation in computing environments and on how digital information can be obtained from data. In addition, the course addresses the mechanisms involved in the process of transmitting information from source to drain. The topics covered include number conversion systems, integer representation formats, Boolean logic, data units, data types, computing of encoding systems, and fundamentals of information theory. Upon completion of the course, students are able to recognize different data representation formats in the digital world. They are also able to apply appropriate techniques in manipulating arithmetic and logical operations in computing environments. They are further able to apply appropriate information theory concepts in digital data communication systems.

A5.10.2 Description of the participants

This is a core, compulsory course for students enrolled in the Bachelor in Computer Science (Software Engineering) (Hons.) at Universiti Tenaga Nasional. The course is part of the 1st year curriculum. On average, a total of 50 - 100 students attend this course every semester. It bears 2 credit points that correspond to a 2 hour lecture each week. 133 students attended the course in the 2020 - 2021 academic year. They were divided into 2 sections, namely:

- Section 1 that was comprised by 78 students.
- Section 2 that was comprised of 55 students.

It bears 4 credit points that correspond to a 3 hour lecture and a 2 hour tutorial per week.

A5.10.3 Description of active learning deploying ALIEN methodologies and tools

Students worked virtually using the Telegram® platform. This platform acts as an on-line public discussion board, in which the lecturer shares with students, class notices and reminders. The platform was popular with students as it supports notifications and

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communication on smart phones. Two different Telegram® groups were created, one for each section. Students were encouraged to participate in discussions, to inquire, and to provide feedback to their peers.

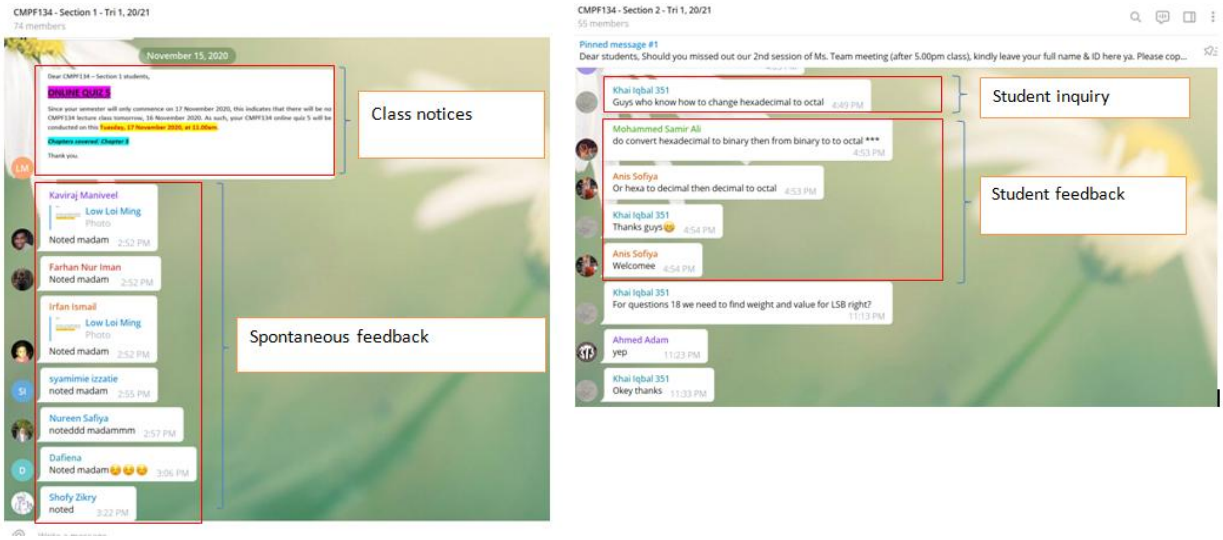

Figure 57. Students communicate on-line in the Fundamentals of Data and Information course.

This active learning approach increased the sense of affiliation of students. Students participated spontaneously by making inquiries, cared for their peers by providing feedback, and appreciated information they received by giving thanks. The lecturer was the facilitator, guiding students when feedback was inaccurate.

Another active learning technique applied in this subject was peer reviewing or peer teaching. In this scenario, students acted as both educator and learner at the same time. Firstly, the subject lecturer divided the students into groups of up to 5 individuals. The lecturer posted tutorial questions for each specific topic onto the Padlet® platform. Each group was required to answer at least one question. At the same time, students reviewed the answers of group members and corrected their peers by leaving comments when they identified mistakes in their classmates' working steps. When the session was completed, the lecturer reviewed and commented on all student submissions. To ensure that all students participated actively in this peer teaching session, the activity had a weight of 10% on the

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final grade. Students agreed that the activity boosted their interaction skills and increased their self-motivation on finding the correct solution to a given problem.

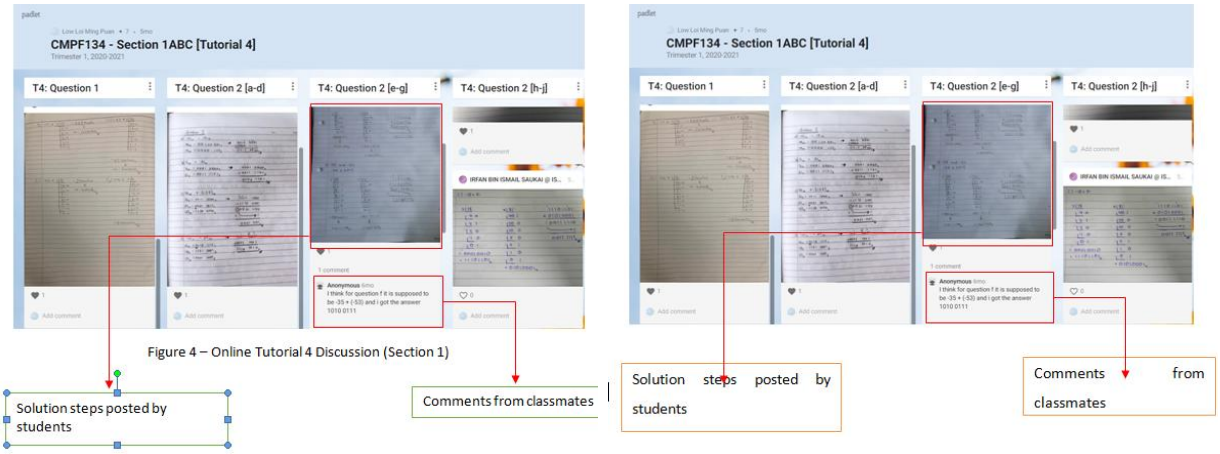

Figure 58. Students post comments to support their peers in solution design in the Fundamentals of Data and Information course.

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A6. ISRA University

A6.1 Course: Advanced Computer Networks

A6.1.1 Description of the course

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, 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.

A6.1.2 Description of the participants

The course is compulsory in the 1st year of postgraduate studies at the Department of Computer Science of the Isra University Hyderabad. Approximately 5 students enrolled in the course in the 2020 - 2021 academic year. The students have been exposed to some networking courses in their undergraduate programs and have knowledge of networking essentials.

A6.1.3 Description of active learning deploying ALIEN methodologies and tools

In the Advanced Topics in Computer Networks course students perform their practical activities in the laboratories of the Department of Computer Science. Students solve given problems using a packet tracer. The ALIEN project provided an opportunity for students to perform real-world activities digitally. The students were asked to wear a VR headset and visit a building to count floors and rooms on each floor. Students were asked to assign different addresses to floors and rooms. Letter on, students were asked to convert those

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addresses into network IP addresses. Students then used Cisco® the packet tracer to design networks based on given problem.

A6.2 Course: Design and Analysis of Algorithms

A6.2.1 Description of the course

The Design and Analysis of Algorithms course introduces covers topics that include applied theoretical tools and techniques for analysis of algorithms, such as recurrence relations, amortization and counting, computation and reasoning on the upper and lower asymptotic bounds of the performance of algorithms, and selecting appropriate algorithms that are expected to have higher performance in a given situation.

A6.2.2 Description of the participants

The course is mandatory for 2nd year students in the Bachelor of Science in Computer Science program. It is also an elective in the Bachelor of Science in Software Engineering and the Bachelor of Science in Information Technology programs. Approximately 50 students are enrolled in the course each academic year. This is an advanced level course. Participants of the course have been exposed to problem-based learning through earlier courses. They apply active learning for the design and analysis of algorithms related to their complexity time and space.

A6.2.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning in the ALIEN problem-based learning laboratory. During the course, students performed practical activities. They followed specific steps given by the teacher to solve specific exercises. The goal of the exercises was to develop understanding of sorting and searching concepts in the analysis of algorithms. Firstly, students performed manual sorting on a deck of cards. Students performed sorting by selecting the smallest card in the unsorted pack and moving the card to a second hand. The activity was concluded when all cards have been removed from the unsorted hand; at that

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time the second hand contained the card in sorted order. Time taken to sort all the cards was recorded.

The steps that students followed were:

1. Get a hand of unsorted cards.
2. Repeat step 3 and 5 until the unsorted hand is empty.
3. Compare unsorted cards.
4. Select the smallest unsorted card.
5. Move this card to the sorted hand.
6. Stop.

A6.3 Course: Final Year Project

A6.3.1 Description of the course

The purpose of this year-wide course is to challenge students to go through all the major steps of project design and development including brainstorming and planning, requirements and feasibility analysis, design, development and coding, integration and testing, implementation and deployment, and operations and maintenance.

A6.3.2 Description of the participants

The final year project is also a mandatory lab-based course for 4th year students at the Bachelor of Computer Science, the Bachelor of Software Engineering, and the Bachelor of Information Technology degree programs. This course is split into 2 semesters. Students engage in the final year project both in the 1st and 2nd semester of the 4th year of the degree program. 34 students were enrolled in the course in the 2020 - 2021 academic year.

A6.3.3 Description of active learning deploying ALIEN methodologies and tools

Students typically work in groups of their own choice. Each group cannot exceed 4 students. Each group is allotted a project supervisor with whom they timely coordinate, report progress, and discuss issues related to the project. Each group delivers 3 presentations to demonstrate progress and get feedback from the committee. These presentations include a

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project proposal, which is delivered at the start of the 1st semester of the project, midway presentation which is delivered in-between the end of the 1st semester and before the start of the 2nd semester of the project, and lastly, the final presentation at the end of the 2nd semester of the project. One of the groups developed a home automation system using gesture recognition. Currently, 2 groups are exploring the use of augmented reality and virtual reality for learning of students in the classroom environment.

A6.4 Course: Object-Oriented Software Engineering

A6.4.1 Description of the course

The Object-Oriented Software Engineering course focuses on using object-oriented principles to build flexible software applications. The course also focuses on how object-oriented principles, software design patterns, and different development approaches fit into the object-oriented software engineering lifecycle. The course further discusses how different stakeholders can communicate clearly through the use of UML use cases to deliver the appropriate software that meets every stakeholder's requirements.

A6.4.2 Description of the participants

The course is a core course of the Bachelor in Software Engineering program and is being offered to 3rd and 4th year students. The course is also offered as an elective in the Bachelor in Computer Science program. As this course is offered to senior semester students, the participants are already familiar with fundamental of programming and software engineering principles. 30 students were enrolled in the course in the 2020 - 2021 academic year.

A6.4.3 Description of active learning deploying ALIEN methodologies and tools

During the course of Object-Oriented Software Engineering, students were exposed to active and problem-based learning in the context of object-oriented programming and software engineering. Different laboratory exercises were carried out during the practical activity hours. Each exercise described an overall goal, objectives, context, and problem.

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Students were divided into groups to discuss and solve the exercises. Early finishers were given some more problem explanations. Half semester classes were conducted through physical presence. The rest of the classes were mixed mode and deployed open source tools on the Moodle® platform due to COVID-19 restrictions.

The active learning activities allowed students to engage in practical software engineering development in groups. Assigned problems exposed them to active learning practices. Laboratory activities were published through the ALIEN platform as good practices for the benefit of engineering students and educators.

A total of 16 different laboratory exercises covering the following activities were conducted:

- Analyzing existing project design and source code.
- Figuring out coding problems that cause inappropriate results.
- Redesigning and rewriting source code fragments that cause problems.
- Testing a project for correct results.
- Re-factoring and improving an existing project.
- Understanding how object-oriented principles help in code refactoring.
- Redesigning and rewriting source code fragments that cause problems.
- Understanding the requirements change phenomenon.
- Learning how to cope with evolving requirements.
- Learning how to avoid duplicate code.
- To understand how software works in real-world context.
- Learning how to create classes from use cases by using textual analysis.
- Learning how analysis can solve software problems in the real-world.
- Understanding how to respond to customers' changing needs.
- Understanding the importance of flexible software.
- Understanding how inheritance and abstract classes are deployed for solving problems.

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- Understanding the situations and scenarios where encapsulation, interfaces, abstraction, and change principles are applied.
- Using design patterns: strategy pattern.
- Using design patterns: decorator pattern.

Students worked in teams and solved above activities by learning and using problem-solving principles.

A6.5 Course: Basic Electronics

A6.5.1 Description of the course

This course introduces basic semiconductor devices, including different types of diodes, such as silicon, germanium, LED, varactor, photo, zener, and tunnel, rectifier, and bipolar junction transistors.

A6.5.2 Description of the participants

The course Basic Electronics is obligatory in the 1st year of undergraduate studies. This is a core course in the formal curriculum of the Department of Computer Science at the Hyderabad campus. Being close to the completion of their studies, participants are well familiar with semiconductor devices and circuits. The main focus of the course is implementing theoretical concepts into practical hardware solutions. 13 students were enrolled in the course in the 2020 - 2021 academic year.

A6.5.3 Description of active learning deploying ALIEN methodologies and tools

The laboratory part of the course is based on problem-based learning and is performed on workbenches with instrumentation and breadboards. It involves performing laboratory exercises for better understanding of the basic principles of circuits and becoming familiar with instrumentation and semiconductor devices.

The practical exercises take place in the Electronics laboratory of the Department of Computer Science.

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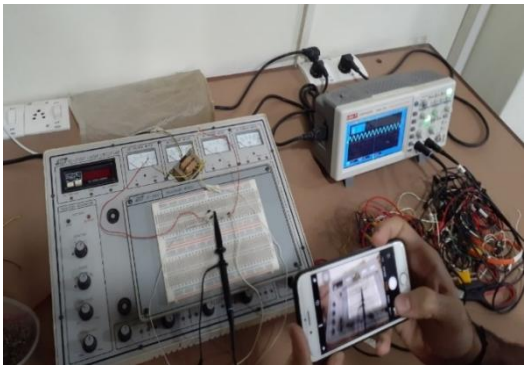
Students introduced a wealth of scenarios, a total of 14, on topics, such as:

- Implementing diode biasing circuits and identifying terminals.
- Analyzing the voltage-current characteristics of diode in forward biased circuits.
- Analyzing the voltage-current characteristics of diode in reverse biased circuits.
- Implementing and analyzing half wave rectifier circuits.
- Performing and analyzing center tapped full wave rectifier circuits.
- Studying the operation of bridge full wave rectifier circuits.
- Implementing and analyzing diode clipper circuits.
- Implementing and inspecting diode clamper circuits.
- Implementing and studying the working of diode voltage multiplier circuits.
- Verifying the reverse characteristics and voltage regulation of Zener diodes.
- Understanding the working of LED and identify its terminals.
- Implementing logical gates using diodes.
- Identifying the terminal and probing the behaviour of bipolar junction transistors as switches.
- Analyzing the behaviour of bipolar junction transistors as amplifiers.

Practical activities are published through the ALIEN platform as good practices for the benefit of technical students and educators.



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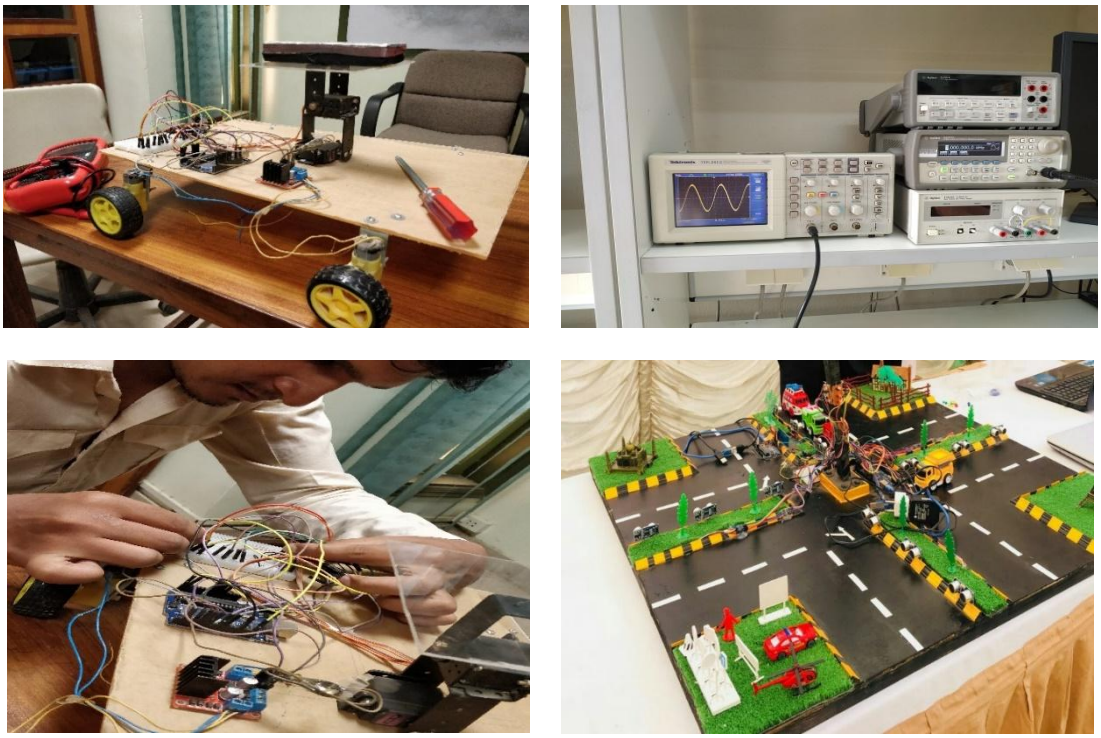

Figure 59. Students develop semiconductor circuits in laboratory practical work in the Basic Electronics course.

This subject presented an approach to designing Electronic Circuits Curricula based on problem-based learning and a common hardware platform, which made the subjects of electronics more appealing to students through a set of multidisciplinary projects. A problem-based learning approach has been designed and implemented taking electronics into account as important background knowledge for other core subjects in Telecommunications Engineering and Computer Science programs, such as signal processing, and communications.

A6.6 Programming Fundamentals

A6.6.1 Description of the course

This course introduces fundamental concepts of structured programming with special emphasis on implementation in the C++ language and provides a comprehensive introduction to programming for Computer Science and Technology majors. Topics include

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variables, data types, control structures, functions, arrays, and the mechanics of running, testing, and debugging.

A6.6.2 Description of the participants

This is a core course of the Bachelor in Software Engineering, Bachelor in Computer Science, and Bachelor in Information Technology programs. It is offered to 1st year students. The classes were conducted partially physically and partially on-line. 15 students were enrolled in the course in the 2020 - 2021 academic year.

A6.6.3 Description of active learning deploying ALIEN methodologies and tools

During the course of Programming Fundamentals students were exposed to active and problem-based learning in the contexts of Programming Fundamentals using the C++ language. Different laboratory exercises were carried out during the practical activity hours. Each exercise described an overall goal, objective, context, and problem. Students were divided into groups to discuss and solve the exercises. Early finishers were given some more problem explanations.

A total of 8 different laboratory exercises covering the following activities were conducted:

- Utilizing basic data types, including arrays, in algorithm design.
- Converting algorithms into programs.
- Tracing programs and verifying their functionality. Finding logical bugs.
- Describing the syntax of various instructions and programming structures.
- Describing the IO streams and role of ASCII control code.
- Addressing conversion-based problems:
    - Numbers into text.
    - Decimal to binary conversion and vice versa.
    - Decimal to octal conversion and vice versa.
    - Decimal to hexadecimal conversion and vice versa.
    - Binary to octal conversion and vice versa.

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- Binary to hexadecimal conversion and vice versa.
- Computing student grades using conditional statements.
- Arranging objects in ascending order using selection sort techniques.

The students worked in teams and solved the above activities by using problem-based learning principles.

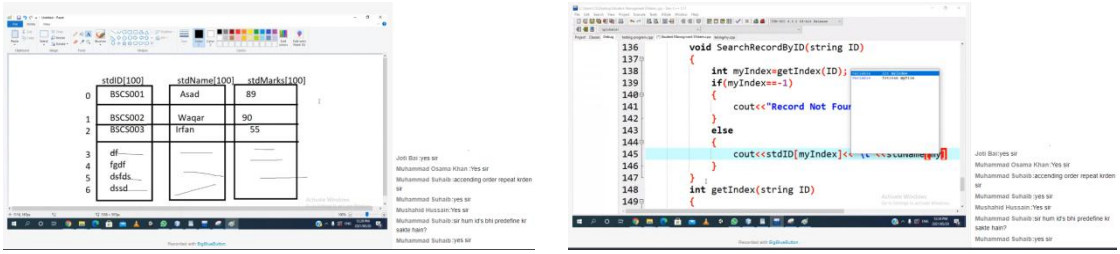

Figure 60. Student project activities in the Programming Fundamentals course.

A6.7 Human-Computer Interaction

A6.7.1 Description of the course

The objectives of the Human-Computer Interaction course are to provide students with a broad view of both theoretical and practical issues in human factors for the design of human-computer interfaces, to equip students with knowledge and understanding of the nature of human computer interactions, human characteristics, computer systems, and interface architecture, and to equip students with sound skills in design, development, and evaluation of user-interfaces. Upon completion of the course, students are able to understand and appreciate the human factors and the theoretical issues involved in human-computer interaction. They can further apply theoretical design principles to the design and evaluation of user-interfaces. And the can collect user requirements, design a human-computer interface according to these requirements, and evaluate the design.

A6.7.2 Description of the participants

The Human-Computer Interaction course is mandatory for 3rd year students in the Bachelor in Computer Science, Bachelor in Software Engineering, and Bachelor in Information Technology programs. The Human-Computer Interaction course involves 2 theoretical

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classes and a 3 hour laboratory session each week. 53 students were enrolled in the course in the 2020 - 2021 academic year.

A6.7.3 Description of active learning deploying ALIEN methodologies and tools

The course was partially conducted physically and partially on-line due to an ongoing pandemic. Several topics were covered in theoretical lectures including interaction paradigms, interaction frameworks, interaction styles, interaction design process, conceptual design, physical design, evaluation, design principles, interaction design models, and usability testing. The laboratory sessions provided students with an opportunity to use the available equipment for the design, development of proof of concept prototypes, and the evaluation of prototypes by users or experts using the typical steps of design lifecycle, including requirements specification, designing alternatives, prototyping, and evaluating. For instance, as a part of the heuristic evaluation topic, students were asked to evaluate AR and VR applications using augmented and virtual reality design heuristics to identify the issues that need to be fixed in the application. In laboratory sessions that took place before the COVID-19 restrictions were in place, students were granted access to all the equipment available in the ALIEN problem-based learning laboratory. Once restrictions were imposed, classes took place on-line.

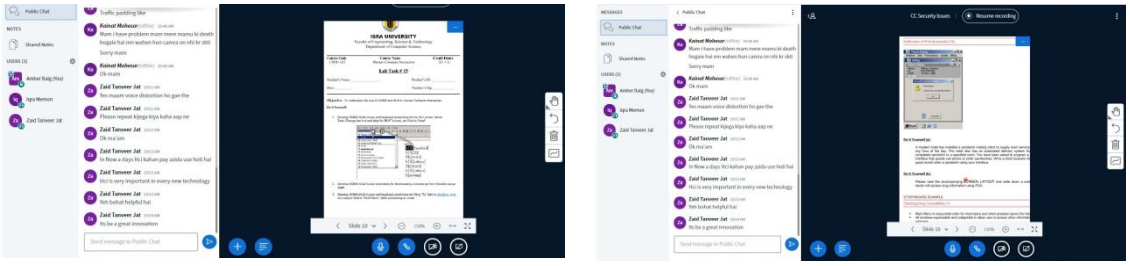

Figure 61. Students engage in on-line activities in the Human-Computer Interaction course.

A6.8 Data Communication and Computer Networks

A6.8.1 Description of the course

The subject Data Communication and Computer Networks is key course at the graduate level. It builds familiarity with the rules and regulations that allow computers with different

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operating systems, languages, cabling, and locations to share resources and communicate with each other. The objective is to develop understanding on enabling seamless exchange of data between any 2 points in the world. This exchange of data takes place over a computer network. Data communications refers to the transmission of digital data between 2 or more computers. A computer data network is a telecommunications network that allows computers to exchange data. The physical connection between networked computing devices is established using either cable media or wireless media.

A6.8.2 Description of the participants

This is a fundamental level course. It is mandatory for 2nd year of 1st semester students in the Bachelor in Computer Science, Information Technology, and Software Engineering programs. Approximately 50 students were enrolled in this course in the 2020 - 2021 academic year. Participants are exposed to the problem-based learning. They apply active learning towards logical design and deployment of topologies and addressing for creating networks.

A6.8.3 Description of active learning deploying ALIEN methodologies and tools

Students used the ALIEN problem-based learning laboratory for performing practical activities. They followed specific steps given by the instructor for solving specific exercises. The goal of the exercises was to develop basic understanding of how to create, design, and test a network. Students had the opportunity to troubleshoot networks building understanding on identifying problems and introducing appropriate solutions. Students solved the given problems using the Cisco® packet tracer to design networks based on specific, given requirements. They visualized several networks by using problem-based learning.

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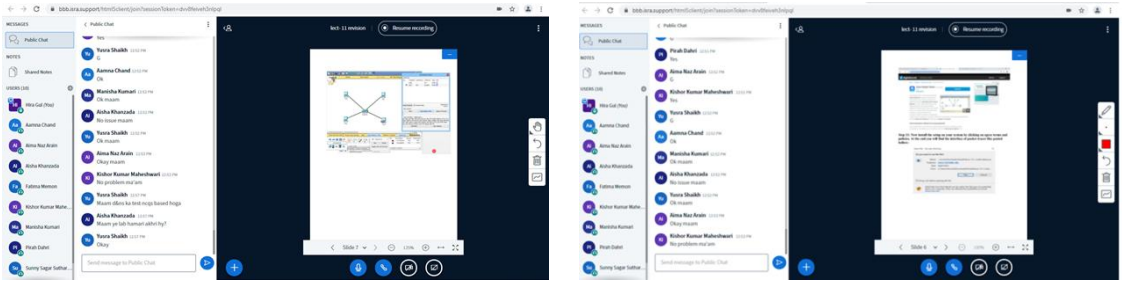

Figure 62. Students work on-line in the Data Communication and Computer Networks course.

A6.9 Software Quality Assurance

A6.9.1 Description of the course

The course focuses on achieving best software quality by introducing hands-on a plan that consists of procedures, techniques, and tools, such as Selenium®, TestingWhiz®, HPE Unified Functional Testing, and others that are typically employed for ensuring that a product or service aligns with system requirements, evaluating the quality of software functions, and validating quality attributes such as functionality, performance, adaptability, and more. The course enables students to develop plans for better software quality, to monitor the progress of applied methods, and to introduce improvements for future betterment.

A6.9.2 Description of the participants

The course addresses students of both semesters in the 4th year of undergraduate studies. Specifically, participants were 2nd semester students of 4th year in the Bachelor in Computer Science, the Bachelor in Software Engineering, and the Bachelor in Information Technology programs. A total of 17 students were enrolled in the 2020 - 2021 academic year. The total number of students was 17, of which 1 student was enrolled in the Bachelor in Information Technology program, 1 student in the Bachelor in Computer Science program, and 15 students in the Bachelor in Software Engineering program.

A6.9.3 Description of active learning deploying ALIEN methodologies and tools

Students were divided into groups. Each group consisted of 4 students with the exception of 1 group that consisted of 5. Groups were assigned puzzles to discuss, such as “a woman

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fired a shot at a man with her gun but the man did not die. List the possible reasons for the man not dying". This exercise helped them to identify possible test scenarios or cases. Almost all performed well in this task and found a number of reasonable explanations. Subsequently students were asked to think of possible reasons for which software implementing a particular logic may not perform well. Likewise, students worked on other tasks that challenged them to think about testing strategies that can ensure the high quality of a Ball Point software tool. Another example of a task was to give instructions to an alien being that asks how to brush its teeth. Students were asked to assume that the alien has teeth exactly like human teeth, is smart as a human, but needs clear step-by-step instructions, as for example hold the toothpaste with your left hand, turn the cap anti-clockwise, and more. After applying testing techniques to familiar activities, students were asked to apply the same techniques to solve software quality assurance problems. They performed well with a keen interest in finding more solutions for better software quality.

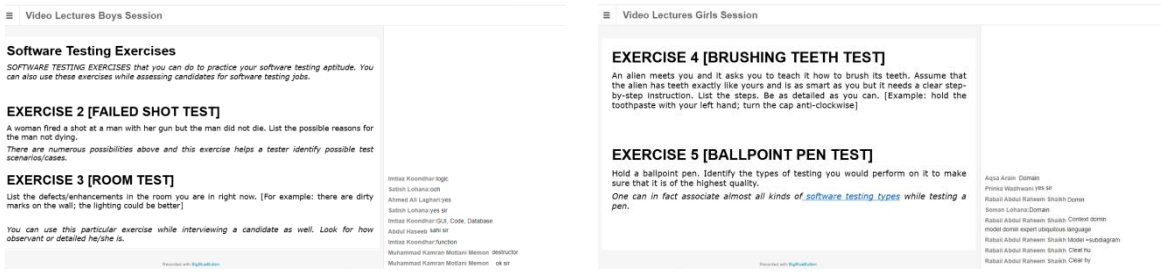

Figure 63. Problem-based activities in the Quality Assurance course.

A6.10 Introduction to Algorithms

A6.10.1 Description of the course

This course addresses problem solving and programming through the development of algorithms. It introduces computational problems. Different types of common algorithms, algorithmic paradigms, and data structures used to solve these problems are discussed in detail. The course emphasizes the relationship between algorithms and programming and introduces basic performance measures and analysis techniques.

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Upon completing of the course students are expected to understand the basics of synthesizing algorithms and using suitable data structures in solving different problems.

A6.10.2 Description of the participants

The Introduction to Algorithms course is mandatory for 1st year, 2nd semester students in the Bachelor in Computer Science and the Bachelor in Software Engineering programs. The course is an optional course for the Bachelor in Information Technology program. The Introduction to Algorithms course consists of 2 theoretical classes and a 3 hour laboratory session each week. 50 students were enrolled in the course in the 2020 - 2021 academic year.

A6.10.3 Description of active learning deploying ALIEN methodologies and tools

During the course, students performed practical activities by using problem-based learning components. In the laboratory activities students were assigned different problems in groups of 3 - 4 individuals that were formed randomly. They followed specific steps given by the instructor on solving the assigned exercises. The goal of the practical exercises was to develop understanding on synthesizing algorithms and using different data structures in problem solving.

During laboratory exercises, students were asked to write the steps for implementing a task they perform in their everyday life. They were then asked to convert those steps into algorithmic notations. Different everyday problems they were asked to convert into algorithms include linear search, binary search, construction of heaps, using stack in expression evaluations, using queues, and using different sorting techniques. The instructor was present during the activities to monitor and guide the students. The course was partially conducted physically and partially on-line due to COVID-19 restrictions.

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A7. Tallinn University

A7.1 Course: Game Design

A7.1.1 Description of the course

The objective of the course is to provide examples and generate ideas for designing gameplay and core mechanics. The course builds knowledge and skills in designing game logics, rules, and interactions. More specifically, the course introduces theoretical and practical knowledge on the theoretical framework of games, analysis of existing games, theory, analysis, and design of game rules, level design and prototyping, and design of game specifications. More information is available at https://ois2.tlu.ee/tluois/subject/IFI7178.DT.

A7.1.2 Description of the participants

This course belongs to the Digital Learning Games Master's program and is scheduled on the 2nd part of the 1st semester. It is delivered yearly in the period November - December.

In 2019 the number of participants was 36. Most of them, namely 27, were enrolled in the Digital Learning Games Master's program, 7 were enrolled in the Educational Technology Master's program, and 2 Erasmus+ exchange students.

In the 2020 - 2021 academic year 16 students were attended, of which 11 were enrolled in the Digital Learning Games Master's program, 3 in the Educational Technologies Master's program, and 2 were Erasmus+ exchange students.

A7.1.3 Description of active learning deploying ALIEN methodologies and tools

This course followed the flipped classroom and project-based learning strategies. Students were asked to become familiar with the theoretical materials individually at home. Contact classes were used for analyzing the logic of existing games and implementing the theoretical knowledge in small teams.

Each course topic was supported by following learning activities:

- Home reading assignments before every next class.

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- Tests for checking the home reading results in the beginning of every class.
- Analytical and design-based assignments implemented in teams of 2.
- Student presentations of analytical or design assignment outcomes.
- Short additional presentations from the teacher.

The course ended with the exam. The exam was organized in the format of a game-fest. Students were asked to play each other's games and provide feedback.

Figure 64. Students participate in a game fest in the context of the Game Design course in 2019.

In 2020 the entire course was delivered on-line via Google® Classroom, Kahoot® and Google® Meet. Students used different tools and platforms, such as Roll20®, Figma®, and Google® Documents for presenting their game prototypes. Some of the games produced by the students appear below:

- Human pill https://app.roll20.net/campaigns/details/9204772/humanpill.
- Who is grandpa? http://www.tlu.ee/~martins/WhoIsGranpaWeb/.

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- Stranded in Antarctica https://docs.google.com/presentation/d/1MHPdXU8jGLIz5Br1v2V8uaXvU1HqEv7GftRHOz_HuhI/edit?usp=sharing.
- Bird-catcher https://docs.google.com/presentation/d/1kikIDJmWORUts1ODOXlRYC34jj2d43-8BQwv0CtpVAM/edit?usp=sharing.
- Sudoku for horses https://docs.google.com/presentation/d/1gKPiq3oECHWZ9_zSiNRUSFhMraaY61uzoIGMHXtgznE/edit.
- Metro https://drive.google.com/file/d/1SeNmJnfqRBamzuBXpFfM1czp15WqaGUr/view
- Japanese learning game https://www.figma.com/proto/TOmMG8QWx0NDPaqxiFr8PN/japanese-learning-game?node-id=27%3A0&scaling=scale-down.

A7.2 Course: Learning Game Design

A7.2.1 Description of the course

This course provides an overview of the instructional design with a focus on didactics of technology enhanced learning. Students build connections between instructional and game design. Students are asked to generate ideas on how learning can be integrated with games and play. They are also asked to design, implement, and evaluate learning games. More information is available at https://ois2.tlu.ee/tluois/subject/IFI7348.DT.

A7.2.2 Description of the participants

This course belongs to the Digital Learning Games Master's program and is scheduled on the 1st part of the 2nd semester. Each academic year it is delivered in the period February - March.

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This course belongs to the Digital Learning Games Master's program and is scheduled on the 2nd part of the 1st semester. It is delivered yearly in the period November - December.

In the 2020 - 2021 academic year the number of participants was 41. Most of them, namely 27, were Master's students enrolled in the Digital Learning Games program. 7 were enrolled in the Educational Technology Master's program, 4 were Erasmus+ exchange students, and 3 were enrolled in other departments.

A7.2.3 Description of active learning deploying ALIEN methodologies and tools

This course followed project-based learning, design-based learning, and learning through teaching educational strategies. Students were asked to form teams of 4 in order to cover all competences needed in learning game design, namely instructional designer, conceptual designer, graphical designer, and developer. Teams were asked to develop a game from idea to a working prototype and use it in a real training situation. Students each year are asked to attend on Euneos vocational training course for teachers as trainers.

In the 2020 - 2021 academic year the Euneos course was cancelled and students were asked to transform all their prototypes into digital format and pair-review each other's games.

Brief summary of created games can be found in following address: https://learninggamedesign2020.wordpress.com/learning-games/.

A7.3 Course: Learning in Interdisciplinary Focused Environment (LIFE)

A7.3.1 Description of the course

The purpose of the LIFE course is to support the development of generic competences and teamwork skills through an interdisciplinary problem or topic implemented in a team. Learning activities take place in teams consisting of 6 students. The project team must include students from at least 3 different study areas. Up to 4 teams, consisting of 6 students each, can join one course.

Projects are carried out in cooperation between supervisors and students, and they include the following components: defining a common topic or problem, setting goals, creating an

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action plan, and carrying out the plan as intended. Participation in the LIFE course is supported by workshops and seminars intended for students. More detailed information on is available at https://ois2.tlu.ee/tluois/subject/YID6001.YM and on the LIFE portal https://elu.tlu.ee/en.

A7.3.2 Description of the participants

This is a cross curricular mandatory course in Tallinn University. Students from at least 3 different fields are expected to join, form teams, and solve some real-life related issues. Supervisors from the Digital Learning Games Master's program have initiated learning series in the form of projects that addressed the following topics:

- In the autumn of 2020: Design of Games on Research Methods 2. The course was attended by 26 students divided in 4 teams.
- In the spring of 2020: Design of Games on Research Methods 1. The course was attended by 18 students divided in 3 teams.
- In the autumn of 2019: Design of Games on Wage Gaps. The course was attended by 22 students divided in 4 teams.
- In the autumn of 2019: Design of Games on STEAM. The course was attended by 26 students divided in 5 teams.
- In the autumn of 2019: Design of Games on Law. The course was attended by 22 students from the Tallinn University Helsinki campus divided in 3 teams.

Students were enrolled in diverse programs that covered the entire Tallinn University department organogram. In addition, the course included 12 students from the Estonian Entrepreneurship University of Applied Sciences Game Design and Development program (https://www.euas.eu/).

A7.3.3 Description of active learning deploying ALIEN methodologies and tools

All LIFE courses have the same structure. Initially, the need or the problem was introduced. Then students were asked to play and find similar games. After that every student had an

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opportunity to present an idea for a new game. The best ideas were selected through voting and teams were formed around selected ideas. During team formation extra care was paid on even distribution of needed competences, such as art, development, research, text, pedagogy, and management. After that, teams were asked to produce the game concept, design a minimalistic project plan, and execute the project, in other words deliver the game, according to their plans. The course ended with testing and playing the finalized games.

Tallinn University central LIFE coordinators organized a mid-term review and final presentations for all projects and teams. This provided an opportunity for students to see what others were working on and to get some additional feedback. Following are some of the student projects:

- STEAM games are available in the address http://dlg.tlu.ee/games/.
- Wage Gap games are available in the address http://web.htk.tlu.ee/rege/.
- Best games on research methods are available in the address http://dlg.tlu.ee/methodyca/.

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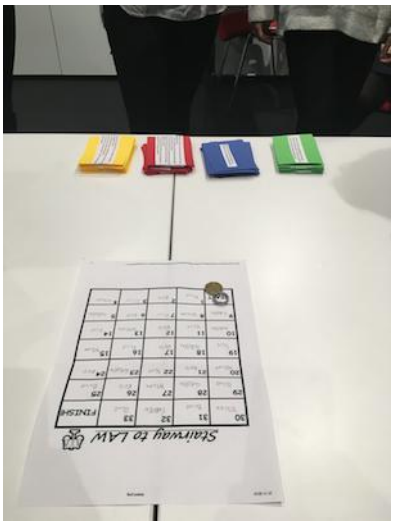

Figure 65. Students work on the design of games for law in the context of the LIFE course of Tallinn University in 2020.

A7.4 Course: Game Development Project

A7.4.1 Description of the course

The course in an elective in the Game Development curriculum. The goal of the course is to apply theoretical knowledge acquired in the context of the previous courses described above in the framework of bigger practical project. The Game Development Project is organized in parallel with the Agile Project Management course. The 2 courses are synchronized and support each other. More information is available at https://ois2.tlu.ee/tluois/subject/IFI7339.DT.

A7.4.2 Description of the participants

The course took place for the first time in the fall of 2020. 22 students attended. Most of them, and specifically 17, were enrolled in the 2nd year of the Digital Learning Game Master's program, while 3 were Erasmus+ exchange students, and 1 was enrolled in a different department.

A7.4.3 Description of active learning deploying ALIEN methodologies and tools

During this course students were asked to form small teams that consist of 3 - 5 members. Teams implement a game from idea design to working and tested product. Topics covered

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include project planning and execution, team forming and leading, role assignments and responsibilities, decision making and problem solving, game development and documentation, work meetings and progress reports, final product presentation. The semester was divided into 5 sprints each of which had a duration of 2 weeks.

At the end of the course students were asked to evaluate games created by fellow teams with the help of an on-line assessment form, available at https://forms.gle/Y1KkqojomRPMwoQe9. They were also asked to complete team self-evaluation where every team member's individual contribution was evaluated. Previously earned points were adjusted according to this evaluation.

Games produced by teams are available in the following addresses:

- Cautious https://alperuste.itch.io/cautious-a-day-in-corona.
- PostalFlip https://drive.google.com/drive/folders/1A69vJ5MA4SDEYKfdiJ1_kTd4chydumNa.
- GamEmo http://www.games.forsatsaz.com/html/game5.html.
- Number Snatchers http://www.tlu.ee/~shenawy/Snatchers/0.35/.

7.5 Course: 2D Graphics for Computer Games

7.5.1 Description of the course

The goal of the course is to develop practical skills and theoretical knowledge in the area of 2D computer game graphics, design concept art, and graphical 2D elements for game projects. The course introduces students to vector graphics, advanced shapes, vector graphics effects, colour models, scales and technical drawing techniques, raster graphics, layers and selections, masks, colour manipulation, raster effects, and web graphics. More detailed information on the course is available at https://ois2.tlu.ee/tluois/subject/IFI7319.DT .

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7.5.2 Description of the participants

The course in an elective in the Digital Learning Games Master's program. It is also part of the Game Elective Module for the Educational Technology Masters' program. For Digital Learning Games students the course takes place in the 1st semester of the academic year, from September to December. For Educational Technologies students the course takes place in the 3rd semester.

The course took place in the fall of 2019, with the participating of 26 students, of whom 3 were enrolled in the Educational Technology program, 21 were enrolled in the Digital Learning Games students, and 2 were Erasmus+ exchange students.

7.5.3 Description of active learning deploying ALIEN methodologies and tools

The course was more close to traditional university teaching activities. Classes took place in the university computer laboratory. At the beginning of each lesson the teacher introduced the concepts and techniques useful for the topic of the class. The 2nd part of the class was dedicated for student individual work. The teacher helped students individually by responding to questions. Every class ended with an individual assignment. To complete this assignment, students had the option of using the university computer laboratory for completing the activities or to work at home.

Innovative assessment methods were used during the course:

- Students were asked to submit the results of the individual assignments before the next class via a digital learning environment, and specifically Google® Classroom. At the beginning of every class the results of home assignments were presented by the teacher to all class participants. Additional questions on the selected tools and final design were asked. Students had a chance to comment on their own and fellow students work.
- Best works were published in social media, such as Facebook® or Instagram® (https://www.facebook.com/media/set/?vanity=digitallearninggames&set=a.1837226059726901).

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- The course ended with a semi-public exhibition opening. Students were asked to design and print a poster on the collection of their course work and present to the audience. After completing the official part of the exhibition more informal activities followed. Students and academic staff members had a chance to chat and consume snacks and drinks.

Figure 66. Students engage in the Graphics for Computer Games class.

7.6 Course: Computer Games

7.6.1 Description of the course

The goal of the course is to provide an overall understanding of game research, theory, design, and implementation. The main focus is on game design. Specifically, the course addresses game definition and elements, game classification and genres, the process of game design, the design of a game idea and concept, player types and target groups, gameplay, core mechanics, interactive storytelling, world design, game character design, and UI. Students form teams and design games from idea to digital prototype. Theoretical aspects are integrated with practical assignments. More information on the course is available at https://ois2.tlu.ee/tluois/subject/IFI6099.DT .

7.6.2 Description of the participants

This course is an elective in the Bachelor in Computer Science programme. It takes place in the 1st semester of the 2nd year of the curriculum. In 2019 the number of participants was 23.

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7.6.3 Description of active learning deploying ALIEN methodologies and tools

This course follows flipped classroom and project-based learning design. Previous versions of this course were also gamified so some elements of the gamification remain until today.

The course started with a couple of individual assignments. One of them was suggesting an idea for a new entertainment game. Each student had a chance to pitch the game idea to the class. The best ideas were selected through voting and teams were formed around the winning ideas. Extra effort was paid to create equal and heterogeneous teams. Each team was comprised by a manager, programmer, and an artist. The focus of activities was on game design, which took place through the collaboration of all team members.

After that most of the course activities were based on team work. At the ends of every class students were assigned individual home reading on different aspects of game design, such as concept, gameplay, core mechanics, assets, prototyping, and more. At the beginning of every class an individual Kahoot® quiz was conducted based on home reading. Students earned points only when they were present. After that, the majority of the class time was spent on game design activities in teams. At the end of every class randomly selected teams presented their design results. For successful presentations, teams earned some extra points. All teams were expected to upload their work results into virtual learning platform, namely Google® Classroom.

The course ended with the public presentation of game prototypes. Academic staff members and game industry representative were invited to this event. Visitors had an opportunity to ask questions to the teams. After the official part of the event, more informal networking activity took place.

For poster for inviting external visitors was created by the group of TLU students and is available at http://dlg.tlu.ee/games/gamebuilds/bigboss/index.html .

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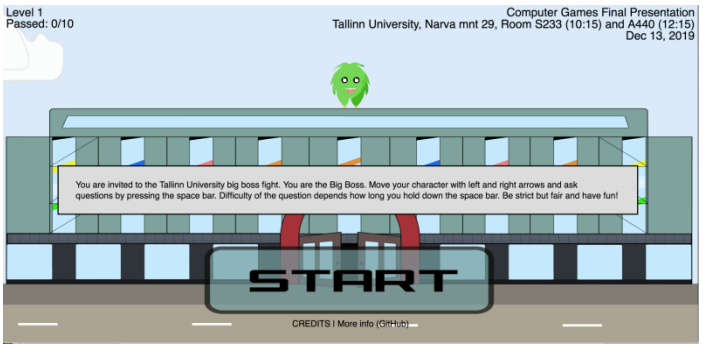

Figure 67. A sample of student work that took place in the Computer Games class.

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A8. Technical University of Gabrovo

A8.1 Course: Control Theory II

A8.1.1 Description of the course

The course focuses on understanding concepts and principles of controlling different systems and building mathematical models on the basis of which matrices are composed. In addition, it builds skills on the MATLAB® Simulink programming environment, in which simulation models are constructed.

A8.1.2 Description of the participants

90 students enrolled in the course in the 2019 - 2020 academic year. The students were in the 3rd year of their undergraduate studies following a degree course in Automation, Robotics, and Computer-Aided Control Systems, Automotive Electronic Engineering, or Power Supply and Electrical Equipment. The course is mandatory in the formal curriculum of the Department of Automation, Information, and Control Systems of the Technical University of Gabrovo.

A8.1.3 Description of active learning deploying ALIEN methodologies and tools

During the course of Automation Control II students were exposed to active and problem-based learning in the context of a team project on modeling and simulation of a DC motor, which was implemented in 3 stages:

Stage 1: **Analytical**

In this stage, students focused on a particular math model of a motor in the form of differential equations. This was the most crucial stage, because there was significant space for errors when composing the equations. To minimize potential errors, students deployed simple-model mathematical modeling. This approach allowed them to create the simplest possible model that represented only the basic features of the motor, while it was still suitable for computer simulation.

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Stage 2: Analytical

During the 2nd stage the teams constructed the state space form of the model and derived the A, B, C, and D matrices. This stage was less error-prone but nevertheless the educator observed carefully the work of each team mainly for oversight errors.

Stage 3: Computer-aided

During the 3rd stage, each team programmed several simulations in MATLAB with different input signals and different parameter values and observed the effect of these changes in the respective plots.

Finally each team presented their results and challenges met in the course of the project.

The active learning activities allowed students to engage in the practical application of controlling a DC motor and simulate different variants in MATLAB. This approached helped prepare students to work in an industrial environment where control theory is applied in practice. It also contributed to the development of collaboration skills, critical thinking, and communication capacity.

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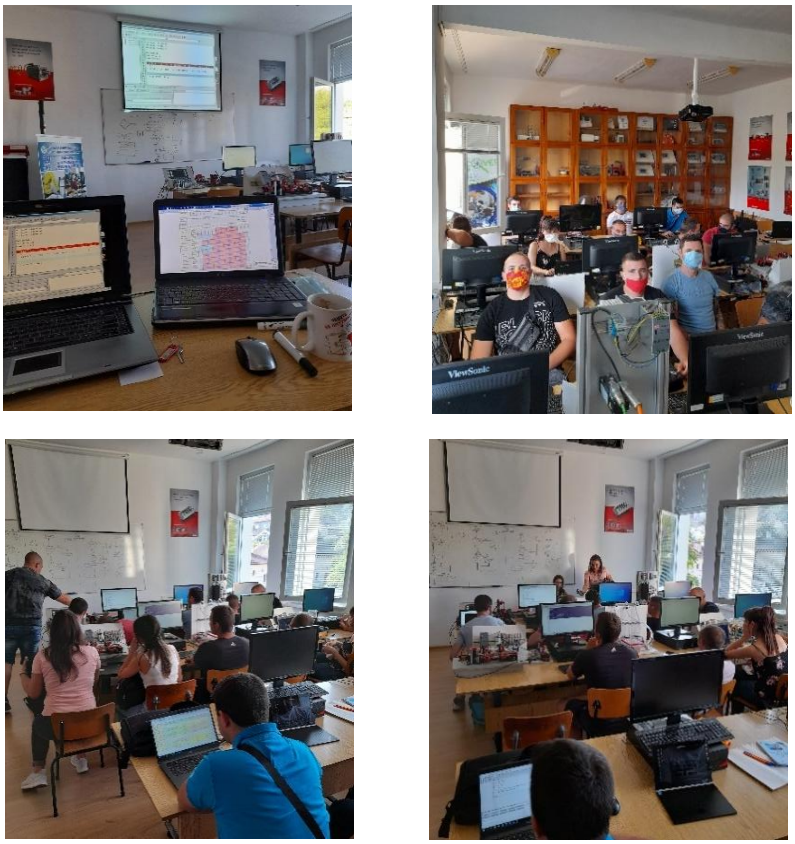

Figure 68. Students work on projects during the Control Theory II course.

A8.2 Course: CNC Tools, Machines, and Technologies

A8.2.1 Description of the course

The course focuses on basic hands-on machining practice on lathes, milling machines, and grinders. It includes set-up, tool selection, and methods used on various materials, such as steel, aluminum, and brass. Moreover, it addresses reading and editing of CNC programs, set-up and maintenance of tool holders, tooling and work holding, and adjustments of work and tool offsets. Finally, it covers operation and programming of CNC machine tools using manual programming and CAMsystems.

A8.2.2 Description of the participants

The course is fundamental for Mechanical Engineering students. 120 students were enrolled in the course in the 2020 - 2021 academic year. The students were in the 2nd year of their

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undergraduate studies in the Faculty of Mechanical and Precision Engineering. The course is mandatory in the formal curriculum of the Department of Mechanical Engineering Equipment and Technologies of the Technical University of Gabrovo.

A8.2.3 Description of active learning deploying ALIEN methodologies and tools

During the course of CNC Tools, Machines, and Technologies students were exposed to active and problem-based learning in the context of a team project on cutting tools, types, and structural and geometric components. The project was implemented through laboratory practice activities and involved e-reading, practical work, and analytical and critical thinking. The laboratory part of the course was based on problem-based learning and was performed on workbenches with instrumentation, drawings, and computers.

Students implemented the following steps:

- Students became acquainted with e-resources and drawings of tools and work pieces.
- The teams used e-catalogues to select a carbide tip and a holder taking into consideration a work piece drawing.
- Each team presented their rationale for selecting a particular tip and holder. They further presented the way in which they would install it on the lathe.
- Students engaged into more practical work by installing the selected cutting tool on a universal lathe so that its nose coincided with the work piece axes.

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Figure 69. Students work on laboratory projects in the CNC Tools, Machines, and Technologies course.

The active learning activities allowed students to use on-line resources for educational and professional purposes, to analyze data, and compare results. It also improved their team work, analytical skills and critical thinking, and communication and presentation skills.

A8.3 Course: Fluid Mechanics

A8.3.1 Description of the course

The course is fundamental for mechanical engineering students and provides basic understanding of fluid properties, fluid statics and dynamics, and fluid flow. It focuses on fundamental laws governing fluid behavior, such as Euler and Lagrangian specification of fluid flow, Bernoulli's equation, Nikuradse experiments, and Moody's diagram.

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A8.3.2 Description of the participants

The course is fundamental for mechanical engineering students. 150 students were enrolled in the course in the 2020 - 2021 academic year. The students were in the 1st year of their undergraduate studies in the Faculty of Mechanical and Precision Engineering. The course is mandatory in the formal curriculum of the Department of Power Engineering of the Technical University of Gabrovo.

A8.3.3 Description of active learning deploying ALIEN methodologies and tools

The laboratory part of the course was based on problem-based learning and is performed on workbenches with instrumentation and on stands. It involved performing laboratory exercises for better understanding by the students of the basic principles of fluid mechanics in a pipe system.

Three teams were formed to define the basic hydraulic parameters of the flow, namely initial energy and head, piezometric pressure and elevations, dynamic pressure and elevations, geodetic elevation, and hydraulic losses in different flows of the fluid based on a given configuration of a pipe system. The 1st team solved the problem analytically by using Bernoulli equations. The 2nd team solved the problem by directly measuring quantities through the use of an experimental stand. The 3rd team solved the problem by modeling it and simulating its operation in the SolidWorks Flow Simulation® environment.

Finally, the teams presented their results in class and compared their findings.

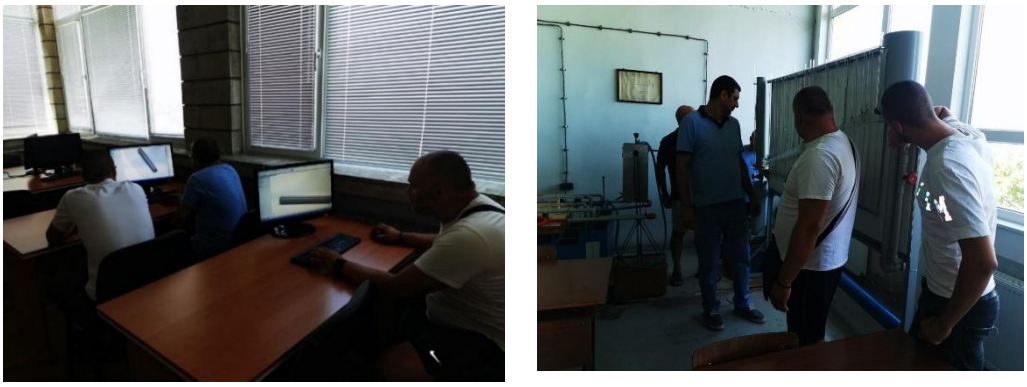

Figure 70. Teams solving the problem by using SolidWorks Flow Simulation and the experimental stand.

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The active learning activities allowed students to use the SolidWorks Flow Simulation® environment for educational and professional purposes, to analyze data, and to compare results. Active learning also improved student team work capacity, analytical skills and critical thinking, and communication and presentation skills.

A8.4 Course: Computer-Aided Measurement

A8.4.1 Description of the course

The main objective of the course is to provide students with first-hand knowledge on the fundamentals of computer-aided measurement techniques, joint measurements and data acquisition, off-line processing of recorded data, and report preparation. Students are also introduced to advanced computer-aided measuring systems.

A8.4.2 Description of the participants

The course is fundamental for mechanical engineering students. 120 students were enrolled in the course in the 2020 - 2021 academic year. The students were in the 2nd year of their undergraduate studies in the Faculty of Mechanical and Precision Engineering. The course is mandatory in the formal curriculum of the Department of Mechanical and Precision Engineering of the Technical University of Gabrovo.

A8.4.3 Description of active learning deploying ALIEN methodologies and tools

During the course of CNC Tools, Machines, and Technologies students were exposed to active and problem-based learning in the context of a team project on analyzing the temperature influence upon measuring the diameter of cylindrical opening. The project took place during laboratory practice.

Students were divided in 3 teams. Teams were asked to perform 20 measurements each in 3 relevant sections of the openings by using a pasimeter, which is an inside-diameter measuring instrument. Each team constructed a histogram of the distribution by using Microsoft® Excel and presented it to the class.

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The active learning activities allowed students to better understand how to operate with a pasimeter and how to use Microsoft® Excel in their future roles in industry. Furthermore, they were able to analyze data and compare results. They also improved their collaboration skills, analytical skills and critical thinking, and communication and presentation skills.

Figure 71. Students construct a histogram in the context of the Computer-Aided Measurements course.

A8.5 Course: Mechanics II

A8.5.1 Description of the course

This course introduces students to the basic physical laws governing the interaction of bodies. It focuses on the planar kinematics and dynamics of rigid bodies, including aspects of force, momentum, impulse, moment (torque), angular momentum, moment of inertia, as well as on the theory of vibrations and mechanical waves. In addition, it focuses on Euler's laws for planar motion, translation and rotation, work and energy, and collisions. The course places a special emphasis on constructing mechanical models by using relevant approximation and analyzing those models by using mathematical methods.

A8.5.2 Description of the participants

The course is fundamental for mechanical engineering students. 120 students enrolled in the course in the 2020 - 2021 academic year. The students were in the 2nd year of their undergraduate studies in the Faculty of Mechanical and Precision Engineering. The course is mandatory in the formal curriculum of the Department of Applied Mechanics of the Technical University of Gabrovo.

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A8.5.3 Description of active learning deploying ALIEN methodologies and tools

During the course of Mechanics II, students were exposed to active and problem-based learning in the context of project work on the mass axial moment of inertia of a body of any shape. The project was implemented in groups of 2 during laboratory practice. Students used the SOLIDWORKS® application and experiments.

Students implemented the following steps:

- Students became acquainted with the definition and application of an axial mass moment of inertia by using on-line resources.
- Students determined the axial moment of an available body through an experiment.
- Students built the geometry of the same body through SOLIDWORKS®.
- Students applied a calculation procedure to the geometry built in order to define the mass moment of inertia.
- Students presented the results of their work and compared to those of the other teams in the class.

The active learning activities allowed students to more effectively experiment through the use of technology, and in particular SOLIDWORKS® and to solve mechanical problems. Students had the help of their peers, the support of whom allowed them to better adapt to future roles.

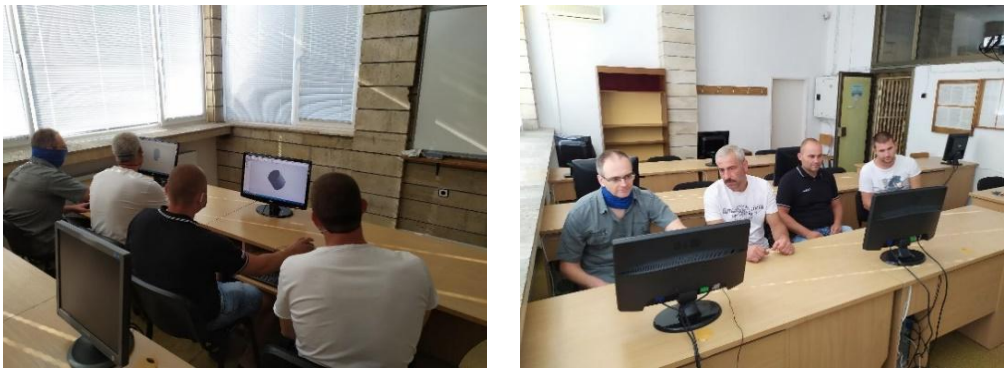

Figure 72. Students work in pair on building the geometry of a rigid body by using SOLIDWORKS® in the context of the Mechanics II course.

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The activities further enabled students to build problem-solving analytical skills, self-confidence, and communication skills.

A8.6 Course: Environmental Chemistry

A8.6.1 Description of the course

The course introduces students to the chemistry of air, water, and soil. It further focuses on how anthropogenic activities affect this chemistry on planet Earth. It focuses on the sources, reactions, transport, effects, and fates of chemical species in air, water, and soil environments. It further focuses on the effects of technology thereon.

A8.6.2 Description of the participants

35 students were enrolled in the course in the 2020 - 2021 academic year. The students were in the 3rd year of their undergraduate studies following a degree course in Environmental Protection Equipment and Technologies and Industrial Management. The course is mandatory in the formal curriculum of the Department of Physics, Chemistry, and Ecology of the Technical University of Gabrovo.

A8.6.3 Description of active learning deploying ALIEN methodologies and tools

During the course of Environmental Chemistry students were exposed to active and problem-based learning in the context of a team project on modeling air pollution with chemical materials, namely gases of different origin, chimneys of production sites, or reservoirs with chemical materials. The students were divided in 2 teams. The 1st team focused on hydrogen sulphide pollution, and the 2nd on ammonia pollution.

The students implemented the following steps:

- The 2 teams modeled the respective pollution from a chimney and estimated the magnitude of the polluted zone by using ALOHA®, which is a hazard modeling software program.
- The teams modeled the respective pollution from a reservoir and estimated the magnitude of the polluted zone.

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- The teams compared the 2 results.
- The teams presented their analysis to the class.


Figure 73. Students work in pairs on modelling air pollution by using the ALOHA® application in the context of the Environmental Chemistry course.

The active learning activities allowed students to better cooperate and work in a team towards simulating various types of pollution by using relevant software which is used today in industrial chemical laboratories. In addition, they were able to improve their analytical and critical thinking as well communication skills.

A8.7 Course: Reliability of Electronic Systems

A8.7.1 Description of the course

The course introduces the fundamental principles of reliability and practical reliability definitions. It focuses on the main stresses and failure mechanisms of electronic components, as well as on the reliability prediction procedure and modelling techniques. It addresses the design for the reliability process and reliability testing for assessing the reliability of an electronic system.

A8.7.2 Description of the participants

The course enrolled 60 students in the 2020 - 2021 academic year. Students were in the 1st year of undergraduate studies, following a degree course in Automotive Electronic Engineering and Automation, Robotics, and Computer-Aided Control Systems. The course is

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mandatory in the formal curriculum of the Department of Electronics of the Technical University of Gabrovo.

A8.7.3 Description of active learning deploying ALIEN methodologies and tools

During the course students were exposed to active and problem-based learning in the context of a team project on calculating the failure intensity of the electronic components of different DC/DC converters by using the ItemTool Kit® application. Students were organized in 4 teams.

The students implemented the following steps:

- Students became familiar with the circuit, components, and principle of operation of the DC/DC converter by using on-line resources.
- Students recorded the nominal and operating values of the parameters of the electronic components of the respective DC/DC converter.
- Students calculated the failure intensity of the electronic components by using either MIL-HDBK-217F method or FIDES method and ItemTool Kit® application.
- Students chose an alternative reliability circuit and calculated the quantitative reliability indicators, including failure probability, probability of failure-free operation, and mean time between failures.
- Students determined and recorded the components of the circuits having the highest failure intensity.
- Students swapped data and made an analysis of the results obtained by comparing the findings for the two circuits and the two calculation methods.

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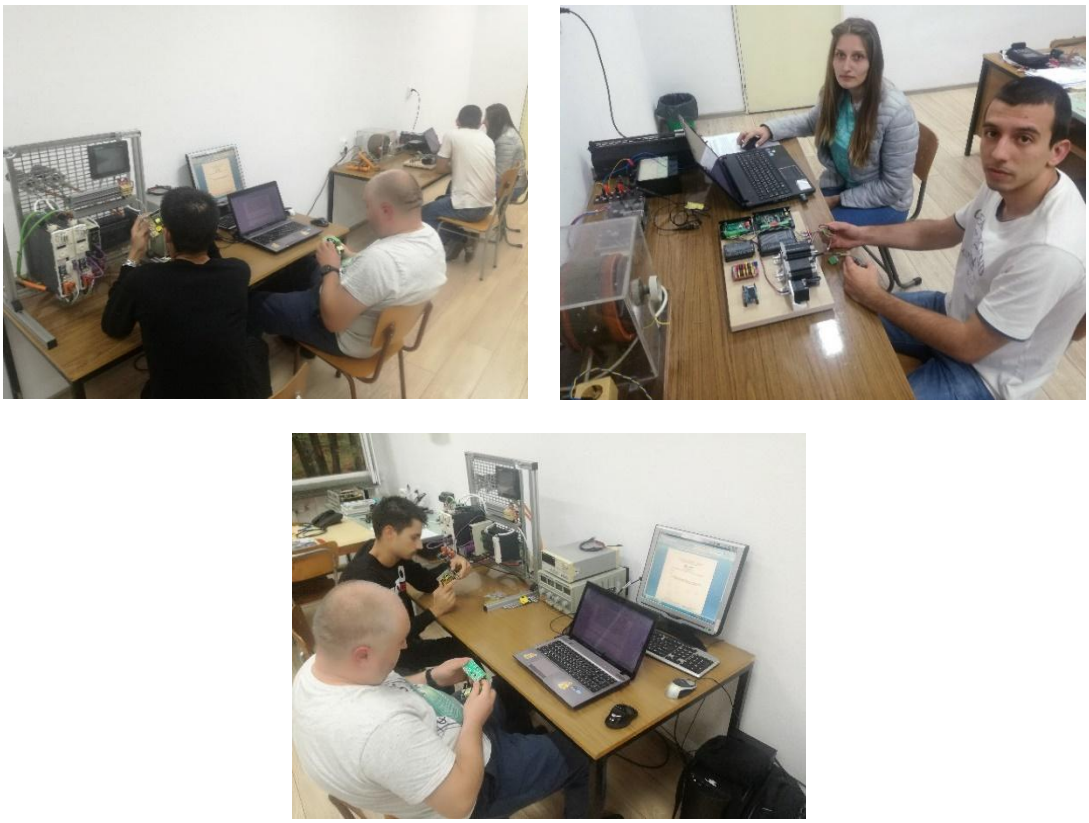

Figure 74. Students calculate the failure intensity by using the ItemTool Kit® in the context of the Reliability of Electronic Systems course.

The active learning activities encouraged students to deploy digital tools in their calculations in a manner that simulated respective real-life activities in the industry. In addition, students improved their analytical and critical thinking as well as communication skills and team spirit. Problem-solving played a key role.

A8.8 Course: Automation Basics

A8.8.1 Description of the course

This course focuses on the theory of linear systems as a type of simple dynamic units. It addresses the stability of linear automatic control systems, the quality processes in the automatic control systems, and controls with continuous operation. The course further focuses on elements of non-linear systems theory. The course particularly emphasizes the adjustment of controls, the optimization of automatic control systems, and the application of

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digital controls.

A8.8.2 Description of the participants

30 students were enrolled in the course in the 2020 - 2021 academic year. The students were in the 3rd year of their undergraduate studies following a degree course in Electrical Engineering. The course is mandatory in the formal curriculum of the Department of Electronics of the Technical University of Gabrovo.

A8.8.3 Description of active learning deploying ALIEN methodologies and tools

During the course students were exposed to active and problem-based learning in the contexts of a team project on the stability of continuous-time linear systems by algebraic criteria. Students worked in groups of 2.

Students implemented the following steps:

- Students became familiar with the resources provided by the teacher.
- Students implemented a transfer function model of a linear automatic control system.
- Using MATLAB Simulink®, students designed a simulation model to investigate the transition and weight function of the system of a transfer function by using zeros and poles of a system.
- Students created a simulation to verify the correctness of the simulation model.
- After verification, students were asked to answer questions on their design and implementation.

The active learning activities allowed students to deploy digital tools in their project implementation with the objective of adapting to their future work life as engineers. In addition, students were able to improve their analytical and critical thinking as well as communication skills and team spirit. Problem-solving played a key role.

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Figure 75. Students very a simulation model in the context of the Automation Basics course.

A8.9 Course: Materials Resistance

A8.9.1 Description of the course

The course introduces the theory of stress and deformation on rigid bodies and dimensioning beam elements subjected to simple resistance, such as tensile forces, cutting and surface compression, twisting of beam elements with circular and non-circular cross sections, and bending. The course further focuses on complex resistance aspects and on solving statistically non-definite structures of beam elements applying the concepts of strength method and fatigue strength.

A8.9.2 Description of the participants

The course is fundamental for mechanical engineering students. 120 students were enrolled in the course in the 2020 - 2021 academic year. The students were in the 2nd year of their undergraduate studies in the Faculty of Mechanical and Precision Engineering. The course is mandatory in the formal curriculum of the Department of Applied Mechanics of the Technical University of Gabrovo.

A8.9.3 Description of active learning deploying ALIEN methodologies and tools

During the course students were exposed to active and problem-based learning in the context of a team project on determining the reaction of beam elements subjected to an arbitrary external load and resting on supports for different purposes. Students worked in groups of 2. Students used the SAP2000® software.

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The students implemented the following steps:

- Students became familiar with theoretical aspects on beam elements and support types.
- Students became familiar with the SAP2000® application.
- Students constructed the geometry of a beam element in SAP2000® and set the element physical characteristics and support.
- Students defined the dimensions of the reactions by using SAP2000®.
- Students compared the results they obtained analytically and through SAP2000®.

Figure 76. Students construct a beam element through the SAP2000® software in the context of the Materials Resistance course.

The active learning activities allowed students to deploy digital tools in their calculations in a manner that simulated real-life engineering practices in industry. In addition, students improved their analytical and critical thinking as well as communication skills and team spirit. Problem-solving played a key role.

A8.10 Course: Computational Mathematics

A8.10.1 Description of the course

The course introduces the study and design of mathematical models for the numerical solution of scientific problems. It focuses on numerical methods for the solution of linear and non-linear systems, basic data fitting problems, and ordinary differential equations.

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Robustness, accuracy, and speed of convergence of algorithms is investigated including the basics of computer arithmetic and round-off errors.

A8.10.2 Description of the participants

20 students enrolled in the course in the 2020 - 2021 academic year. The students were in the 3rd year of their undergraduate studies following a degree course in Industrial Management. The course is elective in the formal curriculum of the Department of Mathematics of the Technical University of Gabrovo.

A8.10.3 Description of active learning deploying ALIEN methodologies and tools

During the course students were exposed to active and problem-based learning in the context of a team project on probability theory and mathematical statistics. Students worked in groups and used computational mathematics systems, and specifically Maple®, MathCad®, Microsoft® Excel, and Mathematica®.

Students implemented the following steps:

- Students became familiar with the resources provided by the teacher.
- Students selected a problem related to probability theory and mathematical statistics from a predefined pool provided by the teacher.
- Students discussed potential problem solutions to be implemented through the computational mathematics systems, namely Maple®, MathCad®, Microsoft® Excel, and Mathematica®.
- Students selected the most appropriate computational mathematics system and applied it to solve the problem.
- Students analyzed their results and responded to questions related to their implementation.

The active learning activities allowed students to incorporate digital tools in their calculations in a manner that simulates their future roles as engineering professionals. In

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addition, students improved their analytical and critical thinking as well as communication skills and team spirit. Problem-solving played a key role.

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A9. John Von Neumann Institute, Viet Nam National University Ho Chi Minh City

A9.1 Course: Enterprise Architecture

A9.1.1 Description of the course

The course builds knowledge on frameworks for building enterprise architectures for an organization. The course further helps students understand how to apply a design tool to describe the different models of business, data, application, and technology. At the same time, students learn how to build and manage an enterprise architecture development project.

A9.1.2 Description of the participants

The course is part of the graduate program in Information and Communication Technologies at John von Neumann Institute. The course is also offered in the Information and Communication Technologies graduate program at the Polytechnic University of Ho Chi Minh City. The following groups of students participated in the activities:

- 12 students enrolled in the semester 1 of the 2019 - 2020 academic year.
- 15 students enrolled in the semester 1 of the academic year 2020 - 2021.

A9.1.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. Practical activities took place in the ALIEN problem-based learning laboratory. The course was organized as a series of activities for building an enterprise architecture, including phases and deliverables. This work did not only require technical skills, such as modeling in business, data, application, and technology, but also business skills to define, collect, and analyze information on developing an enterprise architecture project. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session.

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Students implemented the following steps:

- Students studied, presented, and discussed the general definition of enterprise architecture.
- Students selected a business scenario to build an enterprise architecture work.
- Students looked for different business reference models to use in their scenario.
- Students reviewed lessons with interactive games using Kahoot®. Students created the games themselves under teacher guidance. After each game, the lecturer posed questions on the wrong or unclear answers, encouraging students to discover more on the missed points.
- Students played scenario games in which they provided input related to the practical application of knowledge and techniques in developing enterprise architectures.
- Students used EA Sparx® and Dropbox® to build and share their results with their classmates and lecturer.

In the context of tutorials, students further implemented the following activities:

- Students worked in groups to develop models and presented their results to their peers and the instructor.
- Students summarized their results in a shared document that they collectively edited.

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Figure 77. Students work in the group to fulfil the requirements of the problem in the Enterprise Architecture course.

- Students raised concerns or interests during the course and engaged in discussions with their classmates in the final session. The lecturer helped students align their points with the framework of the course for developing more effective understanding of concepts and enabling student to apply new knowledge in practice.

A9.2 Course: Decision Analysis

A9.2.1 Description of the course

The course builds knowledge on basic concepts and methods of decision theory. They further develop practical skills for applying theoretical constructs to a variety of interesting and important problems. At the same time, students learn how to combine different analysis techniques for solving practical problems and defend their solutions to the lecturer.

A9.2.2 Description of the participants

The course is part of the Quantitative Computational Finance graduate program at John von Neumann Institute. This course is also offered in some Applied Mathematics graduate programs at the University of Economics and Law (VNUHCM) and the University of Natural Sciences (VNUHCM). The following groups of students were engaged:

- 22 students in semester 2 of the 2018 - 2019 academic year.
- 17 students in semester 2 of the 2019 - 2020 academic year.

The lecturer of the course is Dr. Brett Houlding (TCD) and Dr. Man Ngo (JVN). Trinity College Dublin (TCD) is the partner of JVN in the VIDAI project funded by Irish Aid.

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A9.2.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. Practical activities took place in the ALIEN problem-based learning laboratory. The course included a series of activities for building knowledge and applying newly developed skills in decision making in finance or business situations. This work does not only require technical skills, such as data model design and analysis, but also business skills to define and identify appropriate analysis techniques. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session.

Students implemented the following steps:

- Students studied analysis techniques and finished the exercises in different contexts given by the lecturer.
- Students selected a topic in a pre-defined list and prepared a data story through which they illustrated the related concepts to the lecturer and their classmates.
- Students researched different data analysis models and data sources applicable in their scenario.
- Students reviewed lessons with interactive games using Kahoot®. Students created the games themselves under teacher guidance. After each game, the lecturer posed questions on the wrong or unclear answers, encouraging students to discover more on the missed points.
- Students played scenario games in which they provided input related to the practical application of knowledge and techniques in decision making.
- Students used R, Python®, and Google® Class to build and share their results with their classmates and lecturer.

In the context of tutorials, students further implemented the following activities:

- Students worked in groups on the analysis of the scenario that they selected and prepared a presentation summarizing their findings for the benefit of their classmates.

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- Students summarized their results in a shared document that they collectively edited.
- Students assumed roles of professionals in a data science department. They discussed plans for applying their knowledge and skills in the context set by the lecturer.
- Students raised concerns or interests during the course and engaged in discussions with their classmates in the final session. The lecturer helped students align their points with the framework of the course for developing more effective understanding of concepts and enabling student to apply new knowledge in practice.

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Figure 78. Students design solutions under the guidance of their lecturer in the Decision Analysis course.

A9.3 Course: Time Series Analytics and Forecasting

A9.3.1 Description of the course

The course builds knowledge for answering the following problem:

A system X evolves in time. The system is observed. The objective is to predict its future evolution. In this course, the system under observation focuses on financial data. For example, the system may model the prices of assets. Practical observation demonstrates that what is important is not the pricing process but the return process that calculates risk through a covariance function. At the same time, students learn how to build and manage a forecasting model of specific data sources.

A9.3.2 Description of the participants

The course is part of the Quantitative Computational Finance graduate program at John von Neumann Institute. The course is also offered in some Applied Mathematics graduate programs at the University of Economics and Law - Vietnam National University Ho Chi Minh City and the University of Natural Sciences - Vietnam National University Ho Chi Minh City. The following groups of students were engaged:

- 21 students in semester 2 of the 2018 - 2019 academic year.
- 16 students in semester 2 of the 2019 - 2020 academic year.

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A9.3.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. Practical activities took place in the ALIEN problem-based learning laboratory. The course included a series of activities for building knowledge and applying practical skills in analyzing time series data in the financial industry. This work did not only require technical skills, such as data model design and analysis, but also soft skills to investigate the scenario that created the observed data. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session.

Students implemented the following steps:

- Students studied analysis techniques and executed exercises in different contexts provided by the lecturer.
- Students selected a topic and data package from a pre-defined list and applied different data analysis techniques for understanding the story in focus. They presented the story to the lecturer and their classmates. The story was used to predict the future of the scenario using evidence from their analysis results.
- Students reviewed lessons with interactive games using Kahoot®. Students created the games themselves under teacher guidance. After each game, the lecturer posed questions on the wrong or unclear answers, encouraging students to discover more on the missed points.
- Students played scenario games in which they provided input related to the practical application of knowledge and techniques in their scenario of choice.
- Students used R and Python® to build and share their results with their classmates and lecturer.

In the context of tutorials, students further implemented the following activities:

- Students worked in groups on the analysis of the scenario that they selected and prepared a presentation summarizing their findings for the benefit of their classmates.

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- Students summarized their results in a shared document that they collectively edited.
- Students packaged their solutions as an application and demonstrated in a presentation to their lecturer and classmates how to use the application in similar contexts.
- Students raised concerns or interests during the course and engaged in discussions with their classmates in the final session. The lecturer helped students align their points with the framework of the course for developing more effective understanding of concepts and enabling student to apply new knowledge in practice.

Figure 79. Students work with the lecturer in the Time Series Analytics and Forecasting course.

A9.4 Course: Information Technology Management

A9.4.1 Description of the course

The course builds knowledge and skills for managing related application activities in an organization. More specifically the learn to plan and manage information technology

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resources, develop vision, strategies, plans, projects, and solutions for information technology applications, apply new trends in building enterprise information systems, build an information technology skills framework and correspoding performance assessment framework.

A9.4.2 Description of the participants

The course is part of the graduate program on Information and Communication Technologies at John von Neumann Institute. The following students were engaged:

- 17 students in semester 2 of the 2018 - 2019 academic year.
- 21 students in semester 2 of the 2019 - 2020 academic year.

The lecturer of the course is Dr. Huy Nguyen (JVN).

A9.4.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. Practical activities took place in the ALIEN problem-based learning laboratory. The course included a series of activities for building IT strategies, designing and developing IT projects, operating and delivering IT services, and improving the overall IT activities continuously. The course requires diverse skills and knowledge at the management level. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session.

Students implemented the following steps:

- Students studied, presented, and discussed the general definition of and roles in IT management.
- Students selected a business scenario on which they would build an IT plan.
- Students looked for different potential IT solutions to apply in their scenario.
- Students reviewed lessons with interactive games using Kahoot. These games are Students reviewed lessons with interactive games using Kahoot®. Students created the games themselves under teacher guidance. After each game, the lecturer posed

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questions on the wrong or unclear answers, encouraging students to discover more on the missed points.

- Students played scenario games in which they provided input related to the practical application of knowledge and techniques in developing and operating an IT solution effectively.
- Students used Office® software, modeling tools, and Dropbox® to build and share their results with their classmates and the lecturer.

In the context of tutorials, students further implemented the following activities:

- Students worked in groups on aspects related to the development, exploitation, and maintenance of an IT solution for a specific scenario and presented their findings to the teacher and their classmates.
- Students summarized their results in a commonly owned shared document.
- Students raised concerns or interests during the course and engaged in discussions with their classmates in the final session. The lecturer helped students align their points with the framework of the course for developing more effective understanding of concepts and enabling student to apply new knowledge in practice.

Figure 80. Students work in groups the IT Management course.

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A9.5 Course: Management of Information Systems

A9.5.1 Description of the course

The course builds knowledge on the management of information systems, which are important components in information technology. Notably, information technology today plays a significant role in organization management. Students are based in external organizations. Understanding how IT could be productively used is a prerequisite for participating in the course. At the same time, students learn how to build and manage an MIS development project.

A9.5.2 Description of the participants

The course is part of the graduate program on Information and Communication Technologies at John von Neumann Institute. The course is also offered in the Information and Communication Technologies undergraduate program at Ho Chi Minh University of Technology and the Information and Communication Technologies graduate program at the University of Economics and Finance. The following groups of students were engaged:

- 23 students in semester 1 of the 2019 - 2020 academic year.
- 27 students in semester 1 of the 2020 - 2021 academic year.

A9.5.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. Practical activities took place in the ALIEN problem-based learning laboratory. The course included a series of activities on building an IT solution for a management purpose. This work does not only require technical skills, such as modeling in business, data and technology, but also business skills to define, collect, and analyze information related to the development of an MIS. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session.

Students implemented the following steps:

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- Students studied, presented, and discussed the general definition of management roles and management information systems.
- Students selected a business scenario on which they would build an IT solution.
- Students researched different viewpoints in developing and operating an MIS.
- Students reviewed lessons with interactive games using Kahoot®. These games are Students reviewed lessons with interactive games using Kahoot®. Students created the games themselves under teacher guidance. After each game, the lecturer posed questions on the wrong or unclear answers, encouraging students to discover more on the missed points.
- Students played scenario games in which they provided input related to the practical application of knowledge and techniques in developing and operating an MIS.
- Students used Microsoft® Office software, modeling tools, and Dropbox® to build and share their results within their classmates and lecturer.

In the context of tutorials, students further implemented the following activities:

- Students worked in groups on aspects related to the development of an MIS modeling and development plan and presented their findings to the teacher and their classmates.
- Students summarized their results in a commonly owned shared document.
- Students raised concerns or interests during the course and engaged in discussions with their classmates in the final session. The lecturer helped students align their points with the framework of the course for developing more effective understanding of concepts and enabling student to apply new knowledge in practice.

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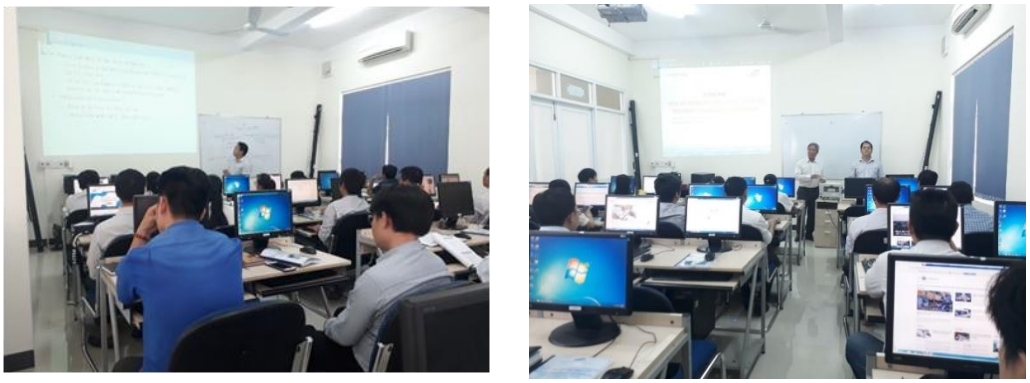

Figure 81. Students work on group projects in the Management of Information Systems course.

A9.6 Course: Network Programming

A9.6.1 Description of the course

The course builds knowledge on developing a Java program to connect computers through a local network using TCP or UDP protocols. The course further helps students understand how to design an interactive application to respond appropriately to business requirements in specific scenarios. At the same time, students learn how to work in a group and finish a project.

A9.6.2 Description of the participants

The course is part of the Information and Communication Technologies undergraduate programs in Vietnam Germany University and University of Information - Technology Vietnam National University Ho Chi Minh City. The following groups of students were engaged:

- 35 students in semester 2 of the 2018 - 2019 academic year.
- 42 students in semester 2 of the 2019 - 2020 academic year.

A9.6.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. Practical activities took place in the ALIEN problem-based learning laboratory. The course included a series of activities on learning how to program an application that connects computers in a

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network with the purpose of exchanging data among different locations in business or social contexts. Course work includes several projects from easy to hard levels. Through these projects students build understanding of network connectivity concepts and practical skills on applying new knowledge in real life. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session.

Students implemented the following steps:

- Students worked in groups on coding Java programs to fulfill system requirements provided by the lecturer.
- Students designed their own solutions based on theoretical frameworks and recommendations introduced through lectures.
- Students researched different models for building effective communication applications.
- Students reviewed lessons with interactive games using Kahoot®. Students created the games themselves under teacher guidance. After each game, the lecturer posed questions on the wrong or unclear answers, encouraging students to discover more on the missed points.
- Students played scenario games in which they provided input related to the practical application of knowledge and techniques in developing networks.
- Students used Eclipse®, Java®, and Dropbox® to build and share their results within their classmates and lecturer.

In the context of tutorials, students further implemented the following activities:

- Students worked in groups on aspects related to the development of an MIS modeling and development plan and presented their findings to the teacher and their classmates.
- Students summarized their results in a commonly owned shared document.
- Students raised concerns or interests during the course and engaged in discussions with their classmates in the final session. The lecturer helped students align their

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points with the framework of the course for developing more effective understanding of concepts and enabling student to apply new knowledge in practice.

A9.7 Course: Methodology and Skills for Scientific Research

A9.7.1 Description of the course

The course builds knowledge on scientific research methodologies. They further practice working skills for digital transformation. At the same time, students are required to apply they newly developed knowledge in a research topic of their choice.

A9.7.2 Description of the participants

The course is part of the graduate programs on Information and Communication Technologies and Quantitative Computational Finance at John von Neumann Institute. The course is also offered in the Information and Communication Technologies graduate programs at the University of Natural Sciences - Vietnam National University Ho Chi Minh City and the Polytechnic University of Ho Chi Minh City. The following groups of students were engaged:

- 39 students enrolled in semester 2 of the 2018 - 2019 academic year.
- 32 students enrolled in semester 2 of the 2019 - 2020 academic year.

The lecturers of the course are Prof. Bao Ho (JVN), Prof. Vu Duong (JVN), Dr. Huy Nguyen (JVN), Dr. An Mai (JVN) and Dr. Quang Nguyen (JVN).

A9.7.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. The course included a series of activities for learning how to find a research topic, write a research proposal with literature review, and write a scientific paper. Students applied newly developed skills on a topic if their choice. The course helped students improve communication and creative skills. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session.

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Students implemented the following steps:

- Students studied the phases of the scientific writing process. They worked in groups on a topic of their choice.
- Students selected their own approach for writing and presenting their work, which was structured as a research paper.
- Students researched related scientific articles and other documents. They discussed their findings under the guidance of the lecturer. They prepared and delivered a presentation of their work for the benefit of their classmates and the lecturer.
- Students reviewed lessons with interactive games using Kahoot®. Students created the games themselves under teacher guidance. After each game, the lecturer posed questions on the wrong or unclear answers, encouraging students to discover more on the missed points.
- Students played scenario games in which they provided input related to the practical application of knowledge and techniques in identifying a research topic of interest, researching the context of the work, and preparing a written research proposal.
- Students used Office® software and Google® class to develop presentations and share their results within their classmates and the lecturer.

In the context of tutorials, students further implemented the following activities:

- Students worked in groups on selecting a research topic and performing a literature review.
- After each important milestone of the project students prepared and presented a progress report that was evaluated by their classmates and lecturers.
- Students executed exercises and tests for evaluating and improving soft skills in the digital age, such as creative thinking, active listening, and team work.
- Students summarized their results in a commonly owned shared document.
- Students raised concerns or interests during the course and engaged in discussions with their classmates in the final session. The lecturer helped students align their

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points with the framework of the course for developing more effective understanding of concepts and enabling student to apply new knowledge in practice.

Figure 82. Students collaborate in the Methodology and Skills for Scientific Research course.

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A10. Hanoi University

A10.1 Course: Multimedia Design

A10.1.1 Description of the course

The course builds knowledge on basic components of multimedia communications and how to combine those using existing tools and techniques. The course further helps students understand how to use pictures, sound, and video clips to convey a message in the most meaningful way. At the same time, students learn how to design and manage a multimedia communication project.

A10.1.2 Description of the participants

This is an elective course that targets 3rd year undergraduate students in the Department of Information Systems, Faculty of Information Technology, Hanoi University. 51 students enrolled in semester 1 of the 2019 - 2020 academic year. The students were divided into 2 classes.

A10.1.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active learning through weekly lectures and tutorials. The course included a series of activities for building understanding on multimedia elements, stages and skills related to producing multimedia, multimedia tools, and more. Diverse learning activities and teaching methodologies were used to best address the objectives of each learning session. Following are some examples:

- Students analyzed different multimedia products in groups to see how these products were used in different fields, such as business, education, at home, at market places, etc.
- Students reviewed lessons with fun and interactive games using Kahoot® (https://kahoot.com/b/) or Quizlet® (https://quizlet.com/latest). After having students play mini-games, teachers asked them to identify the benefit of multimedia in education.

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- Students played a “fonts have feeling” game that aims at building insight on how fonts affect sentiments and presented their choice of better font.
- Students designed their own font using Fontstruct® (https://fontstruct.com/).
- Students played a “heads-up” game to facilitate knowledge retention on the 12 principles of animation.

Figure 83. Students work with fonts in the context of the Multimedia Design course.

A10.2 Course: Special Subject 01

A10.2.1 Description of the course

In the Special Subject 1 course students work on research topics under the guidance of the instructor. Topics are related to web design, human-computer interaction, multimedia design, and more.

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A10.2.2 Description of the participants

This is an obligatory course that targets 2nd year undergraduate students from the Department of Information System, Faculty of Information Technology, Hanoi university. Approximately 17 students were enrolled in semester 1 of the 2019 - 2020 academic year.

A10.2.3 Description of active learning deploying ALIEN methodologies and tools

In the tutorial part of the course, students worked in groups to solve exercises assigned by the educator. All activities were designed using problem-based educational approaches.

Students were provided with appropriate topics to work on, were assisted in identifying and accessing materials and equipment for conducting research, and received necessary feedback and support from the teachers during the researching process. Furthermore, the educator evaluated students' participation aiming to help them build problem-solving as well as writing skills. For example, students were asked to explore information from media or books in the context of literature review activities.

In the Special Subject 01 classroom the educator guided, monitored student progress, and supported students' initiatives rather than present, direct, or give easy solutions. This approach helped build student capacity for independent learning. It further fostered critical thinking, analytical thinking, and entrepreneurial mindsets.

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Figure 84. Students work in groups on projects in the context of the Special Subject 01 course.

A10.3 Course: Special Subject 02

A10.3.1 Description of the course

This course is a continuation of Special Subject 01. The course introduces special topics that can be the extended or advanced part of topics addressed in Special Subject 01. Students work in the same groups as in Special Subject 01 and develop an application based on the results of their research in Special Subject 01. Alternatively, students may conduct additional literature review and research on a topic of interest.

A10.3.2 Description of the participants

This is a 3rd year mandatory course for undergraduate students in the Department of Information System, Faculty of Information Technology, Hanoi University. The course enrolled 20 students in semester 1 of the 2019 - 2020 academic year.

A10.3.3 Description of active learning deploying ALIEN methodologies and tools

The course involved weekly tutorials that take place in the computer laboratories of the Faculty of Information Technology. Tutorials followed problem-based learning approaches.

For example, in the 1st week, students worked in groups to introduce an information system that addressed user needs in a particular scenario. They further designed the user requirements for a related software application. Students identified stakeholders, functional

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requirements, nonfunctional requirements, input and output parameters, and requirements definitions techniques.

Figure 85. Students work in groups on projects in the context of the Special Subject 02 course.

A10.4 Course: Information Systems Design and Implementation

A10.4.1 Description of the course

The course builds understanding on how to design and implement a system step by step. It further focuses on agile software design practices, requirements engineering, deploying digital design tools, accurate analysis and design with subsequent application in development, and project management.

A10.4.2 Description of the participants

This is an obligatory course that targets 4th year undergraduate students in the Department of Information System, Faculty of Information Technology, Hanoi university. Approximately 42 students enrolled in the course in semester 2 of the 2019 - 2020 academic year.

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A10.4.3 Description of active learning deploying ALIEN methodologies and tools

The course typically is delivered in the classroom. However, due to the COVID-19 situation, the course was delivered virtually in the 2019 - 2020 academic year.

Students implemented the following steps:

- Students considered the differences and respective benefits of traditional waterfall and agile software design. They used a think, pair, and share model to brainstorm with their neighbor in the class.
- Students worked with a partner to identify challenges and benefits of agile design in the context of a class project. Students identified 2 different ways for implementing the project.
- Students reviewed lessons through fun and interactive games Quizlet (https://quizlet.com/latest). After having students play the game, teachers will ask students to identify the advantages of AGILE

In the context of tutorials, students further implemented the following activities:

- Students worked in groups on applying their knowledge and skills to solve real-world problems.
- Students chose 1 real problem was posted on ALIEN problem-based learning platform.
- Students worked with real customers to build an information system that helps the customers improve business processes or gain competitive advantages.
- Students designed their working methods. They further defined the software that they would develop by extracting user requirements directly from customers, adopting agile design, and selecting a programming language and implementation support tools for building a system. Upon completion of each development iteration, customers provided the user requirements as well as gave feedback. The systems developed by the students were used by customers after completion. By solving the

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problems, students developed skills on how to build an information system step by step and how to apply in practice the agile software development model.

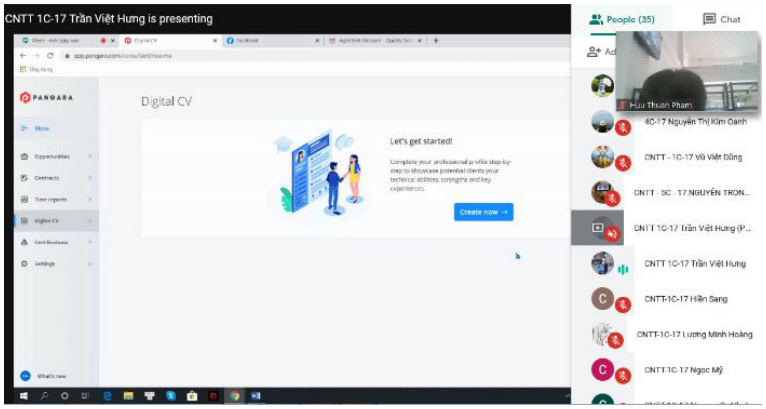

Figure 86. Students and the teacher meet virtually in one of the class sessions for course Information Systems Design and Implementation.

The educator designed a general educational plan for the whole semester, giving the opportunity to students to modify it within reason. The educator introduced standards related to methodology, programming languages, design rules, and more. He further reviewed student work through weekly meetings, organized weekly tasks, monitored student progress, provided useful resources on the course website, and assessed students on a weekly basis. The educator supported students through face-to-face meetings, Skype®, email, and telephone.

A10.5 Course: Data Structures and Algorithms

A10.5.1 Description of the course

The course aims at equipping learners with basic knowledge on algorithms and data structures as well as their practical applications. It builds student capacity to understand and apply algorithms and data structures properly, to evaluate and select appropriate algorithms or data structures for a specific project, and to design and implement algorithms or data structures in the Java® programming language for learning, researching, and working.

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A10.5.2 Description of the participants

This is an obligatory course that targets 3rd year undergraduate students in the Department of Information System, Faculty of Information Technology, Hanoi university. Approximately 32 students enrolled in the course in semester 2 of the 2019 - 2020 academic year.

A10.5.3 Description of active learning deploying ALIEN methodologies and tools

The course aims at building student competence on data structures, algorithms, and Java® programming. Students worked in teams to design a solution to a given problem statement.

Students implemented the following steps:

- Students brainstormed on the problem and its parameters.
- Students developed software code individually.

These activities encouraged student involvement in the class. In addition, quizzes were used to assess knowledge increase. In some cases students were required to solve new problems following the paradigm of known, already solved exercises in order to develop confidence. For example, students were asked to implement sorting through well-known algorithms such as selection sort, insertion sort, bubble sort, and merge sort. The students were encouraged refer to examples given by the educator while developing their software code. Once the software was complete, students used the implemented algorithm to solve practical problems.

As an example, students were given a list of N student names and grades in the range of 0 - 10. Students were asked to find the M students with the highest grades by writing a Java® program. The program requested as input the number of students N as well as their names and grades. It further requested the integer M. The program responded with a list of M student names with the highest grades in the class. Some of the problems used in the course are published in the ALIEN problem-based learning platform.

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A10.6 Course: Systems Analysis and Design

A10.6.1 Description of the course

The course builds understanding on different software development lifecycles, UML diagrams, analysis and specification of system requirements, analysis and design of information systems using object-oriented approaches, database design, user-interface design for input and output, and protection mechanisms for system data.

A10.6.2 Description of the participants

This is an obligatory course that targets 3rd year students. Approximately 121 students enrolled in the course in semester 1 of the 2020 - 2021 academic year, from September 2020 to January 2021.

A10.6.3 Description of active learning deploying ALIEN methodologies and tools

This course was delivered through 2 sessions per week, the first focusing on theory and second on practice. Tutorials and practical activities took place in the ALIEN problem-based learning laboratory. During tutorial hours, students participated in activities to reinforce theoretical knowledge developed in lectures. Some popular activities included working in groups to solve a problem on the ALIEN platform, reading a concept and sharing with neighbors undertaking the role of a concept expert, drawing UML diagrams and then working with partners to share ideas in think-pair-share tasks, analyzing pictures to see problems in requirements definitions, and more.

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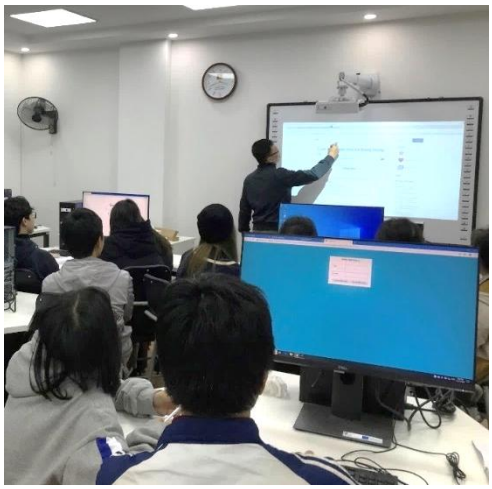

Figure 87. Students work on projects in the context of the Systems Analysis and Design course.

Through this course students developed problem-solving capacity through activities inspired by real-world needs.

A10.7 Course: Database Design and Development

A10.7.1 Description of the course

In the Database Design and Development course students develop knowledge on relational database design. The course focuses on practical concepts and examples. Activities include using appropriate design tools to design a relational database system for a substantial problem, understanding and being able to normalize a database using the first 3 normal forms of database normalization, developing a fully functional relational database system based on an existing system design, and testing the system against user and system requirements.

A10.7.2 Description of the participants

This is an obligatory course conducted to 3rd year students. Approximately 105 students enrolled in the course in the 1st semester of the 2020 - 2021 academic year, from September 2020 to January 2021.

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A10.7.3 Description of active learning deploying ALIEN methodologies and tools

This course was delivered in the ALIEN problem-based learning laboratory instead of a typical classroom in which teacher-centered activities take place. Thanks to the flexible design of the laboratory the lesson plan focus on a specific concept as usual but was enriched with diverse activities for engaging students. Students built knowledge on many concepts of relational database management systems deploying fun and attractive methods including games delivered through Quizlet® or Kahoot®. During practical activities related to physical design students were required to work in groups to solve problems posted on the ALIEN problem-based learning platform. Example of problems used in this course are available at https://virtual-campus.eu/alien/problems/enhanced-entity-relationship-diagram/ and https://virtual-campus.eu/alien/problems/enhanced-entity-relationship-diagram/ .

Figure 88. Students work on projects in the context of the Database Design and Development course.

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A11. University of Battambang

A11.1 Course: JavaScript® and internet Programming

A11.1.1 Description of the course

This course builds knowledge and practical skills on JavaScript®, the most important programming language for building internet applications. It covers programming language concepts that range from basic to advanced, such as variables, constants, operators, loops, methods, functions, arrays, control statements, and HTML manipulation. The course further demonstrates concepts related to developing an interactive webpage. It further develops problem-solving skills. The course also builds practical skills on integrating a simple software tool into the webpage, such as a simple calculator, a simple ATM tool, etc. With the basic understanding of these fundamental students are to develop fully functional software and to follow more advanced related courses.

A11.1.2 Description of the participants

A total of 30 students enrolled in the course in the 1st and 2nd semester of the 2019 - 2020 academic year, from September 2019 to June 2020.

A11.1.3 Description of active learning deploying ALIEN methodologies and tools

Activities aimed to develop understanding on an assigned problem, which students split into smaller tasks.

Figure 89. Students working on projects in the Javascript® and Internet Programming course.

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Students worked in 5 groups each of which consisted of 6 individuals. Group members discussed how to use JavaScript® to develop solutions to the smaller tasks and brainstormed towards designing a solution. The lecturer walked around the class and provided help to each team. Students interacted with the lecturer, asking for tips and ideas on solving the assigned problem. At the end of the class, students are required to submit their work and present to the whole class. The activities took place in the ALIEN problem-based learning laboratory.

A11.2 Course: Data Communications and Networking

A11.2.1 Description of the course

The course focuses on strategies for managing data communications networks. It builds understanding of basic peer-to-peer networks. It develops student capacity to design effective network solutions.

A11.2.2 Description of the participants

A total of 35 students enrolled in the course in the 1st and 2nd semester of the 2019 - 2020 academic year, from September 2019 to June 2020.

A11.2.3 Description of active learning deploying ALIEN methodologies and tools

Activities focused on computer network design and security. The following activities took place:

- The instructor introduced a problem and asked questions for facilitating understanding.
- The instructor provided all necessary resources for students to research and learn, such as an operating system, software, an internet connection, and an eBook.
- The teacher assigned research work and initiated group discussion on the problem in focus.
- Students were encouraged to ask questions, which the instructor answered for the benefit of the entire class.

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- The instructor reviewed the results of students and assessed whether they had reached the expected outcome. If the instructor discovered problems in student solutions, he corrected them and asked the students to retry.
- At the end of the class the instructor summarized the tasks that took place and wrapped-up activities.

The activities took place in the ALIEN problem-based learning laboratory.

Figure 90.Students working on projects in the Data Communications and Networking course.

A11.3 Course: Management Information Systems

A11.3.1 Description of the course

This course builds knowledge on the deployment of business application software. It further builds practical skills on addressing issues that may arise from the use of related software. Topics include computer systems, management information systems, microcomputer operating systems, word processing, electronic spreadsheets, database management, business graphics, networks, and integrated packages. Industry-accepted microcomputer software is used.

A11.3.2 Description of the participants

A total of 30 students enrolled in the course in the 2nd semester of the 2019 - 2020 academic year, from February to June 2020.

A11.3.3 Description of active learning deploying ALIEN methodologies and tools

The following activities took place:

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- The instructor introduced a problem and asked questions for facilitating understanding.
- The instructor provided all necessary resources for students to research and learn, such as an operating system, software, an internet connection, and an eBook.
- While students worked in groups on research, the instructor went around the class to make sure that all teams were on track.
- Students were encouraged to ask questions, which the instructor answered for the benefit of the entire class.
- The instructor reviewed the results of students and assessed whether they had reached the expected outcome. If the instructor discovered problems in student solutions, he corrected them and asked the students to retry.
- At the end of the class the instructor summarized the tasks that took place and wrapped-up activities.

The activities took place in the ALIEN problem-based learning laboratory.

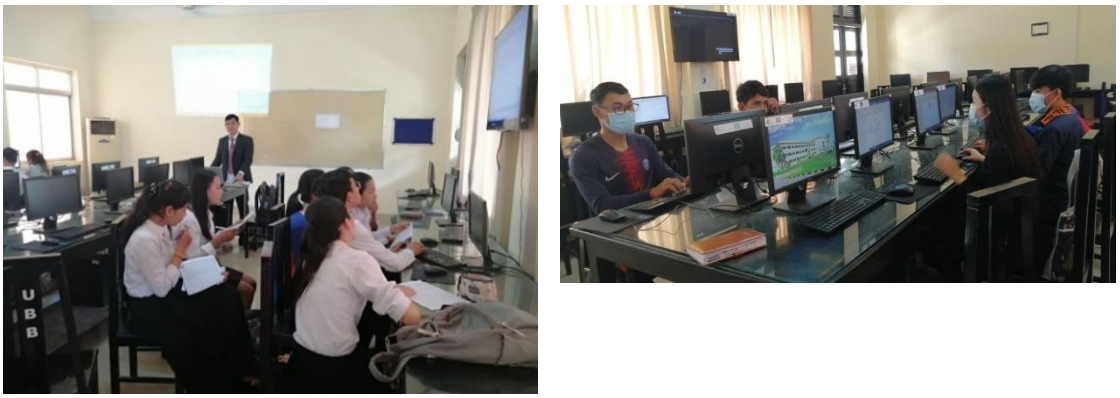

Figure 91. Students collaborate in the Management Information Systems course.

A11.4 Course: Scientific Writing and Communication

A11.4.1 Description of the course

This course provides basic knowledge on academic writing. It is useful to students that work on their graduation thesis. Students build their capacity to write a thesis following the

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university's guidelines on writing thesis proposals and scientific papers. Students learn how to cite references based on the APA style and build awareness on research ethics.

A11.4.2 Description of the participants

The course is attended each year by students close to graduation. A total of 60 students enrolled in the course in the 1st and 2nd semester of the 2019 - 2020 academic year, from February to June 2020.

A11.4.3 Description of active learning deploying ALIEN methodologies and tools

The objective of the course activities was to teach students how to write a thesis, dissertation, a scientific paper, a review paper, and other scientific report. Activities equipped students with academic writing skills applicable throughout the document, from introduction to conclusion chapter. It further focused on good reference practices. Students deployed problem-solving skills for developing a sound scientific document that follows university and international guidelines. The activities took place in the ALIEN problem-based learning laboratory.

Figure 92. Students collaborate in the Scientific Writing and Communication course.

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A11.5 Course: Creating an HTML Web Page

A11.5.1 Description of the course

This course teaches students the basics of HTML5 including the latest in CSS styling. It focuses on basic syntax; then moves forward to advanced features such as JavaScript® with animations, CSS3 and media queries, and styling with some of the new HTML5 tags. The course doesn't just discuss HTML5; it also teaches students how to implement actual design elements using embedded CSS classes. The course builds knowledge on deploying the latest form-field tags that make gathering information and input from users much easier.

A11.5.2 Description of the participants

A total of 30 students enrolled in the course in the 1st and 2nd semester of the 2018 - 2019 academic year, from September 2018 to June 2019.

A11.5.3 Description of active learning deploying ALIEN methodologies and tools

During the course students focused on understanding a given problem and breaking it down into smaller tasks. Students collaborated in 5 groups each of which consisted of 6 individuals. Group members discussed strategy towards solving each task by creating an HTML web page.

Figure 93. Students work on projects in the Creating an HTML Web Page course.

The instructor walked around the class providing help to the teams as necessary. Students were encouraged to ask for hints or ideas towards solving the assigned problem. At the end of the class, students submitted their work and presented it for the benefit of the entire class. The activities took place in the ALIEN problem-based learning laboratory.

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A12. Institute of Technology of Cambodia

A12.1 Course: Algorithms and Programming

A12.1.1 Description of the course

The main objective of the course is to build knowledge on algorithms and on how to solve a problem step-by-step. Furthermore, the course builds knowledge on the C and C++ programming languages, which are used as tools for building beginner programming skills. The course is organized in 3 main thematic areas, namely theory, practice, and laboratory activities. The combination of the 3 allows students to build knowledge more effectively. Each topic addressed in theory is further elaborated in practice and laboratory work to help students clearly understand and be able to apply theoretical concepts.

A12.1.2 Description of the participants

This course targets 3rd year students in the Department of Information and Communication Engineering, Institute of Technology of Cambodia. Approximately 60 students were enrolled in the course in the 2020 - 2021 academic year.

A12.1.3 Description of active learning deploying ALIEN methodologies and tools

The course included weekly laboratory sessions that took place in the computer laboratory of the Department of Information and Communication Engineering. The laboratory part of the course was based on problem-based learning and was executed on a Microsoft® Windows operating system environment. The laboratory problems were inspired by the real-world, allowing students to analyze, find appropriate algorithms for addressing them, and then encouraging them to develop a C program that implemented the selected algorithm. The course covered basic programming concepts such as variables, operators, functions, decision making with conditional statements, loops, advanced data structures, such as arrays, stacks, queues, and trees, and commonly used sorting algorithms.

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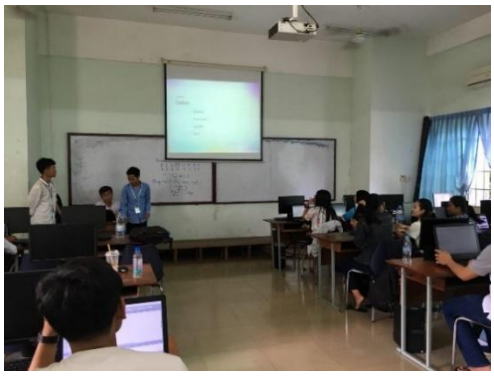


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Figure 94. Students research solutions and perform practical exercises in the Algorithms and Programming course.

A12.2 Course: Compilers

A12.2.1 Description of the course

The course builds understanding on compilers used to interpret programming languages. The content of the course ranges from high-level languages designed for humans to low-level designed to be executed by machines. Furthermore, students learn about compiler architecture. They also learn how to build each component of a compiler. For syntax analysis students use the Jflex® program. For lexical and syntax analysis they use the CUP® application.

A12.2.2 Description of the participants

The course is obligatory in the 4th year of the Engineering Program in the Department of Information and Communication Engineering, Institute of Technology of Cambodia. Approximately 45 were enrolled in the course in the 2020 - 2021 academic year.

A12.2.3 Description of active learning deploying ALIEN methodologies and tools

The course included weekly practice sessions that took place in the laboratory of the Department of Information and Communication Engineering.

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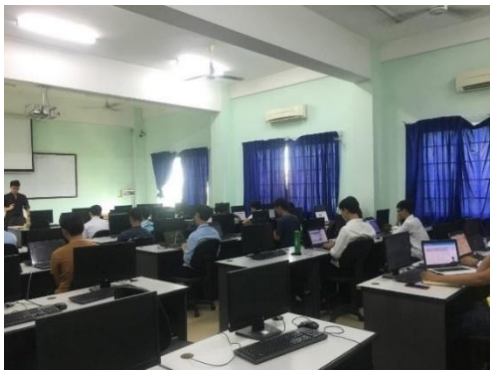
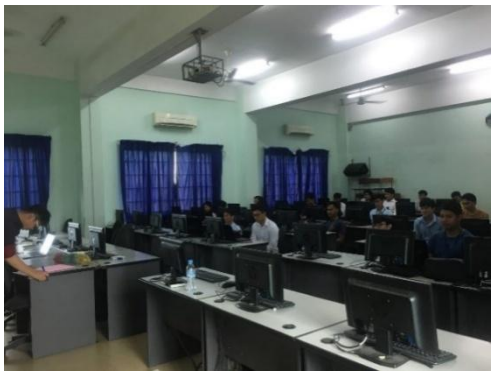

Figure 95. Students participate in an introductory lesson on symbol table definition.

The activities focused on defining a parser, a scanner, and a symbol table, all of which were part of a compiler.

A12.3 Course SNA402: Computer Networks

A12.3.1 Description of the course

The main objective of the course is to develop knowledge on computer networks and security. The course further aims at building general problem-solving skills. Students are introduced to virtual network environments, Microsoft® Windows servers, DNS servers, active directories, DHCP servers, file servers, OpenSSH servers, remote desktop services, and hypervisors. The course is accompanied by mandatory laboratory practice in which the participants practically apply in a series of tasks theoretical aspects of the course to deepen their understanding of concepts and techniques.

A12.3.2 Description of the participants

The course is obligatory in the 4th year of studies for the Engineering Degree of the Department of Information and Communication Engineering, Institute of Technology of Cambodia. Approximately 50 students were enrolled in the course in the 2020 - 2021 academic year.

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A12.3.3 Description of active learning deploying ALIEN methodologies and tools

The course included weekly practice sessions that took place in the laboratory of the Department of Information and Communication Engineering. During practice students engaged with exercises on configuring a DNS Server, an active Directory, a DHCP server, a file server, an OpenSSH server, a remote desktop service, and a hypervisor using problem-based learning techniques executed on a Microsoft® Windows server. The activities involved analyzing system requirements for a virtual network environment by simulating a server with multiple clients that access and use the server's services.

Figure 96. Students practice network design and implementation in the context of the Computer Networks course.

A12.4 Course: Image Processing

A12.4.1 Description of the course

The course provides an introduction on image processing. It focuses on basic image structure and patterns. The course further touches upon research aspects on image

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processing, such as image analysis techniques, image restoration methods, image detection techniques, and image recognition.

A12.4.2 Description of the participants

The course is obligatory in the 5th year of studies in the Engineering Program of the Department of Information and Communication Engineering, Institute of Technology of Cambodia. Approximately 40 students were enrolled in the course in the 2020 - 2021 academic year.

A12.4.3 Description of active learning deploying ALIEN methodologies and tools

The course included practical activities that took place in the laboratory of the Department of Information and Communication Engineering. The activities were based on problem-based learning approaches. They were implemented using the OpenCV® library on Linux® or Microsoft® Windows. The activities built student capacity to apply image detection, restoration, and recognition mechanisms in real-life scenarios.

A12.5 Course: Informatics Practice

A12.5.1 Description of the course

This course constitutes the practical aspect of the Informatics theoretical course. Students build introductory skills in the Python® programming language. Students are assigned weekly programming exercises. The goal of these assignments is to introduce students to programming in a step-by-step manner familiarizing them with the Python® syntax and building coding ability.

A12.5.2 Description of the participants

This is an obligatory course of the 1st year of the undergraduate program at Institute of Technology of Cambodia. Approximately 30 students were enrolled in the class in the 2020 - 2021 academic year.

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A12.5.3 Description of active learning deploying ALIEN methodologies and tools

The course applies problem-based learning. The teacher assigned exercises and explained their objective and scope to ensure that students clearly understood what they were required to do. Students had the option of either completing the assignment in class or submitting it later before the deadline.

To solve an exercise students needed to review the teaching material, search the internet, develop Python® code, and sometimes brainstorm on potential solutions.

A12.6 Course: Project Management

A12.6.1 Description of the course

This course builds general project management skills. It is further linked to information mining. The course is delivered through lectures that are followed by related practical activities that help students understand content. The course involves both independent and group work. Practical activities are based on students' experiences, examples from books, and real problems or issues. Student work starts with a small project. Students discuss in groups and in a final step the write a project proposal following instructor guidelines.

A12.6.2 Description of the participants

This course is obligatory in the 5th year of the undergraduate program in the Faculty of Geo-Resources and Geotechnical Engineering. 31 students were enrolled in the course in the 2020 - 2021 academic year.

A12.6.3 Description of active learning deploying ALIEN methodologies and tools

Course activities started with the sharing of internship experiences by students. The educator linked course lectures to student experiences. Practical activities followed the lectures. They were linked to lecture content and encouraged students to reflect upon a small project that was related to real-life challenges in Cambodia.

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Figure 97. Students work on a project that challenges them to introduce solutions to real-life issues in Cambodia in the context of the Project Management course.

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Students synthesized a solution to the problem based on course content and presented their work to the class. A link was created to student content, which is still available for everyone's benefit. Finally, students were assigned a simplified mining project on which they worked in groups, submitting upon completion a report.

A12.7 Course: Natural Language Processing

A12.7.1 Description of the course

The main objective of the course is to build fundamental knowledge in the field of natural language processing. This foundational knowledge helps students pursue further study in the related fields. The main topics of the course include text pre-processing, named-entity recognition, term extraction, WordNet® English lexical database, introduction to machine learning, semantics analysis, etc. The Python® programming language is used in practical experimentation. The course includes both lectures and laboratory sessions. Blended learning, including on-line learning and in-class learning, is used in the course.

A12.7.2 Description of the participants

The course targets 5th year in the Department of Information and Communication Engineering, Institute of Technology of Cambodia. Approximately 40 students were enrolled in this course in the 2020 - 2021 academic year.

A12.7.3 Description of active learning deploying ALIEN methodologies and tools

Course activities involved a weekly laboratory session that took place in the computer laboratory of the Department of Information and Communication Engineering. Laboratory work was based on problem-based learning. Students engaged in programming either on Linux® or Microsoft® Windows operating systems environments. However, it was recommended to use the Linux® environment due to its rich library features and its open-source nature. The laboratory challenges were inspired by real-world problems. They allowed students to practice, analyze, and apply what they had learnt to solve actual issues of industry and society. Students used educational material that was published by the

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educator on the university's learning management system. At the end of the course activities, students participated in a wrap-up session which allowed them to ask questions and receive additional feedback following the review of the on-line material.

Figure 98. Students work on problem-based learning activities in the context of the Natural Language Processing course.

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For laboratory sessions, students were divided into groups of 3 - 5 individuals. The educator assigned exercises that reflected real-world challenges. Students worked in groups to introduce potential solutions.

A12.8 Course: Ore Microscopy

A12.8.1 Description of the course

This is a mostly practical course that builds student knowledge on minerals, and especially ores, through naked eye analysis of specimens as well as the use of a microscope. Students define the physical properties of the ore mineral through naked eye observation and the deployment of small tools. Lectures address the preparation of samples for analysis under reflected light microscope. Lectures also address the identification of the properties of ore minerals with the use of a microscope and its optical properties. After students complete the lectures that introduce the theoretical background of the work, they are divided into groups of approximately 3 individuals and are provided with ore specimens for practical analysis in the laboratory. Finally, students prepare and submit a report on their work.

A12.8.2 Description of the participants

This course is obligatory for 3rd year undergraduate students in Faculty of Geo-Resources and Geotechnical Engineering. Approximately 15 are enrolled in the class in a given session. The total number of students that have completed this course so far is 32.

A12.8.3 Description of active learning deploying ALIEN methodologies and tools

A prerequisite for the course is general geology. Upon entering the course, students have already been introduced to general geology principles and are familiar with some common minerals. Students were divided into small groups and were provided with tools such as a hand lens, a magnetic pen, a scratch pen, and a streak plate. The tools allowed students to inspect the physical properties of the ore mineral in focus.

Subsequently, students followed a lecture on the optical properties of ore minerals. They were further instructed on the use of a reflected light microscope. Next, ore samples taken

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from different places are provided to each group. The groups polished the ore minerals in order to be able to observe them under the microscope. After preparing the sample, students inspected the ore minerals under microscope and produced a report.






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Figure 99. Students observe ore samples under microscope in the context of the Ore Microscopy course.

A12.9 Course: Software Engineering

A12.9.1 Description of the course

The main objective of the course is to build knowledge on managing a software development project. Students build experience on UML, which allows them to model the behavior of a software application through diagrams. They further build experience on object-oriented design and development. Finally, students build knowledge on the design and development of user-interfaces using the Java® programming language and JDBC that supports the connection of a database to an application user-interface.

A12.9.2 Description of the participants

The course is obligatory in the 4th year of undergraduate studies in the Department of Information and Communication Engineering, Institute of Technology of Cambodia. Approximately 56 students were enrolled in the course in the 2020 - 2021 academic year.

A12.9.3 Description of active learning deploying ALIEN methodologies and tools

The course involved weekly practical work that took place in the computer laboratories of the Department of Information and Communication Engineering. The laboratory part of the Software Engineering course was based on project-based learning by using Java®. It involved analyzing and modeling user requirements through UML. It further involved software and project development using concepts and fundamentals of object-oriented design.

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A13. Meanchey University (MCU)

A13.1 Course: Mathematics for business

A13.1.1 Description of the course

Mathematics for Business addresses situations that are uncertain and volatile, influencing the use of data, data interpretation, and data analysis in practice in many areas, especially in real-time applications. This course provides the necessary foundation related to data analysis and manipulation aiming to assist in the effective decision-making of managers who are facing constant competition.

A13.1.2 Description of the participants

The course addresses 2nd and 4th year undergraduate students in the Faculty of Science and Technology. 47 students attended the course in the 2020 - 2021 academic year.

A13.1.3 Description of active learning deploying ALIEN methodologies and tools

Course activities exposed students to use SPSS® software for statistical analysis in problem-solving and research data analysis. Students worked in groups solving problems introduced by the educator on the projector. Students researched and presented their results to the entire class. The course took place in the ALIEN problem-based learning laboratory.

Figure 100. Students work on projects in the Mathematics for Business course.

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A13.2 Course: Java® Programming Language

A13.2.1 Description of the course

Java® programming is deployed for website development through Javascript® or for application development addressing specific needs. The language's flexibility makes it very popular in the current job market.

A13.2.2 Description of the participants

The course targets 4th year undergraduate students in the Faculty of Science and Technology at Mean Chey University. 16 students attended the course in the 2020 - 2021 academic year.

A13.2.3 Description of active learning deploying ALIEN methodologies and tools

Active learning involved coding, saving, compiling, and running programs with the JCreator® suite. Students became familiar with data typing, variable arrays, and class creation through practical activities that took place in the ALIEN problem-based learning laboratory.

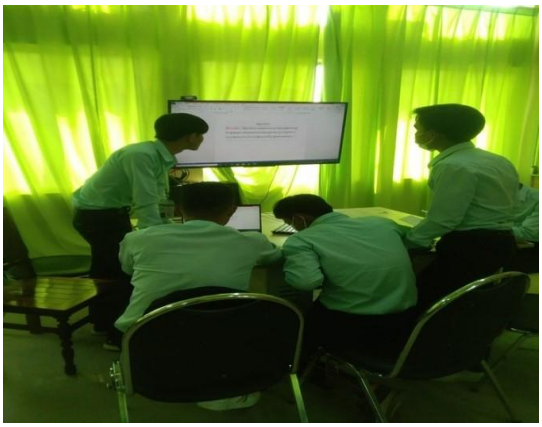

Figure 101. Students work on projects in the Java® Programming Language course.

A13.3 Course: Database Systems

A13.3.1 Description of the course

This course builds foundational knowledge on data systems management. It develops understanding on all phases of data management in programming activities. It is a practical

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course in which students deploy popular data management software tools such as MS-Access® and Visual Basic®.

A13.3.2 Description of the participants

The course targets 2nd year students enrolled in the Faculty of Science and Technology at Mean Chey University. 12 students attended the course in the 2020 - 2021 academic year.

A13.3.3 Description of active learning deploying ALIEN methodologies and tools

Through active learning students developed a software application for the management of the daily operations of a book store. Students worked in 3 groups. The activities took place in the ALIEN problem-based learning laboratory.

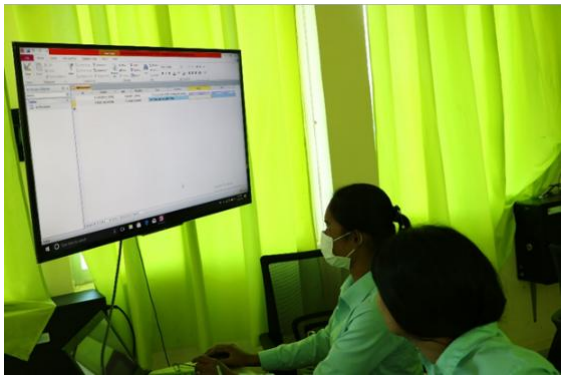

Figure 102. Students work on projects in the Database Systems course.

A13.4 Course: Data Structures

A13.4.1 Description of the course

The course focuses on data structures and algorithms and their role in building communications layers in a program. It further focuses on the deployment of data structures in the implementation of algorithms. The course highlights the important role of data structures in effective decision making.

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A13.4.2 Description of the participants

The course targets 2nd year undergraduate students in the Faculty of Science and Technology at Mean Chey University. 12 students attended the course in the 2020 - 2021 academic year.

A13.4.3 Description of active learning deploying ALIEN methodologies and tools

Students worked on problem-solving through active learning approaches. The educator assigned problems that highlighted the relationship between data structures and algorithms. The problems challenged students to use data structures in algorithm implementation. The activities took place in the ALIEN problem-based learning laboratory.

Figure 103. Students work in projects in the Data Structures course.

A13.5 Course: Computer Networks or CCNA Discovery

A13.5.1 Description of the course

The course builds basic networking knowledge. It equips students with the knowledge and skills needed for entry-level careers in IT. It deploys a hands-on approach to networking education that allows students to gain practical experience early in the curriculum. The knowledge developed is useful towards CCNA certification. CCNA discovery is a blended curriculum involving both on-line and classroom learning. The course is designed for students with basic PC skills and offers a hands-on, career-oriented approach to building networking knowledge that emphasizes practical experience. The course covers key networking concepts related to all types of practical network environments students may

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encounter in professional activities, ranging from small office or home office (SOHO) networking to more complex enterprise environments. Students engage in laboratory activities that help them understand the theory on building networks. The course closes with theoretical networking models.

A13.5.2 Description of the participants

The course targets 3rd year students in the Faculty of Science and Technology at Mean Chey University. 14 students to attends the course in the 2020 - 2021 academic year.

A13.5.3 Description of active learning deploying ALIEN methodologies and tools

The students set up a PC system, including the operating system, interface card, and peripheral devices, designed and installed a home or small business network and connected it to the internet, and verified and troubleshot the network and internet connectivity. Students shared resources such as files and printers among multiple computers, developed understanding on the use of wireless technology, recognized and mitigated security threats to a home network, and troubleshoot problems using an organized, layered procedure. Students worked in groups in the ALIEN problem-based learning laboratory.

Figure 104. Students in Computer Network course.

A13.6 Course: Information System Analysis and Design

A13.6.1 Description of the course

The course develops information system analysis and design knowledge and skills. It helps students understand how to manage basic data and use information skills to solve

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problems. It further helps students build knowledge on creating data management systems. The course provides students with basic understanding on data management systems analysis and stages. Work includes the collection of data and it's structuring into a specific data set before engaging in the creation of an entire database management system.

A13.6.2 Description of the participants

The course targets 3rd year undergraduate students in the Faculty of Science and Technology at Mean Chey University. 14 students attended the course in the 2020 - 2021 academic year.

A13.6.3 Description of active learning deploying ALIEN methodologies and tools

The course involved weekly theoretical sessions followed by practical assignments during which students solved problems in groups. The course took place on-line, so it was not possible to deploy the ALIEN problem-based learning laboratory. Through course activities students understood the general definitions of systems, functions, and responses in system design.

A13.7 Course: Client-Server Computing

A13.7.1 Description of the course

Information technology is an effective vehicle for implementing client-server architectures. The client-server model offers more power to desktop applications by allowing information to be available on the user's PC, supporting decision-making processes.

Students are exposed to client-server computing technology, which, when integrated into business processes, supports informed decision-making. The technology is cost-effective and user-friendly.

The course demonstrates how an organization can continue to gain value from existing technological investments while using the special capabilities that client-server technology offers. It further demonstrates how to build SDFES architectures and design solutions that are solidly based on evolving technologies. The course shows how client-server technology

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can address current technical challenges while supporting in a flexible manner the integration of future technologies.

A13.7.2 Description of the participants

The course targets 4th year students in the Faculty of Science and Technology at Mean Chey University. 16 students attended the course in the 2020 - 2021 academic year.

A13.7.3 Description of active learning deploying ALIEN methodologies and tools

Activities demonstrated that client-server computing is the way successful organizations will apply technology in the next decade. They highlighted the fact that client-server computing is the culmination of the trend toward downsizing from the minicomputer and mainframe to the desktop. Activities further showed how enabling technologies, such as object-oriented development and graphical user-interfaces, empower producers and consumers of information to use technology personally and directly. Finally, activities demonstrated that through client-server architectures users no longer need continues assistance from professional information systems personnel for creating and storing their business data.

Figure 105. Students engage in problem-solving in the Client-Server Computing course.

A13.8 Course: Visual Basic Programming

A13.8.1 Description of the course

The course provides students with basic and understanding of each step in the preparation and development of Microsoft® Windows applications for use in any company, organization, or institution. Students learn about record sets, understand the properties and methods

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used in record set management, and apply data entry from a form to a table. Students learn how to download data from a table or query and insert it into a form using an SQL statement.

A13.8.2 Description of the participants

The course targets 3rd year students in the Faculty of Science and Technology at Mean Chey University. 14 students attended the course in 2020 - 2021 academic year.

A13.8.3 Description of active learning deploying ALIEN methodologies and tools

The instructor used student-centered methodologies. The instructor presented problems on an LCD projector screen, explained the related concepts, and asked students to solve the assignment. Upon completion, students presented their findings to the entire class. The course took place in the ALIEN problem-based learning laboratory.

A13.9 Course: Internet Programming HTML

A13.9.1 Description of the course

The web is built of pages created in HTML. Although many individuals, particularly recruiters, refer to HTML as a programming language, HTML is really not a programming language at all. HTML is exactly what is claims to be: a mark-up language. HTML is used to mark up a text document similarly to marking a printed text with a red pencil. The marks indicate the format, or style, that should be used when displaying the marked text. This course introduces students to the basics of HTML programming.

A13.9.2 Description of the participants

The course targets 3rd year students in the Faculty of Science and Technology at Mean Chey University. 14 students attended the course in the 2020 - 2021 academic year.

A13.9.3 Description of active learning deploying ALIEN methodologies and tools

The course highlighted how the web is the fastest growing part of the internet, with thousands if new sites added daily. It developed skills highly demanded by industry as

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business and commerce begin to embrace the web more fully. It demonstrated that creative like writers, designers, and artists should also be learning more about the web. It highlighted the fact that the commercial art and advertising worlds are already making the transition to this new medium. Students became aware that nearly any computer professional should have some notion of how HTML works and why the web is based on it. The course activities demonstrated that one does not need to be a scientist to create web pages, rather office workers, editors, public relations specialists, salespeople, real estate agents, financial advisors and consultants of all flavours can benefit from HTML programming. Students understood that the web is so diverse that it is impossible to categorize all the reasons to learn HTML page creation. HTML can be used for developing home office pages, presenting small businesses on-line, disseminating family photo sessions, and more. Students developed basic understanding of HTML use through hands-on projects. The activities took place in the ALIEN problem-based learning laboratory.

Figure 106. Students participate in the internet Programming HTML course.

A13.10 Course: Basic Accounting

A13.10.1 Description of the course

Accounting refers to information and measurement systems that are well-defined, record and communicate information reliably, and offer the capacity to compare information related to an organization's business activities. Business records are kept in a chronograph of transactions and events. They are classified and summarized in a useful way. Business communication activities require the preparation of accounting statements, such as

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financial statements, etc. Accounting also focuses on the analysis and interpretation of such reports. This course exposes students to basic concepts of accounting and develops practical skills on well accepted accounting methods.

A13.10.2 Description of the participants

The course targets 2nd year students in the Faculty of Business Management and Tourism of Mean Chey University. 35 students attended the course in the 2019 - 2020 academic year.

A13.10.3 Description of active learning deploying ALIEN methodologies and tools

The course was conducted partially in the ALIEN problem-based learning laboratory and partially on-line. Specifically, activities started in the ALIEN problem-based learning laboratory and continued virtually due to COVID-19 restrictions. Students worked on projects from home and were responsible for finding effective ways to display the results of their work on-line.

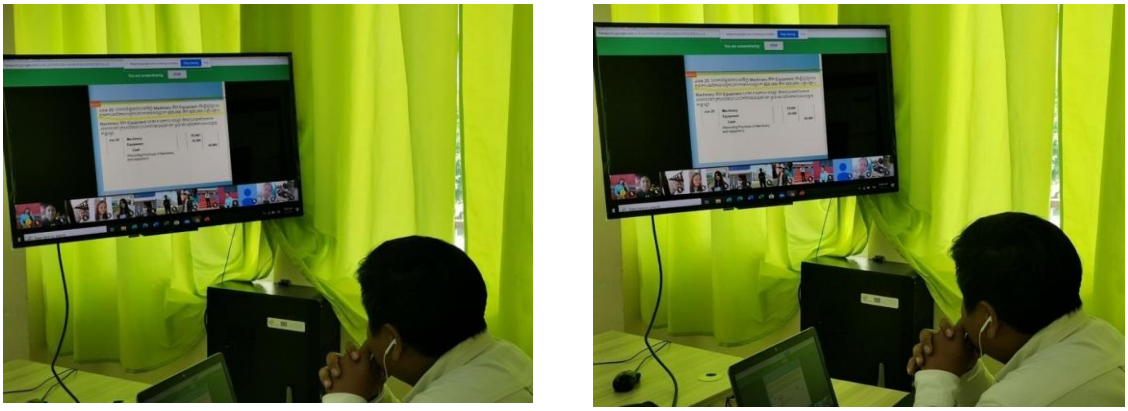

Figure 107. Students work on projects in the Basic Accounting course.

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A14. Institute of Engineering, Tribhuvan University (IOE/TU)

A14.1 Course: Social Computing

A14.1.1 Description of the course

This course focuses on how social groups and networks evolve, interact, and are supported with computer systems. It covers social, scientific, and technical concepts of social computing in terms of computer systems supporting social behaviour, socially intelligent computing carried out by communities, and human computation and crowd sourcing systems.

A14.1.2 Description of the participants

The course is an elective course offered in Information Technology related Master's programs of IOE, Tribhuvan University. Up to 20 students are typically enrolled in the course each year.

A14.1.3 Description of active learning deploying ALIEN methodologies and tools

Students were divided into groups of 3 - 4 individuals. Each group was assigned a project related to social computing systems. For example, a project might focus on the development of a system for sentiment analysis of tweets in a certain theme.

Each group of students collected and reviewed materials on the web and campus intranet. They explored existing systems from the web and presented a project proposal. Each group presented their project idea and received feedback by other groups and the instructor. Subsequently, each group developed a prototype. Teams demonstrated their prototypes in their final presentation to all other groups, the instructor, and other faculty members.

The activity took place in the ALIEN problem-based learning laboratory, which includes workstations, projectors, and internet support. Students developed their software using coding environments and API's related to social media interaction. They used Microsoft® PowerPoint to deliver their presentations. Students used as reference educational resources on the fundamentals of social computing as well as related books available on the internet.

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Figure 108. Students collaborate on social media projects in the ALIEN problem-based learning laboratory in the Social Computing course.

In the beginning of the course the students used workstations and laboratory connectivity to explore sources and collect required data and documents. They downloaded the material from the internet and proposed a project title based on their research. Subsequently, students set-up the required software development environment on the computers for developing the software code required for their project. Each group delivered 2 presentations. The 1st presentation focused on a solution proposal. Students received feedback on their idea by the instructor. The 2nd and final presentation focused on a demonstration of their completed project. The presentations were the basis for student evaluation.

A14.2 Course: Operations Research and Management Science

A14.2.1 Description of the course

Operations Research and Management Science is the use of mathematical models and quantitative approaches for decision-making. As a science, it has its toots to the 2nd World War some 70 years ago. Operations Research and Management Science is now profusely used in managerial decision-making especially with the widespread application of personal computing in business, industrial, and household sectors since 1990s. This course aims to introduce the theory and practical application of Operations Research and Management Science for engineer-managers. The course also focuses on problem solving in real-world

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conditions, including the involvement of multiple stakeholders, multiple criteria solutions, and more. Students were also exposed to the expert judgement method, game theory, goal programming, multiple objective programming, and genetic algorithms. The course has a strong focus on practical applications of Operations Research and Management Science.

A14.2.2 Description of the participants

The course is a 1st year elective in the curriculum of the Master's Degree in Engineering in Energy Systems Planning and Management in the Department of Mechanical Engineering. The course is typically attended by approximately 20 students from each of the 3 Master's programs each year, which leads to a total of 60 students in each class.

A14.2.3 Description of active learning deploying ALIEN methodologies and tools

Students were challenged to solve multiple criteria decision-making problems in different scenarios using different methods, such as equal weight for each criterion, different weights based on the importance of different criteria without consulting other groups, and different weights based on the importance to different criteria after consulting with other groups. Students present their results to their peers and explain the importance of multiple stakeholder participation in decision making processes.

The activity took place in the ALIEN problem-based learning laboratory. Students developed their solutions with the help of spreadsheet software such as Microsoft® Excel and its add-in software like SOLVER®, CRYSTAL BALL®, and more. Students worked in groups of 4 - 6 individuals on the design and implementation of multiple criteria decision-making problems. Students used multiple books as reference.

As part of their project work, students allocated weights to criteria based on different conditions representing different stakeholders. They were challenged to make decisions working as an independent team, and subsequently revisiting the same exercise taking into account feedback by peers.

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Figure 109. Students work on decision making projects in the Operations Research and Management Science course.

A14.3 Course: Image Processing

A14.3.1 Description of the course

The objective of the course is to build foundational knowledge and practical skills on image processing and pattern recognition. More specifically, the course aims at developing a theoretical foundation of fundamental digital image processing concepts. It further aims at building mathematical foundations on the digital manipulation of images, image acquisition, pre-processing, segmentation, Fourier domain processing, and compression. Finally, the course aims at building experience on practical techniques related to software coding on the same topics.

A14.3.2 Description of participants

The course is a 2nd semester elective offered in the Master's Degree in Computer System and Knowledge Engineering program of the Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University. 20 students are typically enrolled in the course each year.

A14.3.3 Description of active learning deploying ALIEN methodologies and tools

Students were divided into groups of 5 individuals. Groups were assigned a common problem that was inspired either from current research on image processing or from real-life problems. A sample activity was writing a program for evaluating the photos of

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applicants to participate in the entrance examination to the program through image processing and pattern recognition. Each student in the group searched the internet on potential solutions and presented their ideas to the team, which collectively selected the best for subsequent project steps. Students were then challenged to write a research paper on the selected idea. Work on the preparation of the research paper was divided among group members. For example, one student wrote the introduction part, another the methodology, another the results, and another the abstract and conclusions.

The activity took place in the ALIEN problem-based learning laboratory. Students used software tools such as MATLAB® and other tools for making projections. Students used educational resources on image processing, pattern recognition, and the MATLAB® tool available on the internet. Students used the laboratory facilities to download reference material and tutorials, based on which they designed their solutions. Upon completion of the work, students presented their results on the display screens of the laboratory. The instructor selected and rewarded the best idea.

Figure 110. Students collaborate in groups in the Image Processing course.

A14.4 Course: Knowledge Engineering

A14.4.1 Description of the course

The course aims to familiarize students with basic concepts of knowledge engineering. In addition, the course aims to teach basics of knowledge acquisition methods, IR, NLP, and machine learning techniques. The course builds skills on knowledge representation, logic,

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and reasoning. Finally, the course builds knowledge ontology engineering and the semantic web.

A14.4.2 Description of the participants

This is a 1st semester introductory core course offered in the Master's Degree in Computer System and Knowledge Engineering program of the Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University. 20 students are typically enrolled in the course each year.

A14.4.3 Description of active learning deploying ALIEN methodologies and tools

Students were divided into groups of 5 individuals. Each group was assigned a mini-project. The mini-project was a case study, in which students were challenged to develop a simple knowledge-based system that would be useful for the institute. A sample mini-project was to develop a system for student performance analysis in semester exams and to correlate the calculated data to entrance exam and high school scores.

To implement the project, each group of students collected and reviewed material from the web and campus intranet. Students participated in meetings and interacted with experts of the concerned knowledge domain collecting additional reference information. Students were exposed to potential solutions by researching the web. Based on their findings they proposed a knowledge-based system for solving the assigned problem. Groups presented their suggested solutions and received feedback by other groups, the instructor, and the domain experts. They developed a solution prototype and demonstrated its functionality in a presentation to other groups, the instructor, and the domain expert upon completion of the activities.

The activity took place in the ALIEN problem-based learning laboratory. Students used software tools such as Microsoft® PowerPoint for delivering presentations. They further used database and knowledge management platforms for developing their software solutions. Students used reference material on the fundamentals of knowledge engineering from the web. They further used books on artificial intelligence from the university library.

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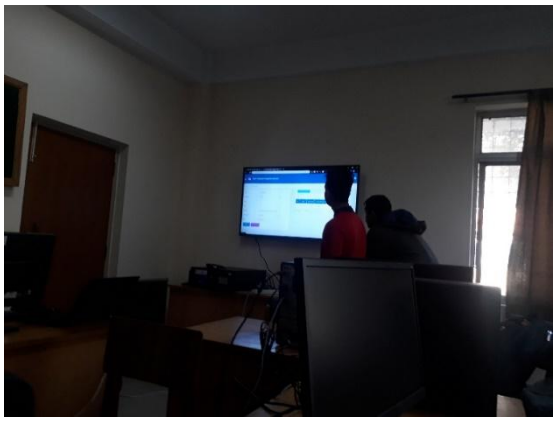

Figure 111. Students present their ideas on knowledge management systems in the Knowledge Engineering course.

In the beginning of the course the students used workstations and laboratory connectivity to explore sources and collect required data and documents. They downloaded the material from the internet and proposed a solution to the assigned problem. Students presented their idea to the class and received feedback by the instructor, their peers, and the domain expert. Subsequently, students set-up the required software development environment on the computers for developing the software code required extracting information for their project. Students demonstrated their final solutions upon completing the activity. The presentations were used as the basis for student evaluation.

A14.5 Course: Information Visualization

A14.5.1 Description of the course

The course aims at developing knowledge and skills on how to present information in an understandable, efficient, effective, and aesthetic manner for the purpose of explaining ideas and analysing data. The course further aims at developing skills at designing and evaluating information visualizations and other forms of visual presentation. Finally, the course aims at building familiarity with core principles and some of the literature of the field.

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A14.5.2 Description of the participants

This is a 2nd semester core course offered in the Master's Degree in Computer Engineering Specialization in Data Science and Analytics program of the Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University. 20 students are typically enrolled in the course each academic year.

A14.5.3 Description of active learning deploying ALIEN methodologies and tools

Students were divided into groups of 5 individuals. Each group was assigned a mini-project. The focus on the mini-project was to develop an information visualization application on a specific topic and dataset. A sample project was to develop a system for information visualization and analysis student results in semester exams.

Each group of students collected and reviewed material on the web and campus intranet. Students also downloaded necessary datasets and tools from the internet. They studied the datasets and proposed a visualization solution. Students presented their suggested solutions and received feedback from their peers and the instructor. Subsequently, groups developed a solution prototype and demonstrated it to other groups, the instructor, and invited guests.

The activity took place in the ALIEN problem-based learning laboratory. Students used software tools such as Microsoft® PowerPoint for delivering presentations. They further used information visualization software packages. Students used reference material and datasets from the internet as well as books on information visualization from the university library.

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Figure 112. Students collaborate on projects in the Information Visualization course.

In the beginning of the course the students used workstations and laboratory connectivity to explore sources and collect required data and documents. They downloaded the material from the internet and proposed and proposed a solution to the assigned problem. Students presented their idea to the class and received feedback by the instructor, their peers, and the domain expert. Subsequently, students set-up the required software development environment on the computers for developing the software code required for information visualization. Students demonstrated their final solutions upon completing the activity. The presentations were used as the basis for student evaluation.

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A14.6 Course: Artificial Intelligence

A14.6.1 Description of the course

This course aims at developing basic knowledge on artificial intelligence. The course familiarises students with different search techniques, fields related to artificial intelligence, and applications of artificial intelligence.

A14.6.2 Description of participants

This is a 6th semester core course offered in the Bachelor in Computer Engineering program of the Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University. 48 students are typically enrolled in the course each year.

A14.6.3 Description of active learning deploying ALIEN methodologies and tools

Students were divided into 12 groups of 4 individuals. Each group was assigned a mini-project, the focus of which was a case study on the development of a simple application that deployed artificial intelligence and could be used for solving a real-world problem. For example, students developed a system that provided recommendations based on the purchase history of users.

Each group collected and reviewed material on the web and campus intranet. They conducted meetings and had interactions with experts. They further collected necessary data and documents from experts or the internet. They explored existing solutions from the web and proposed an artificial intelligence-based system for the project. Groups presented their work and received feedback by the instructor and the expert. Finally, students developed a prototype on their design and demonstrated it to the class. The activity took place in the ALIEN problem-based learning laboratory. Students used software tools such as applications required for projections, Microsoft® PowerPoint for presentations, software development environments, and artificial intelligence-based platforms. In terms of educational content, students used material and datasets required for the mini-project

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domain, content on fundamentals of artificial intelligence available on the internet and related books available at the university library.

At the beginning of the course students used the laboratory workstations and connectivity for exploration and data collection purposes. Students downloaded tutorials and articles over the internet and proposed a feasible solution for the problem assigned. Subsequently, students set-up the required development environments on the laboratory workstations for implementing an artificial intelligence solution. Each group delivered 2 presentations. The 1st presentation was on their proposed solution idea, on which they received feedback. The 2nd was a demonstration of the final product. The presentations were used as the basis for student evaluation.

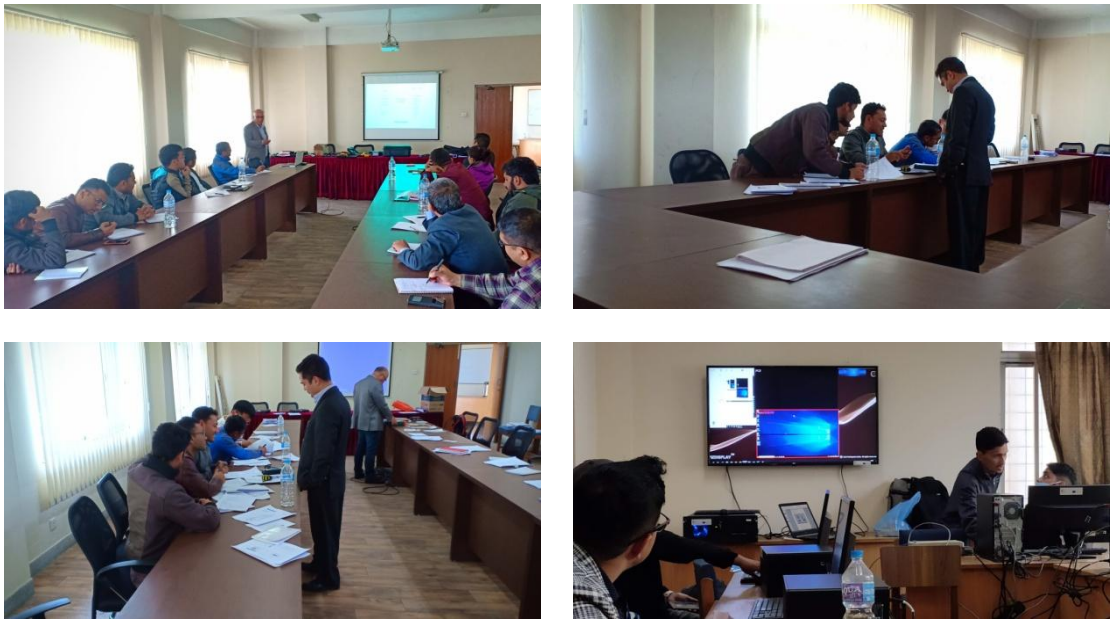

Figure 113. Students collaborate with their professor in the Artificial Intelligence course.

A14.7 Course: Big Data Application and Analytics

A14.7.1 Description of the course

This course aims to provide an overview on big data and the latest trends on big data analysis. It introduces students to technologies for handling big data. It further exposes students to the Hadoop® platform and its components. And it builds practical skills on

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applying big data tool for advanced analytics disciplines such as predictive analytics, data mining, text analytics, and statistical analysis.

A14.7.2 Description of participants

This is a 2nd and 3rd semester elective the Master's Degree in Engineering programs of the Department of Electronics and Computer Engineering, Pulchowk Campus, IOE, Tribhuvan University. 6 students were enrolled in the 2020 - 2021 academic year.

A14.7.3 Description of active learning deploying ALIEN methodologies and tools

Students were divided into groups of 3 individuals. Each group was assigned a mini-project, the focus on which was the development of a simple application based on big data tools and their application towards solving a real-world problem. For example, students developed a mini-project on collecting logs from a system in a real-time, identifying fraud, and generating notifications using tools from big data ecosystems.

Each group collected and reviewed material on the web and campus intranet. They conducted meetings and had interactions with experts. They further collected necessary data and documents from experts or the internet. They explored existing solutions from the web and proposed a big data-based solution. Groups presented their work and received feedback by the instructor and the expert. Finally, students developed a prototype on their design and demonstrated it to the class. The activity took place in the ALIEN problem-based learning laboratory. Students used the classic laboratory equipment, namely workstations for conducting research and projectors for displaying their work. Students used built-in software required for projections, Microsoft® PowerPoint for developing presentation, the Hadoop® platform and ecosystem, AWS, and other tools from big data ecosystems. In terms of educational material, students used datasets related to the domain of their mini-project, data science and big data analytics content available on the internet, and related books from the university library.

Similarly to the previous courses, at the beginning of the semester students used the laboratory workstations for conducting research and built experience through tutorials and

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articles. Subsequently, the installed on the workstations the necessary software packages for designing a solution on their mini-project and focused on software development. Students delivered 2 presentations. The 1st focused on their design idea, while the 2nd on the final outcome of their work. The presentations were used as the basis for student evaluation.

Figure 114. Students collaborate in the Big Data Application and Analytics course.

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A15. Kathmandu University (KU)

A15.1 Course Comp 342: Computer Graphics

A15.1.1 Description of the course

The course addresses basic concepts, mathematical foundations, fundamental theory and algorithms, software techniques, hardware and system issues, and application examples of computer graphics. Key topics are modelling, rendering, and interaction. Learning is delivered through lectures and through practical hands-on activities that take place in computer laboratories. The practical activities encourage students to apply their theoretical knowledge into real-life problems.

A15.1.2 Description of the participants

The course is mandatory in the formal curriculum of the Department of Computer Science and Engineering at Kathmandu University. Upon completion of the course, the students are familiar with basic technique used in computer graphics and their application in the field of animation. 59 students in the 6th semester of the Bachelor of Computer Engineering program were enrolled in the course in the 2020 - 2021 academic year.

A15.1.3 Description of active learning deploying ALIEN methodologies and tools

The students are asked to solve mathematical problems related to computer graphics during tutorial classes. The course normally includes bi-weekly laboratory work that takes place in a laboratory, but due to COVID-19 restrictions the course was organized in a virtual environment. The laboratory part of computer graphics was based on implementing the algorithms taught in lectures and using those algorithms for solving real-life problems.

At the end of the course students are asked to submit a mini-project based on the concepts taught. The students are allowed the flexibility of selecting a problem of their interest and are asked to solve it using concepts of computer graphics. Some of the problems are:

- Ambient light simulation in 3D objects.

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- Visualization of the digits of PI.
- Client-server architecture simulation.
- Super-ellipse visualization.
- Mandelbrot set visualization.
- Visualization of a shortest path finding algorithm.
- Fibonacci spiral (golden ratio) visualisation.

Students used the Active Learning Lab set-up by the ALIEN project for solving problems during the tutorial sessions in pairs. The ALIEN digital problem-based learning platform was used for introducing problems to students.

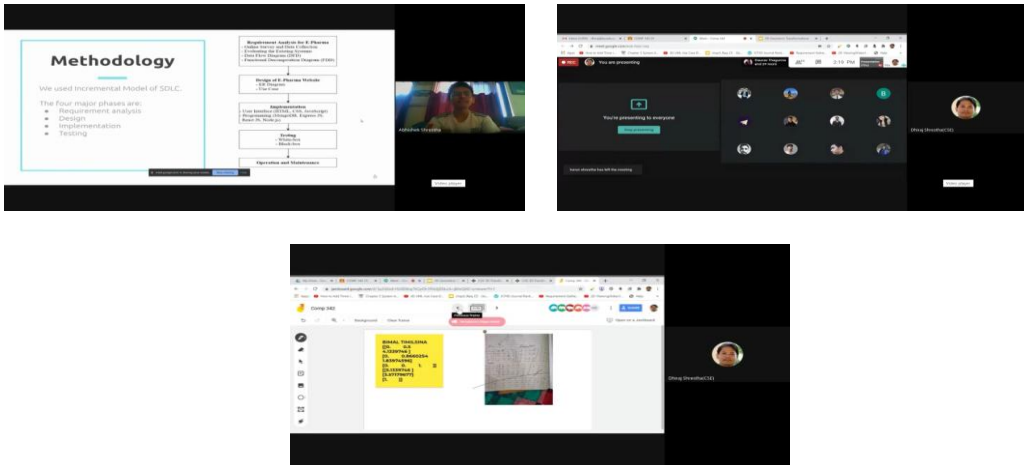

Figure 115. Students explaining their project work and receiving instructor feedback in the Computer Graphics course.

A15.2 Course Comp 307: Operating System

A15.2.1 Description of the course

The course focuses on introducing and applying the fundamentals of computer operating systems concepts including process management, memory and input-output management, processor scheduling, synchronization, and file systems. It also familiarizes students with the design and implementation aspects of operating systems.

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A15.2.2 Description of the participants

The course is mandatory in the 6th semester of the Bachelor in Computational Mathematics program offered by the Department of Mathematics at Kathmandu University. 15 students were enrolled in the course in the 2020 - 2021 academic year.

A15.2.3 Description of active learning deploying ALIEN methodologies and tools

Learning is typically delivered through lectures and through practical hands-on activities that take place in computer laboratories, but due to COVID-19 restrictions the laboratory work and lectures were conducted in a virtual environment.

The students solved problems related to different topics of operating systems in tutorial sessions. In addition, students were asked to implement algorithms taught in theoretical classes in laboratory projects. Topics included process management, memory management, deadlocks, and page replacement algorithms. Sessions were conducted in a virtual environment. The ALIEN digital problem-based learning platform was used for introducing the problems to the students.

Once Kathmandu University reopens for face-to-face instruction, the Active Learning Lab built through the ALIEN project will be used for practical work.

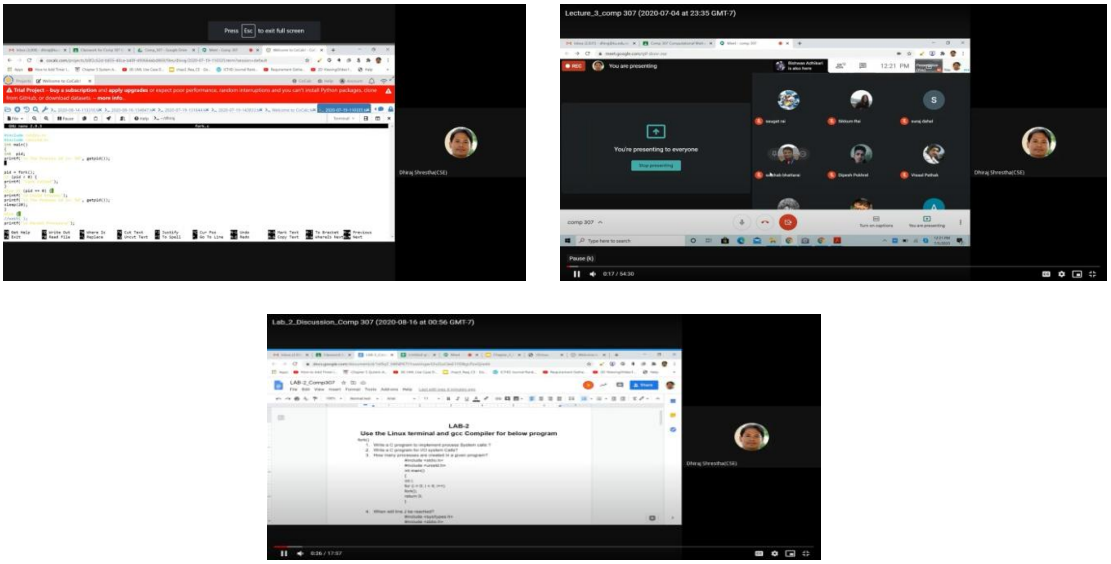

Figure 116. Students participate in the Operating Systems Course.

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A15.3 Course Comp 302: System Analysis and Design

A15.3.1 Description of the course

This course provides foundational knowledge on system analysis and design. This course helps to launch the careers of successful systems analysts or of users assuming an active role in building systems that satisfy their organization's information needs. The course exposes students to real systems development practices and addresses various factors that need to be considered in systems design. Students become familiar with practices on the identification and documentation of users' needs as well as systems development.

A15.3.2 Description of the participants

The course is obligatory in the 3rd year of undergraduate studies of the Department of Computer Science and Engineering at Kathmandu University. 49 students were enrolled in the course in the 2020 - 2021 academic year.

A15.3.3. Description of active learning deploying ALIEN methodologies and tools

In the context of active learning, students were asked to prepare a report that summarized all topics taught in their theoretical classes. Students worked in groups of 4 - 5 individuals. They were allowed flexibility on selecting a system of the choice for implementation. Subsequently, students selected a system development methodology and justified their choice. The performed a feasibility analysis in order to analyse their suggested solutions taking into account various factors, including economic, operational, technical, and scheduling aspects. The next step was the definition of system requirements. Students conducted surveys and interviews for gathering information. They used different computer-aided software engineering tools for modelling their system, including DFD, decision tables and ER diagrams. Finally, they had the opportunity to test their system. These activities took place virtually due to COVID-19 restrictions. When instruction returns to face-to-face the Active Learning Lab developed through ALIEN will be used for practical work.

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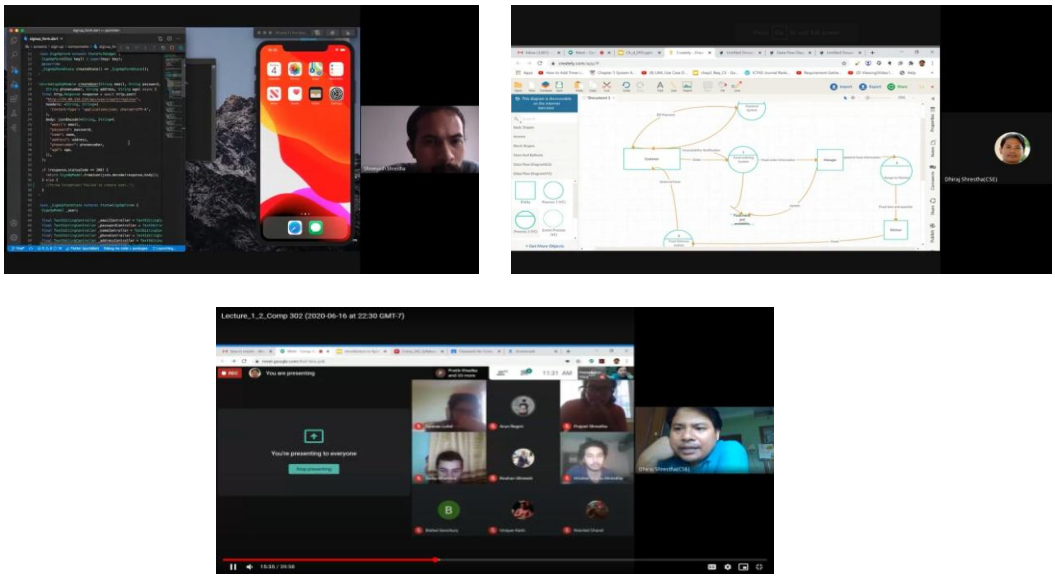

Figure 117. Students discuss a problem and explain their project work in the System Analysis and Design Course.

A15.4 Course Comp 315: Computer Architecture and Organization

A15.4.1 Description of the course

The main objective of the course is to introduce the concepts of computer architecture as well as computer organization and design. The course addresses designing the basic computer design, central processing units, control units, input and output organization, and memory organization. The Digital Logic and Microprocessor courses are prerequisites.

A15.4.2 Description of the participants

The course is obligatory in the 3rd year of undergraduate studies at the Department of Electrical and Electronics and Department of Mathematics at Kathmandu University. 74 students were engaged in the course in the 2020 - 2021 academic year.

A15.4.3 Description of active learning deploying ALIEN methodologies and tools

In the context of active learning, students were asked to design a basic computer using knowledge gained in the course. Students worked independently. They were allowed to make the assumptions on design aspects such as word length, memory size, and instruction format. Practical work supported students in developing a clear understanding of computer

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architectures. Instruction took place virtually due to COVID-19 restrictions. When Kathmandu University resumes face-to-face instruction the Active Learning Lab developed through ALIEN will be used for practical work.

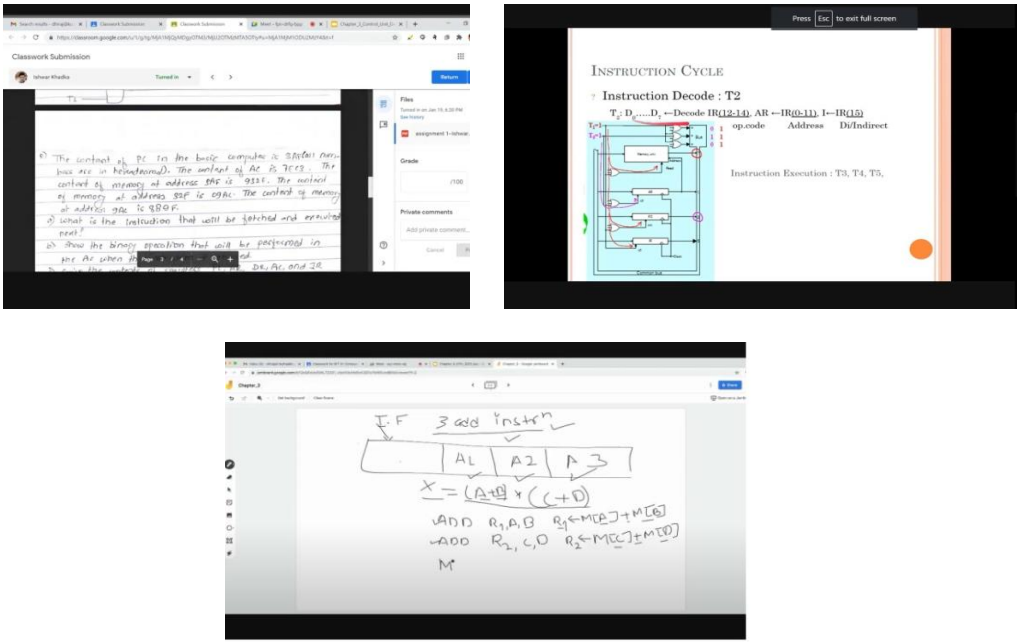

Figure 118. Students discuss problems in the Computer Architecture and Organization course.

A15.5 Course Comp 306: Embedded Systems

A15.5.1 Description of the course

The course introduces general concepts of embedded systems. It focuses on the design of both hardware and firmware for addressing specific needs. It also addresses a variety of communication interfaces that can be used in embedded systems for transferring data. The courses Communication Networks, Computer Architecture, C & C++, and Microprocessors are prerequisites.

A15.5.2 Description of the participants

The course is compulsory in the 3rd year of undergraduate program of the Department of Computer Science and Engineering of Kathmandu University. 60 students were enrolled in the course in the 2020 - 2021 academic year. Students had basic understanding of

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programming languages, computer networking, computer architecture, and microprocessors, allowing them to be active in class.

A15.5.3 Description of active learning deploying ALIEN methodologies and tools

Students were exposed to active and problem-based learning through assignments and project work. Assignments were carried out in groups. Assignment topics were presented to the entire class at the beginning of the course. The assignments encouraged students to research various embedded system mishaps and suggest a configuration management process for addressing it. Students presented assignments on a plethora of topics such as:

- Boeing 737 MAX.
- Northeast blackout of 2003.
- Failure of Deep Space 2 mission.
- Pace maker failures.
- Self-driving Uber®.
- Mars Pathfinder.
- Therac-25 error.
- Ariane 5 flight 501 failure.
- Computer chip failure in nuclear alarms.
- Patriot missile failure.
- Galileo signal outage.
- AT&T network collapse.
- Unintended acceleration in Toyota® cars.
- Air traffic control failure.

Students were also assigned a variety of projects at the end of semester. The projects focused mainly on socket programming but other themes were also welcomed and considered. Student participation was active despite the COVID-19 restrictions. Presentations and demonstrations were conducted on-line. The ALIEN Active Learning Lab

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will be used when Kathmandu University returns to face-to-face instruction. The varieties of projects completed by students are listed below.

- Media control by phone.
- Rover control by cell phone.
- Desktop screen sync and mouse control with android mobile devices.
- Television controlled by smart phone.
- Basic remote computer control.
- Computer control using Bluetooth from mobile app.
- Mouse cursor remote control.
- VLC media player control using smart phone.
- File transfer over LAN using TCP/IP.
- Gas detection system using Arduino (Tinkercad®).
- RADAR system simulation (Tinkercad®).
- Presentation slide control using smart phone.
- ChromeCast control using smart phone.
- Remote LED control.

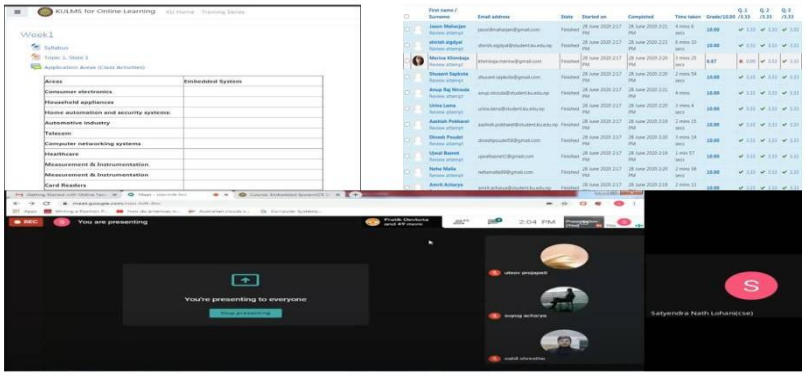

Figure 119. Students engage in the Embedded Systems course.

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A15.6 Course Comp 314: Algorithms and Complexity

A15.6.1 Description of the course

The course builds upon pre-existing skills on mathematical analysis of algorithmic complexity, including analysis of any algorithm in terms of time and space. The course addresses well known algorithms, such as divide and conquers, greedy, and dynamic programming approaches, in the context of problem domains, such as a graphs, sorting, and optimization. This course builds knowledge on techniques used in the design and analysis of algorithms. Classic algorithms are discussed, emphasizing the problems that arise in computer applications. The course also covers NP-completeness. Students further build skills on developing pseudocode for problem solving in computer systems and analysing pseudocode in terms of time and space with active participation thorough discussions.

A15.6.2 Description of the participants

The course is mandatory in the undergraduate programs of Computer Science, Computer Engineering, and Computational Mathematics. 125 students were enrolled in the course in the 2020 - 2021 academic year.

A15.6.3 Description of active learning deploying ALIEN methodologies and tools

Students were asked to develop an efficient approach in pseudocode for solving a computer problem. Students were divided in groups. The solution introduced by each group was thoroughly discussed among group members and presented to the whole class. The instructor introduced a discussion on possible improvements and enhancements based on logical reasoning. The same approach was deployed in the context of activities that encouraged students to analyse a problem in terms of time and space. The best and worst-case scenarios were discussed among class members, while the instructor provided feedback.

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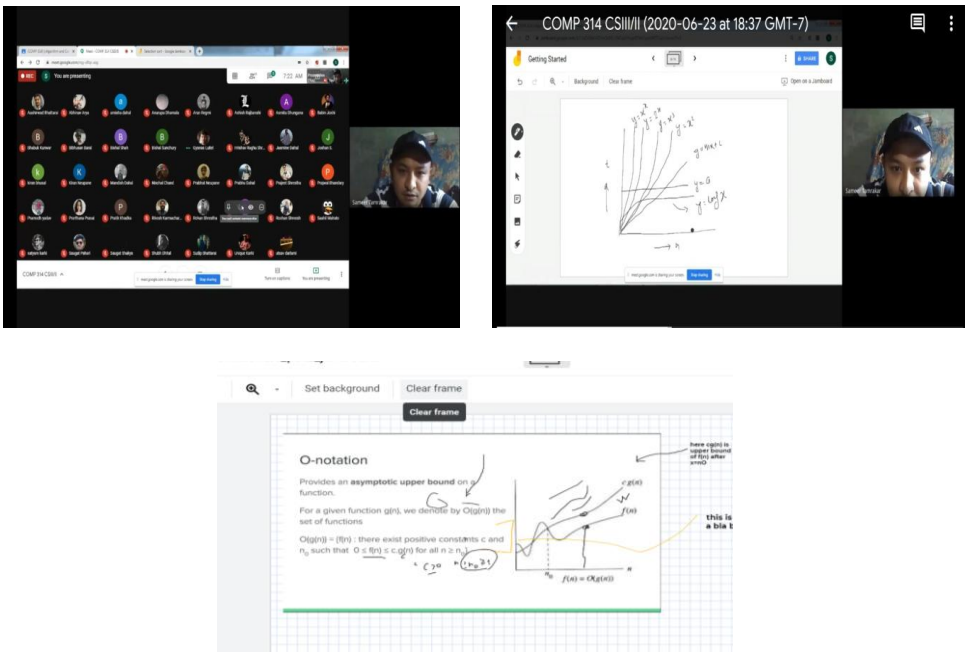

Figure 120. Students participate in a discussion in the Algorithms Complexity course.

A15.7 Course Comp 116: Object-Oriented Programming

A15.7.1 Description of the course

The course aims at enhancing programming skills of 1st year students who already have basic knowledge of structured programming in the C programming language. The course introduces fundamental concepts of object-oriented programming constructs in C++. Topics include classes, objects, inheritance, polymorphism, templates, and more. The course takes place mandatorily in a laboratory environment where students learn through practical work.

A15.7.2 Description of the participants

This course is mandatory for 1st year, 2nd semester students of the School of Engineering at Kathmandu University. Approximately 400 students were enrolled in the course in the 2020 - 2021 academic year. The course enhances the programming horizon of engineering students, who build knowledge on object-oriented programming by modelling real-world modelling problems in different engineering fields.

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A15.7.3 Description of active learning deploying ALIEN methodologies and tools

The course is typically delivered in a laboratory set up. Students are divided in groups of 6. Each student is provided with a computer that runs the Linux operating system. Theoretical knowledge is deepened through discussions on specific problems and their probable implementations that cover the entire course content. Due to COVID-19 restrictions, the course took place virtually.

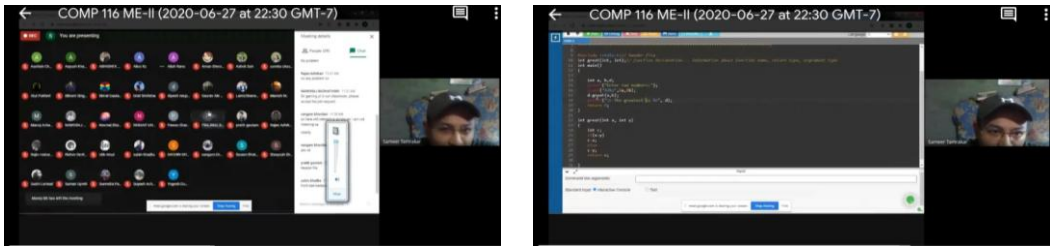

Figure 121. Students participate in problem-solving and group discussions in the Object-Oriented Programming course.

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A16. National University of Computer and Emerging Sciences

A16.1 Course CS303: Software Engineering

A16.1.1 Description of the course

The course introduces students to the fundamental principles and methodologies of Software Engineering. The course covers traditional and modern software development life cycles' stages with practical examples and case studies. Furthermore, the course covers requirements engineering, design, architecture, testing, and project management in detail. The course introduces new topics in all stages of the traditional workflow of the software development process. The course further addresses software process improvement models and their details. More specifically, students build knowledge on the basics of software process models and learn how to choose the best fit for the variable nature of projects in industry; they build their capacity to carry out a project from the beginning to end on their own using the SCRUM agile software development method; they build their capacity to design and test their software; they build their capacity to design and choose the appropriate architecture for their projects.

A16.1.2 Description of the participants

This course targets undergraduate students in the Faculty of Computer Science, Department of Software Engineering.

- 250 students enrolled in the course in the spring 2019 session.
- 250 students enrolled in the course in the spring 2020 session.

Most participants were 3rd year students.

A16.1.3 Description of active learning deploying ALIEN methodologies and tools

Students were assigned a software engineering project, which was conducted through active learning, and more specifically project-based learning, with the intention of following the SCRUM framework for developing any web-based or android app. The context of

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application of these topics was embedded in the broader objectives of the project, which included design and specification, implementation, and testing of a web-based or Android® applications.

The course took place in the ALIEN problem-based learning laboratory of the Software Engineering Department, Faculty of Computer Science NUCES and in the lecture hall environment. The ALIEN problem-based learning laboratory consists of 5 islands with 8 workstations in all. The laboratory can accommodate of 40 students at any given time so. 5 students may share 1 workstation. Each island is equipped with movable workstations and monitors.

During the course students worked on a series of deliverables, using the problem-based learning laboratory equipment. The deliverables revolved around the implementation of a software project. Students identified user stories, or in other words system and user requirements, broke them down into tasks, organized the tasks with popular project management tools, such as Trello®, selected a suitable systems architecture for implementation, designed a graphical user-interface, and submitted a complete report on all activities.

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Figure 122. Students in Software Engineering course.

A16.2 Course CS203: Human-Computer Interaction

A16.2.1 Description of the course

The course constitutes an introduction of human and computers, evolution of design, interaction designs styles, interaction design paradigms, basic design tools, human-computer interaction design, design rules, design evaluation, design heuristics, cognitive process in design, task analysis and categorization, and hieratical task analysis.

The course covers both human factors and the technical methods related to design and evaluation of software. The course develops understanding on the importance of designing user-friendly systems receptive to actual needs so that users can achieve their objectives faster, with lesser mistakes, and greater satisfaction. It develops understanding on the impact of human-computer interaction to society, economy, and culture. It develops basic

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skills required for designing and implementing human-computer interfaces that are acceptable to all. It builds knowledge on the fundamental use of design patterns. It develops understanding on the need and significance of design in development. And it enables students to evaluate the usability of design to make it understandable and acceptable for the community.

A16.2.2 Description of the participants

The course targets undergraduate students in the Faculty of Computer Science. The course enrolled:

- 250 students enrolled in the course in the fall 2018 session.
- 250 students enrolled in the course in the fall 2020 session.

Most participants were 3rd year students.

A16.2.3 Description of active learning deploying ALIEN methodologies and tools

Students were assigned a human-computer interaction project, which was conducted through active learning, and more specifically project-based learning, with the intention of covering the following topics: design principles, conceptual design method, storyboarding, personas, and usability testing through heuristic analysis. The context of application of these topics was embedded in the broader objectives of the course, which include design, prototyping, and evaluating a web-based or Android® applications.

The course took place in the ALIEN problem-based learning laboratory, using the available equipment of 5 islands and 8 movable workstations.

Students developed a series of deliverables, which revolved around the implementation of a human-computer interaction project. As a 1st step, students defined their project by identifying the project scope, its depth, and its objectives, the system requirements, and the project modules and tasks. In a 2nd step, students prepared a navigation map and identified the users. In the following steps, students further analysed the users in terms of demographic profile, professional background, and environment. They further identified

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and described in detail use scenarios and design a user-interface for those. Students were encouraged to design keeping in mind the desirable characteristics of their application, such as ease of use and flexibility. Upon completion of the activities students presented their results by preparing a video and a report.

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Figure 123. Students work on joint projects in the Human-Computer Interaction course.

The students also used the ALIEN digital problem-based learning platform for communicating on project objectives and activities.

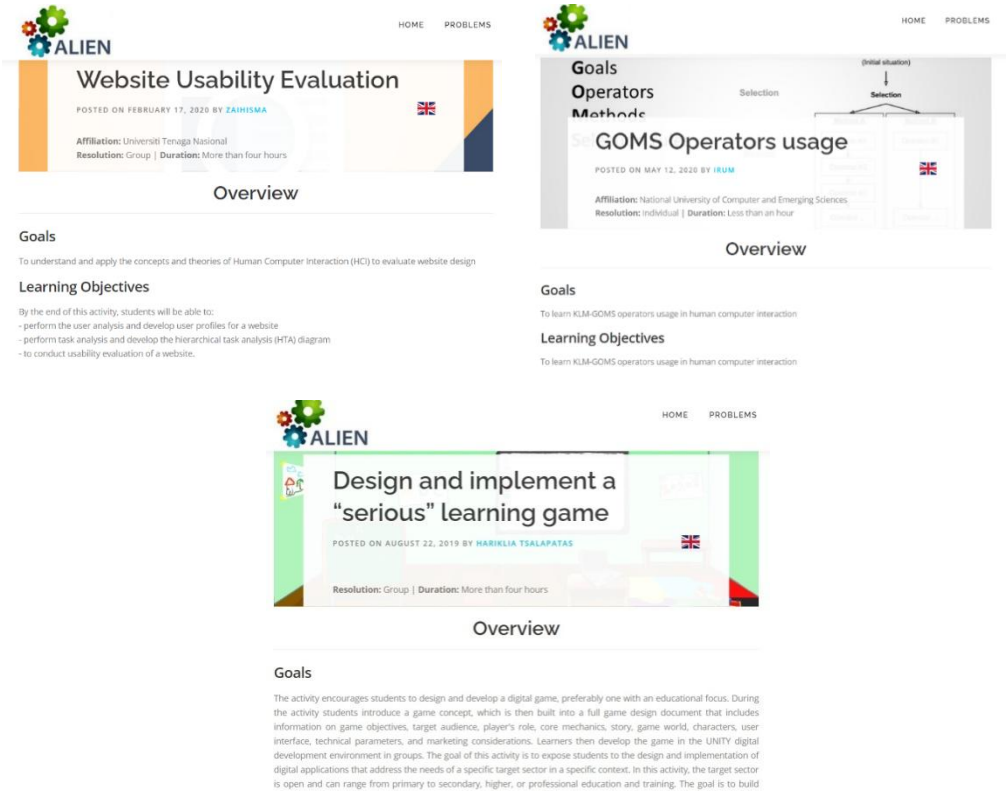

Figure 124. Problems published in the ALIEN digital problem-based learning platform in the Human-Computer Interaction course.

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A16.3 Course SE592: Software Engineering in Industrial Automation Systems

A16.3.1 Description of the course

The course builds knowledge on the application and usage of software engineering approaches in industrial automation systems. This involves the traditional software development lifecycle activities with respect to industrial automation systems, including advanced topics such as requirements quality, requirements patterns, design practices, testing, and commissioning. In addition, the course focuses on industrial automation standards, risk management approaches for industrial automation, functional safety, and cyber security for industrial automation. The course introduces SCADA systems and cyber security issues and mechanisms for SCADA systems. The course aims at developing understanding on the concepts of industrial automation and control systems. It further enables students to apply software engineering lifecycle steps for industrial automation and control systems. It builds knowledge on risk assessment techniques for Industrial automation systems. It builds knowledge on cyber security of SCADA systems. And it builds knowledge on the standards of cyber security and functional safety in industrial automation.

A16.3.2 Description of the participants

The course targets graduate students in the Faculty of Computer Science. Approximately 60 students were enrolled in 3 sessions. Most participants were 3rd semester, 2nd year, students enrolled in the Master of Science in Software Engineering Program. The course is an elective in the Master of Science curriculum. The course took place in the fall semester of the 2018 and 2020 academic year.

A16.3.3 Description of active learning deploying ALIEN methodologies and tools

Students were assigned 2 projects, which were conducted through active learning, and more specifically project-based learning, with the intention of covering topics of safety risk analysis, security risk analysis, and PLC coding techniques.

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The course activities took place in the ALIEN problem-based learning laboratory.

Figure 125. Students collaborate in groups in the Software Engineering in Industrial Automation course.

Students worked in groups of 3. They developed FTA, STPA, and FMEA for both of the given SCADA cases (Case 1-Dam, Case 2-Manufacturing system). They applied relevant safety standards to check system safety requirements. They proposed possible mitigation mechanisms related to safety standards applicable in the assigned cases. Upon completion of the activities, students submitted the PLC code of the given systems.

A16.4 Course SE502: Advanced Software Requirements Engineering

A16.4.1 Description of the course

This course introduces students to the fundamental principles and methodologies of requirements engineering. It covers traditional topics, such as requirements engineering processes and activities in detail, value-based requirements engineering, AI in requirements engineering processes, goal-based requirements engineering, NFR testing, and more. More specifically, students build knowledge on the basics of requirements engineering for

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developing industry projects. They are exposed to cutting-edge research on advanced topics on requirements engineering. They are introduced to modern methods of requirements prioritization, elicitation, and testing. And they are exposed to safety management, security requirements, and risk analysis of mission critical systems.

A16.4.2 Description of the participants

This course targets graduate students in the Faculty of Computer Science. Approximately 90 students were enrolled in 3 sessions. Most participants were 2nd semester, 1st year students enrolled in the Master of Science in Software Engineering Program. The course is mandatory in the Master of Science curriculum. Learning sessions took place in the fall semesters of the 2018 and 2020 academic years.

A16.4.3 Description of active learning deploying ALIEN methodologies and tools

Students were assigned 2 projects, which were conducted through active learning, and more specifically project-based learning, with the intention of addressing topics such as requirements elicitation, requirements specification, requirements prioritization, dependency identification, requirements validation, and pattern identification. More specifically, students were assigned a case study and they were divided into groups to develop understanding of the case and discuss it with each other. Then, they were challenged to identify the requirements and desirable features of the project modules as per the description given. In a second step, students were asked to perform requirements quality analysis. Work continued with students categorizing requirements, identifying dependencies among requirements, validating requirements, and identifying patterns.

This step-by-step project was implemented with the help of classroom tutoring and lecture notes. Each topic was discussed in class and was subsequently reinforced through completion of a milestone in the hands-on project.

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Figure 126. Students work requirements analysis in the Advanced Software Requirements Engineering course.

A16.5 Course CS309: Object-Oriented Analysis

A16.5.1 Description of the course

The course introduces basic concepts of the object-oriented paradigm, elicitation of requirements through use cases, identification of domain concepts through domain models, selection of classes and assignment of roles and responsibilities to various classes, identification of relationships among classes, and their realization to implement systems. The course further focuses on design patterns and higher-level structures such as packages, layers, deployment, using UML. Students build knowledge on analysing problems from an object perspective. They understand the application of iterative, use case-driven, architecture-centric processes on the development of a robust design model. They build

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practical skills on using UML 2.0 to represent a design model. And they apply object-oriented concepts of abstraction, encapsulation, and inheritance.

A16.5.2 Description of the participants

This course targets undergraduate students in the Faculty of Computer Science. Approximately 240 students were enrolled in five sessions that were delivered in the spring of the 2019 - 2020 academic year. Most of the participants were 3rd semester 2nd year students enrolled in the Bachelor of Science in Computer Science Program. The course is mandatory for Master's students.

A16.5.3 Description of active learning deploying ALIEN methodologies and tools

Project based learning was deployed. Students were divided into groups of 2 - 3 for conducting a semester project. A small project was assigned to each group. Students analysed problems from an object perspective, applied iterative, use case-driven, architecture-centric processes to the development of a robust design model, used UML 2.0 to represent design models, applied the object-oriented concepts of abstraction, encapsulation, inheritance, and polymorphism, created object-oriented designs and implemented them in Java++®, and developed understanding of basic design considerations, including the use of patterns.

Figure 127. The ALIEN digital problem-based learning platform was used in the Object-Oriented Analysis course.

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A16.6 Course CS497: Software Testing

A16.6.1 Description of the course

The course aims at preparing students for effective testing of software systems. It introduces the state of art in software testing, quality assurance, and program analysis techniques. In particular, course content focuses on the review of testing tools, emphasizing the significance of each phase when testing different types of software. Students build knowledge on the state of the art in testing technology for object-oriented, component-based, concurrent, distributed, graphical-user-interfaces, and web software. Emerging concepts, such as test-case prioritization, and their impact on testing are also examined. Students gain hands-on experience in testing and analysis through assignments. Students become familiar with widely used tools in the testing industry. They build practical knowledge on applying software testing techniques to real-life projects. And they build the necessary knowledge for starting to test software. Furthermore, students develop presentation skills, both oral and written. The course exposes students to test cases that address diverse criteria.

A16.6.2 Description of the participants

This course targets undergraduate students in the Faculty of Computer Science. Approximately 240 students were enrolled in five sessions that were delivered in the spring of the 2019 - 2020 academic year. Most of the participants were 7th semester, 4th year, students enrolled in the Bachelor of Science in Computer Science Program. The course is an elective.

A16.6.3 Description of active learning deploying ALIEN methodologies and tools

The course included a mandatory laboratory session, which corresponded to 15% of the final grade. More specifically, 10% of the grade corresponded to a project and 5% to other assignments. The project challenged students to apply hands-on different software testing/analysis tools. Tutorial sessions were conducted on the required tools. The course deployed project-based learning. The students were divided into groups of 4 for

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implementing a semester project. A small project was allocated to each group. The students performed a series of activities in the laboratory session, including introduction to testing concepts and tools, use of hands-on testing tools such as JUnit, testing of web applications, testing of graphical user-interface design, generation of test cases for static and loop testing procedures, equivalence partition boundary value analysis, and state transition, white box and black box testing, flow control analysis, inspection, bug reporting, and debugging. Students practiced hands-on using the Selenium® tool.

Figure 128. Projects published on the ALIEN digital problem-based learning platform in relation to the Software Testing course.

At the end of the semester students presented their results to their classmates and the instructor.

A16.7 Course CS220: Operating Systems

A16.7.1 Description of the course

The course addresses operating system design and implementation. Major topics covered include process management, thread management, process synchronization, deadlock management, memory management, file management, and more. This is a programming intensive course and involves implementation and use of system calls, multithreaded applications, memory management simulations, and scheduling with an emphasis on synchronization issues.

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The course objectives are to describe, discuss, and analyse services provided by the modern operating systems. The course builds understanding and develops capacity on designing and implementing solutions that deploy concepts on processes and threads. The course further builds knowledge on comparing and contrasting commonly used scheduling tasks in operating systems, analysing synchronization issues, and implementing synchronization mechanisms such as semaphores, monitors, and more. The course builds understanding and develops capacity on deploying operating system concepts related to virtualization. And finally, it builds understanding on operating system resource management, dead lock management, and memory management techniques.

A16.7.2 Description of the participants

This course targets undergraduate students in the Faculty of Computer Science. Approximately 250 students were enrolled in five sessions that were delivered in the spring of the 2019 - 2020 academic year. Most of the participants were 4th semester, 2nd year students enrolled in the Bachelor of Science in Computer Science Program. The course is mandatory in the Master's program

A16.7.3 Description of active learning deploying ALIEN methodologies and tools

The course deployed active learning methodologies in the context of project work. Students implemented hands-on exercises that focused on shell scripting, process creation and handling, system call execution, inter-process communication, signal handling, threading for parallel processing, and synchronization.

Student evaluation took place through problem-based learning approaches that integrated laboratory work, practical quizzes, and a project. Each student submitted a written report of typically 8 pages and delivered a 15-minute presentation. Students were evaluated on technical content, completeness, and accuracy of their work.

Class work deployed the ALIEN digital problem-based learning platform, which was used for communicating problems to students.

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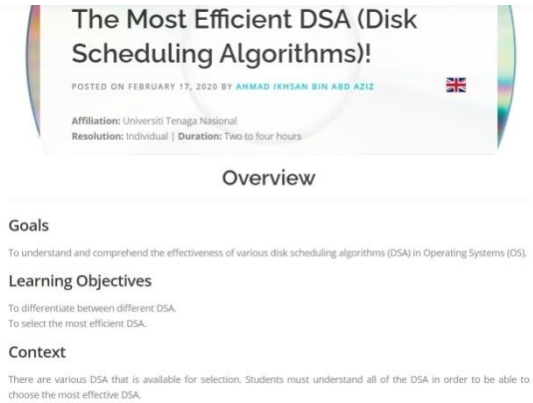

Figure 129. Projects published on the ALIEN digital problem-based learning platform in relation to the Operating Systems course.

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A17. Hanoi University of Science and Technology (HUST)

A17.1 Course IT4130E: Parallel and Distributed Programming

A17.1.1 Description of the course

The course introduces an overview of parallel and distributed programming, which is applied towards solving high-performance problems that are executed on parallel or distributed computing platforms. The course addresses topics of parallel and distributed computational architectures, such as multi-threaded architectures, multi-core computational architectures, general purpose GPUs, parallel algorithms for high-performance problems, parallel programming models such as OpenMP, MPI, CUDA, parallel program development for typical activities such as matrix computations, graphs, sorting, and partial differential equation. Upon completion of the course, students are in a position to design parallel algorithms and develop parallel programs using different parallel programming models that are applied to a wealth of high-performance practical challenges.

A17.1.2 Description of the participants

The course is obligatory in the 4th year of undergraduate studies in Data Science and Artificial Intelligence at the School of Information and Communication Technology, Hanoi University of Science and Technology. Approximately 60 students are enrolled in the course in the 2020 - 2021 academic year.

A17.1.3 Description of active learning deploying ALIEN methodologies and tools

The course applied problem-based and active learning design. Students worked in small groups of 3 - 5 individuals. The work took place in the problem-based learning computer laboratory that was developed through the ALIEN project. Each group selected a problem from a list introduced by the educator. Students explored related material, brainstormed under educator guidance, designed an algorithm, implemented a software program, analyzed and evaluated, and reported results.

Following are examples of problems that students worked on:

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- Matrix multiplication.
- Solving ODE and PDE problems.
- Solving wave equations.
- Solving heat equations.
- Solving hydrodynamic flow models.


Figure 130. Students work on group projects under teacher guidance in the context of the Parallel and Distributed Programming course.

A17.2 Course IT2030: Technical Writing and Presentation

A17.2.1 Description of the course

The course builds student knowledge and skills on preparing scientific and technical documents and making effective presentations. Students are introduced to the entire range of writing activity steps, including planning, drafting, evaluating, and editing. Students also build practical skills on analyzing the objectives of a written communication, organizing information, and using graphical support tools. Upon completing the course, students are able to write technical reports, theses, abstracts, proposals, resumes, and other documents in a correct and professional way. Effective presentation techniques, such as using voice, changes of tone, and body language are also introduced in the course. During the course, students work in groups to formulate ideas and prepare the necessary materials for oral or written presentations, building at the same time collaboration capacity and positive team work attitudes.

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A17.2.2 Description of the participants

The course is obligatory for 3rd year undergraduate students in all majors at the School of Information and Communication Technology, Hanoi University of Science and Technology. As an example, the course was included in the 1st year curriculum of talented engineers in information technology and communication, which was delivered in the 1st semester of 2020. Approximately 20 students are enrolled in the class in the 2020 - 2021 academic year.

A17.2.3 Description of active learning deploying ALIEN methodologies and tools

The course deployed active and problem-based learning. The course consisted of 2 partsthat focused, respectively, on presentations and writing. Each part had a duration of 7 weeks.

In each part of the course students chose a topic from a list provided by the educator. Examples of topics included computer graphics, data bases, data base management systems, security, computer ethics, artificial intelligence, internet of things, the 4th industrial revolution, data science, and digital transformation.

Figure 131. Students deliver presentations in the context of the Technical Writing and Presentation course.

Students performed literature review, explored content, and prepared slides. At this stage of the course the class was divided into small groups of 5 - 7 individuals. Each student presented his work to his group and received comments and evaluation by all group members.

During the course students were assisted by educators and teaching assistants to improve their presentation and writing skills. They deployed the equipment of the ALIEN problem-

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based learning laboratory, including projectors, screens, TV monitors, laptops, and audio systems.

A17.3 Course IT2030: Scientific Computing

A17.3.1 Description of the course

The course focuses on scientific computing concepts. More specifically, it focuses on common problems in science and engineering and methods and algorithms for soling complex problems. The course further familiarizes students with programming languages and tools that are used for performing calculations and for developing software that solves complex problems.

The course includes topics as calculating and programming using the MATLAB® software application, problem conditions and errors, algebraic numerical methods, calculus, systems of linear equations, systems of non-linear equations, approximation of derivatives and integrals, numerical methods for differential equations, curve fitting, numerical methods for optimization, linear programming, non-linear programming, and MATLAB® deployment in scientific computing.

A17.3.2 Description of the participants

The course is an elective in the 4th year of undergraduate studies in Computer Science at the School of Information and Communication Technology, Hanoi University of Science and Technology. More than 40 students participated in the course in the 1st semester of the 2019 - 2020 academic year.

A17.3.3 Description of active learning deploying ALIEN methodologies and tools

The course applied active and problem-based learning. It involved both theory and practice. First, the educator delivered theoretical lectures to the entire class. Then, each student chose an assignment to work on from a list of available topics, such as: diffusion equations, Jacobi method, regression algorithms, weather forecast problems, traffic optimization problems, curve match problems, and more.

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Students studied the assigned problem to understand its parameters, build algorithms, develop software programs that practically implement the designed algorithms, run and evaluate their programs, and present the results to the class.

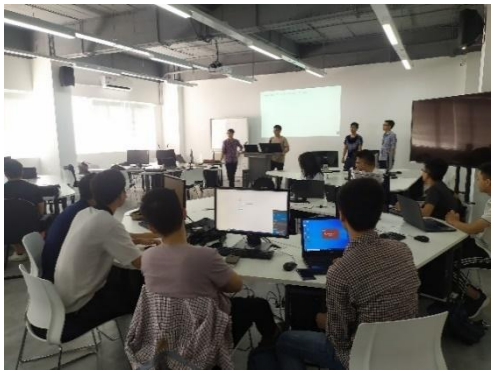


Figure 3: Students in the course Scientific computing.

During the course, students were assisted by educators and teaching assistants to improve their problem-solving techniques. They deployed the equipment of the ALIEN problem-based learning laboratory, including projectors, screens, TV monitors, laptops, and audio systems.

A17.4 Course IT3020: Discrete Mathematics

A17.4.1 Description of the course

This is an introductory course in discrete mathematics objects and their relationships. The course builds student knowledge on basic concepts of mathematical structures that are fundamentally discrete, rather than continuous. Concepts and notations from discrete mathematics are extremely useful in studying and describing objects and formulating problems in branches of computer science, such as computer algorithms, programming languages, cryptography, automated theorem proving, software development, and many others. Topics include logic, sets, functions, number theory, induction, combinations and permutations, graphs, recurrence relations, theoretical principles of cryptography, and trees. The course is mostly theoretical and takes place in an amphitheater. However, it is one of the key courses that develop highly important problem-solving capabilities, critical,

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and analytical thinking. The curriculum is designed to build fundamental knowledge that is of use in other courses in the curriculum.

A17.4.2 Description of the participants

The course is obligatory in the 2nd year of undergraduate studies at the School of Information Communication and Technology, Hanoi University of Science and Technology. Approximately 180 students are engaged in the course every semester.

A17.4.3 Description of active learning deploying ALIEN methodologies and tools

Discrete Mathematics is a theoretical course that is entirely designed using problem-based learning approaches. Students were exposed to problems in the class in almost every lecture. Students solved problems through pen and paper. Students were also asked to implement algorithms and methods on digital platforms applying discrete mathematics concepts towards solving famous problems in order to better understand the underlying theory. The digital applications allowed students to explore potential solutions to a given problem through computational experimentation before introducing a formal mathematical solution. This activity aimed at demonstrating the links between discrete mathematics and programming. It challenged students to analyze a problem and experiment with potential solutions while striving to arrive to a solution formula. It furthermore addressed issues related to solution and programming optimization. Digitally implementing solutions to specific problems typically took place in the context of programming courses.

Additional classic problems introduced in the course that demonstrate links with other curriculum courses, such as programming, include the finding a recurrence relation for the Fibonacci sequence, counting the number of paths in the classic travelling salesman problem, calculating shortest paths in graphs, calculating the maximal flow of a network, and more.

Students were encouraged to participate in practical laboratory sessions held by lecturers and professors. Students had an opportunity to solve real-life problems using the fundamental concepts and theories of discrete mathematics. This activity aimed at

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demonstrating the application of discrete mathematics towards solving realistic problems, and particularly towards formulating problems using basic discrete structures and objects.

Figure 132. Students solve problems in the context of the Discrete Mathematics course.

A17.5 Course IT3100: Object-Oriented Programming

A17.5.1 Description of the course

The course focuses on object-oriented programming (OOP), a programming paradigm based on the concept of "objects". Object-oriented programming is one of the core developing approaches that is widely accepted around the world. Many of the most widely used programming languages, such as C++, Java®, Python®, etc., are multi-paradigm and support object-oriented programming to a greater or lesser degree. The course exposes students to basic concepts of objects and classes as well as the fundamental features of object-oriented design, such as encapsulation, composition, inheritance, and delegation. The course further aims at demonstrating good practices on using object-oriented programming in the deployment process of a software. Applying object-oriented programming offers benefits in re-usability, data redundancy, security, extensibility, troubleshooting, software maintenance, and more. Concepts and schemes of object-oriented design can be applied to improve programming and designing skills, which is highly important in almost every computer science field and particularly in software engineering. The course furthermore focuses on the development of transversal skills including analytical thinking, critical

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thinking, entrepreneurial thinking, problem solving, planning and designing, ability to work in a team, and more.

A17.5.2 Description of the participants

The course is obligatory in the 3rd year of undergraduate studies at the School of Information Communication and Technology, Hanoi University of Science and Technology. Approximately 100 students are engaged in the course every semester.

A17.5.3 Description of active learning deploying ALIEN methodologies and tools

Object-oriented programming is both a theoretical and practical course. In the 1st half of the course students built knowledge on fundamental concepts of object-oriented programming, the schemes and features of the approach, and its benefits. Students were further encouraged to deploy object-oriented theoretical approaches in implementing software applications in known programming languages that support object-oriented design with the purpose of building deeper understanding of related techniques. This activity aimed at demonstrating the direct deployment of object-oriented design in programming and to help students build initial experience in object-oriented implementation.

In the 2nd half of the course students were divided into teams of 4 and worked collaboratively towards programming an application using object-oriented schemes. Students cooperated to create a program from scratch. They engaged in planning, designing, programming, and debugging. Students were allowed flexibility in the selection of a topic to work on, which could be, for example, a sales program, a parking lot management program, a game, and others. The scale of the program was not necessary to be large. As object-oriented approaches were deployed in every step of application design, course activities helped students understand the process of building a program under the object-oriented paradigm from the beginning to the end. Students appreciated the benefits of object-oriented programming in improving programming experience, developing systematical thinking, and designing effective software.

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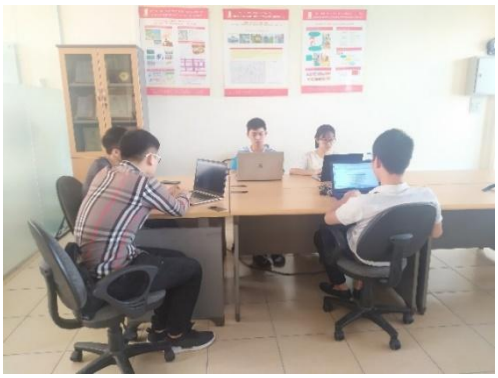

Figure 133. Students develop object-oriented programs individually and in groups in the context of the Object-Oriented Programming course.

A17.6 Course IT-4815: Network Management

A17.6.1 Description of the course

Network management remains the least understood aspect of networking. Managers of today's enterprise and carrier networks face great challenges as they manage a variety of devices, protocols, and mechanisms to meet a diverse set of goals in performance, security, availability, and cost. The course provides students with a comprehensive view of network management, including concepts, scope, challenges, techniques, and related tools. Students study network management concepts in the context of concrete applications and scenarios, such as MPLS, VPN, VLAN, and more. The course furthermore focuses on how practical network management can contribute, in combination with pedagogical models, towards the development of basic, transversal skills including analytical thinking, critical thinking, entrepreneurial thinking, problem solving, ability to work in a team, and more.

A17.6.2 Description of the participants

The course enrolled 100 students in the 3rd and 4th years of undergraduate studies in the formal curriculum of the Department of Data Communication and Computer Networks of School of Information and Communication Technology, Hanoi University of Science and Technology in the 2020 - 2021 academic year.

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A17.6.3 Description of active learning deploying ALIEN methodologies and tools

During the course students were exposed to active and problem-based learning through obligatory projects the grade to which contributes to mid-term credits. Initially, the educator introduced a set of project assignments from which students may select a topic to work on. Students are divided in groups randomly. Each group was assigned a network management scenario problem. For each scenario students identified their educational goals: they described the network management funtional block, its objectives, and the tools expected to be developed or used.

More specifically, students implemented the following steps:

- Students analyzed the network requirements.
- Based on the identified requirements students designed the fundamental network infrastructure and network operation services.
- Students designed network security tools and services.
- Students integrated tools for monitoring services and internet bandwidth.
- Students monitored network management according to the identified funtional blocks.
- Students implemented reporting services.
- Students designed a web-based user-interface for their network.

Students worked in teams. To complete their work, students were challenged to deploy a network simulation scenario. The simulation further built student understanding on the practical application of network management. Students designed a network management solution that deployed up-to-date techniques and tools. This activity enriched student experiences, contributed to the achievement of learning goals, supported the validation and scaffolding of knowledge, and helped link education to real-world needs. Upon completion of the activity students delivered a presentation to the class demonstrating their network function through a simulation that deploys digital tools.

Following are some examples of student presentations in the context of the course:

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Simulation of assignment group project	Link
Exploit network vulnerabilities in Enterprise networks	https://youtu.be/lc9L_UuhCOU
Network management with Nagios	https://youtu.be/WwE_AIH14Kc
Network performance with MGEN	url
Network management with Cacti	https://youtu.be/rYhUyy6towc
Network discovery with Nmap	https://youtu.be/2MOtv1KzlVY
Network security with AirCrack	https://youtu.be/IaiPxl_AW6I
Proxy server with WinGate	https://youtu.be/E0RHoa50Vw0
Proxy server with SQUID	https://youtu.be/LnpFROH_S6c

Table 134. Links of videos that demonstrate students presenting the results of their work in the Network Management course.

Figure 135. Students collaborate on projects in the context of the Network Management course.

A17.7 Course IT-4030: Database Management System

A17.7.1 Description of the course

The course introduces database systems management concepts. The course emphasizes the understanding of the fundamentals of relational systems including data models, database architectures, and database manipulations. The course also provides an understanding of

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new developments and trends, such as internet database environments and data warehousing.

A17.7.2 Description of the participants

The course is an elective in the formal curriculum of the Department of Computer Science of School of Information and Communication Technology, Hanoi University of Science and Technology. 60 students in the 3rd of undergraduate studies were enrolled in the course in the 2020 - 2021 academic year.

A17.7.3 Description of active learning deploying ALIEN methodologies and tools

This course is designed to help students understand the foreseen content and be successful in exams, assignments, and projects. The course deployed active and problem-based learning design.

Students were introduced to data storage models and execute exercises building deeper understanding. Students were furthermore introduced to practical information management systems. They worked in groups to work of 3 - 5 individuals. Each group was assigned a project. Group members developed user requirements, analyzed, and design the system to be implemented. They discussed in groups under the guidance of the educator and teaching assistants. Each group presented their work to the class and received feedback. The presentations helped students develop a more thorough understanding on the system they were about to develop. Upon completing the analysis and design processes, students engaged in software development deploying a database management system to store data. Programming helped students build problem solving skills. After completing the project, students reported the results to the class. The educator evaluated each member's contribution by asking individual questions.

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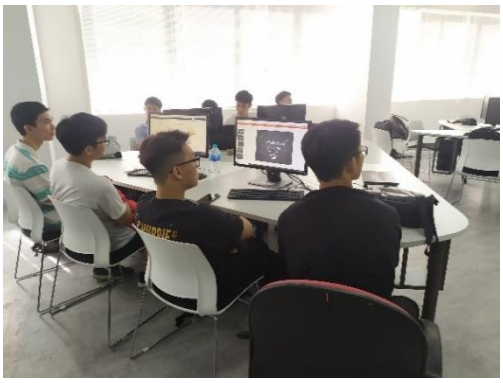


Figure 136. Students work on projects in the context of the Database Management Systems course.

The ALIEN project provided a platform for the publication of database practical exercises for the benefit of wide engineering higher education audiences.

A17.8 Course: Data structure and Algorithms

A17.8.1 Description of the course

The course provides basic knowledge on principles, computational features, and complexity of fundamental algorithms and data structures that are used as the basis for developing information processing systems. Students build knowledge on the implementation of information processing systems through the development of simple application programs. The data structures part of the course covers the concepts of arrays, lists, stacks, queues, tree structures, and graphs. The algorithms section of the course addresses recursion, sorting, searching, and graph management.

A17.8.2 Description of the participant

The course targets 2nd year students enrolled in the Department of Computer Science of School of Information and Communication Technology, Hanoi University of Science and Technology. Approximately 50 students attended the course in the 2020 - 2021 academic year.

A17.8.3 Description of active learning deploying ALIEN methodologies and tools

Students implemented and used basic data structures, such as stacks, queues, priority queues, lists, trees, and hash tables. Students designed and implemented programs that

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used data structures within larger information processing systems. Students understood and implemented basic search and sorting algorithms, such as quick sort, heap sort, merge sort, and hash table management. They mastered basic algorithm building techniques such as recursion and division. They further analyzed complexity in asymptotic notation language for basic algorithm and data structure settings. Through the above, students built problem-solving capacity.

The theoretical part of the course was delivered in the classroom through lectures. Practical work took place in the computer laboratory of the department. Teaching assistants guided students during laboratory practice that was based on the theoretical foundations built through lectures. Students were assigned a project to work in groups with an implementation timeframe of approximately 2 - 3 weeks. Each project involved a number of in-depth math problems some of which were complex requiring significant effort to be solved. The exercises helped students prepare for their exams.

The key to success in the course was practice. Programming took place in the C programming language. Through practical work students built their capacity to apply knowledge towards solving real-life problems. Students experimented using tutorials that were based on theoretical concepts. For example, a lecture on sorting algorithms delivered by a lecturer was followed by a related teaching assistant-led practical workshop. Upon completion of their work students prepared a report that documented the efficiency of the algorithms in focus on real datasets.

Students implemented the following activities:

- Short, practical exercises.
- Wide scope complex exercises
- A mid-term exam.
- A final exam.

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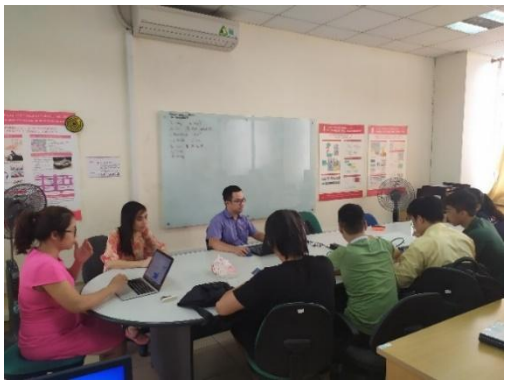

Figure 137. Students collaboratively work on projects in the context of the Data Structures and Algorithms course.

A17.9 Course IT3052E: Fundamentals of Optimization

A17.9.1 Description of the course

Optimization problems appear in many fields of daily-life: resource planning, machine design, automation, business administration, finance, transportation, manufacturing, urban architecture, and more. This course provides students with theoretical foundations of linear programming, integer programming, exact algorithms, and heuristic methods. Students build understanding and capacity to model different optimization problems under mathematical formulations. Students are familiarized with optimization software and programming libraries used to model and solve practical optimization problems.

A17.9.2 Description of the participants

Participants are students in the 2nd year of undergraduate studies of the Artificial Intelligence program of the Department of Computer Science of School of Information and Communication Technology, Hanoi University of Science and Technology. They have a thorough background in English and the Python® programming language.

A17.9.3 Description of active learning deploying ALIEN methodologies and tools

The course deployed active and problem-based learning design. It was completed in 15 weeks during which students followed lectures, executed practice exercises, and worked on mini-projects.

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In the 1st period of the course, which lasted approximately 5 weeks, students developed their background on algorithmic methods for solving linear programming problems. The course focused on the gradient method, simplex method, branch-and-cut algorithms, constraint programming, meta-heuristic method, and more.

Subsequently, the educator assigned optimization problems that involved operations management, building mathematical models, and demonstrating the application of Python® libraries towards solving the mathematical models. During these sessions, students were engaged in building models under teacher guidance.

Furthermore, students worked on mini-projects in groups. Each group was assigned a complex optimization case study that involved, for example, task assignment problems, vehicle routing problems in transportation, bin packing problems, and more. Students worked collaboratively, brainstormed, and designed mathematical models for describing the assigned problem. Students presented their proposed mathematical model to the educator, explaining decision variables, constraints, and objectives of the model. The educator provided feedback and, where needed, suggested corrections to the proposed mathematical models. After that, students employed Python® library tools for implementing algorithms towards solving the assigned problems through experimentation.

Figure 138. Students work in groups in the context of the Fundamentals of Optimization course.

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Finally, students presented and explained their results to the teacher and fellow students. The audience was encouraged to ask questions that led to a discussion on mini-project implementation.

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PART B. INSTRUCTOR TRAINING SESSIONS

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B0. Introduction on ALIEN instructor training sessions

This section describes instructor training activities that took place in the context of the ALIEN project. The activities aimed to familiarize instructors at partner sites on the general concepts of active and problem-based learning as well as on the practical deployment of the ALIEN learning intervention, including the use of the ALIEN problem-based learning laboratories at Asian partner sites and the ALIEN digital problem-based learning platform and content.

Instructor training was an on-going process that started in spring 2019 and continued until the end of the implementation period in spring 2021. A series of training sessions took place at each partner site targeting educators as well as supporting staff with the objective of building the capacity of participating organizations to deploy emerging active and problem-based learning design.

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B1. University of Thessaly

1st instructor training event, November 26, 2019

The 1st instructor training event took place on November 26, 2019 at the Department of Electrical and Computer Engineering of the University of Thessaly. The ALIEN project was presented to 9 instructors who teach in the Department of Electrical and Computer Engineering and 2 PhD candidates who participated in the instructor training event.

Figure 139. Educators follow instructor training at the Department of Electrical and Computer Engineering of the University of Thessaly on November 26, 2019.

The attendees followed a presentation on problem-based learning as well as the objectives and activities of the ALIEN project on promoting the adoption of problem-based learning as a strategic educational approach in higher education.

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The attendees had the opportunity to see how the ALIEN digital problem-based learning platform functions, how they can publish problems, and how they can access problems published by others. The audience further discussed the benefits of problem-based learning, to reflect on how to best apply problem-based learning on large groups of students, and to exchange viewpoints on the benefits of technology towards increasing interactivity in the classroom.

After the training, the instructors used the ALIEN digital problem-based learning platform functionality to publish problems related to their courses. In addition, they deployed problem-based learning in their courses for building the capacity of their students to address today's modern challenges.

2nd instructor training event, April 8, 2020

The 2nd instructor training event took place on April 8, 2020. The event took place on-line. 20 individuals participated in the event who were external to UTH educators and other professionals with an interest in using technology for upgrading educational processes. The event focused on both the theoretical framework of the ALIEN project. The presentations focused on the principles of problem-based learning and related active and experiential learning methodologies that offer advantages in terms of linking educational practices to the real-world and promoting the transferability of knowledge from the educational to the work environment. In addition, the presentations focused on good practices introduced by the ALIEN project on the deployment of project-based learning, and specifically provided insight on the laboratories under development at Asian universities. Finally, the presentations focused on the ALIEN digital problem-based learning platform through a demonstration of the problem repository, the functionality for structuring problems that targets educators, the functionality for accessing problems that targets students, and the community building forums that allow ALIEN platform participants to share knowledge and experiences on subjects, such as problem-based learning methodologies and tools, problem-based learning and software engineering, problem-based learning and AI, problem-based

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learning and gamification, and individual interests related to problem-based learning in participating countries.

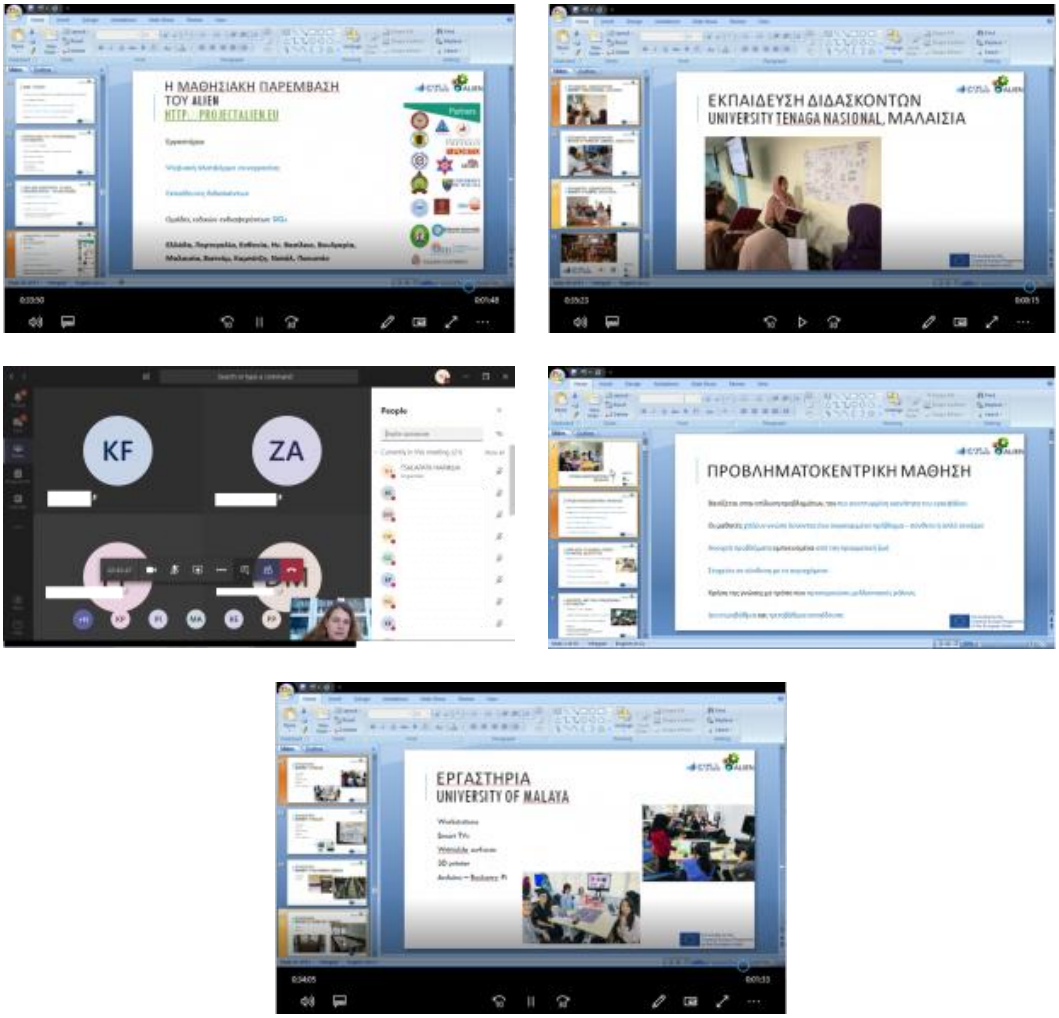

Figure 140. Educators and professionals follow the 2nd instructor training event at the University of Thessaly on April 4, 2020.

3rd instructor training event, June 1, 2020

The 3rd instructor training event was hosted on June 1, 2020. The event targeted administrators and researchers at the University of Thessaly Research Committee, the department of the university that supports the management of research projects. The event was attended by 10 individuals and it took place on-line due to the COVID-19 restrictions. During the event the audience had the opportunity to be exposed to the concepts and

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benefits of problem-based learning and related educational methodologies of active learning and experience-based learning.

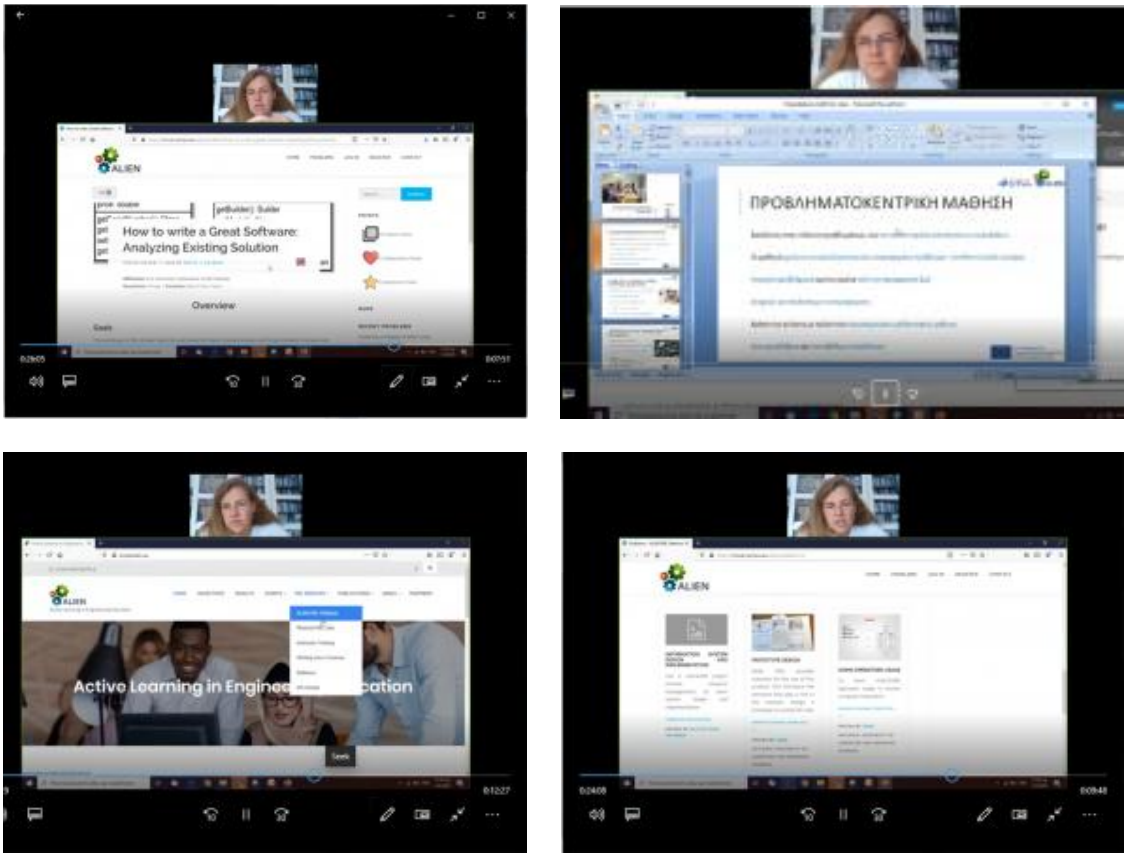

Figure 141. Administrators and researchers follow the 3rd instructor training event at the University of Thessaly on June 1, 2020.

The audience reflected on how these emerging methodologies help build fundamental knowledge as well as transversal learning skills include critical thinking, analytical thinking, collaboration ability, entrepreneurial thinking, and more. In addition, the audience's awareness was raised on the opportunities that problem-based learning offers towards building skills that are desirable by industry and society, bridging the skills gap between academia and industry, and fostering the transferability of skills from the educational environment to the world of work through learning scenarios inspired by real-life.

The audience further had the opportunity to be exposed to the ALIEN digital problem-based learning platform that acts as a repository of problem-based learning activities that deploy

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digital tools and also as a collaboration platform that encourages student engagement, brainstorming, problem analysis, and solution synthesis.

Finally, the audience was exposed to some of the ALIEN project instructor training activities and physical problem-based learning laboratory development taking place at Asian partner universities.

4th instructor training event, September 15, 2020

The 4th instructor training event took place on September 15, 2020. The event took place virtually due to the measures for the prevention of COVID-19. The event targeted instructors at the Diana Lab of the Department of Informatics with applications in Biotechnology of the University of Thessaly that is located in the town of Lamia in Central Greece. The laboratory is affiliated with the Pasteur institute of Greece. 5 individuals participated in the event.

During the event the individuals had the opportunity to reflect on the benefits of problem-based and active learning in engineering education. Most importantly, they had the opportunity to be exposed to the ALIEN learning intervention that is developed around 3 tangents, namely the installation of physical laboratories at universities in Asia, the development of a digital learning repository, and capacity building in the form of instructor training sessions and community events.

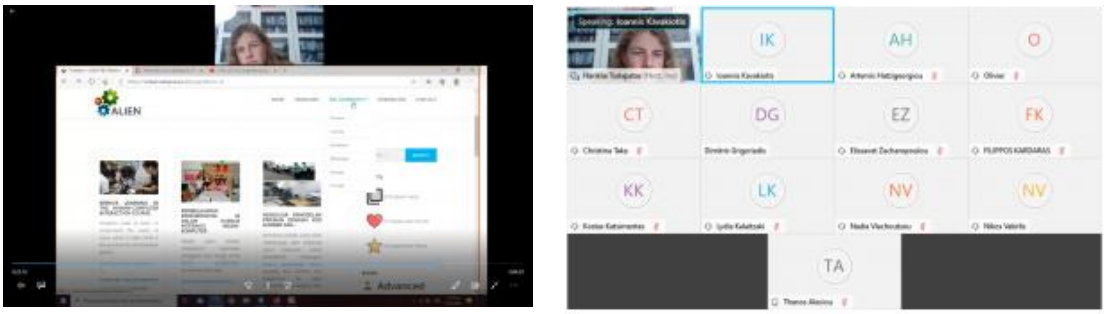

Figure 142. Instructors of the Department of 4th instructor training event at the Department of Informatics with applications in Biotechnology of the University of Thessaly on September 15, 2020.

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In relation to the ALIEN digital problem-based learning platform, the audience was familiarized with the repository of learning activities and the emphasis that the platform puts on the publication, sharing, and re-use of material through functionality that allows the creation of new problems from old for adapting them to the learning needs of additional educational scenarios.

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B2. Instituto Politécnico do Porto

1st instructor training event, February 15, 2019

The 1st instructor training event took place on the February 15, 2019 at ISEP as part of the CASHE 19 conference. 14 teachers from the entire Porto Polytechnic and external educators participated in the event. The event started with a presentation of the ALIEN project, followed by a theoretical background for active learning and problem-based learning. Then, the ALIEN platform was demonstrated to participants. The event was followed by practical deployment of problem-based learning.


Figure 143. Educators participate in the 1st instructor training event at Porto Polytechnic on February 15, 2019.

2nd instructor training event, October 12, 2019

The 2nd instructor training event took place on October 12, 2019 at ISEP. It was attended by 18 educators from the School of Engineering. The event started with a presentation of the ALIEN project, followed by a theoretical background for active learning and problem-based learning. Then, the ALIEN platform was demonstrated to participants, who were able to test it and be involved in the community.


Figure 144. Educators participate in the 2nd instructor training event on October 12, 2019.

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3rd instructor training event, January 11, 2020

The 3rd instructor training event took place on the January 11, 2020 at ISEP with the participating of 16 educators from the School of Engineering as well as a few from other schools of the Polytechnic. The event started with a presentation of the ALIEN project, followed by a theoretical background for active learning and problem-based learning. Then, the ALIEN platform was demonstrated to participants who were able to test it and be involved in the community.

4rd instructor training event, January 25, 2020

Due to the large number of teachers interested, a 4th instructor training event was organized on the January 25, 2020 at ISEP with the participation of 16 educators from the School of Engineering as well as a few from other schools of the Polytechnic. The event started with a presentation of the ALIEN project, followed by a theoretical background for active learning and problem-based learning. Then, the ALIEN platform was shown to participants who were able to test it and be involved in the community.

5th instructor training event, June 30, 2020

Due to COVID-19 restrictions, the 5th instructor training event was organized virtually on June 30, 2020. This event was dedicated to external teachers from higher education and other levels of education. The event started with a presentation of the ALIEN project, followed by a theoretical background for active learning and problem-based learning. Then, the ALIEN platform was demonstrated to participants who were able to test it and be involved in the community.

6th instructor training event, September 30, 2020

Due to COVID-19 restrictions, the 6th instructor training event was also organized virtually on the September 30, 2020. This event was dedicated to external teachers from higher education and other levels of education. The event started with a presentation of the ALIEN project, followed by a theoretical background for active learning and problem-based

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learning. Then, the ALIEN platform was demonstrated to participants who were able to test it and be involved in the community.

Figure 145. Educators participate in the 6th instructor training event on September 30, 2020.

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B3. University of Central Lancashire

1st instructor training event, November 27, 2019

This event was held at the University of Central Lancashire and was attended by 15 educators. The event provided an opportunity for discussion with the audience. It allowed team members to determine some key themes including that there was variety in the way different individuals thought about active learning. This predicted the format for the following 3 events.

Figure 146. Educators participate in the 1st instructor training event at University of Central Lancashire on November 27, 2019.

2nd instructor training event, January29, 2020

The 2nd instructor training event took place on January 29th 2020. It was attended by 12 educators. The theme was introducing active learning. This event was planned to be the 1st in a series of 3 events that could be taken in a row or individually. Attendees included staff from several different parts of the university as well as staff from local colleges and from other places.

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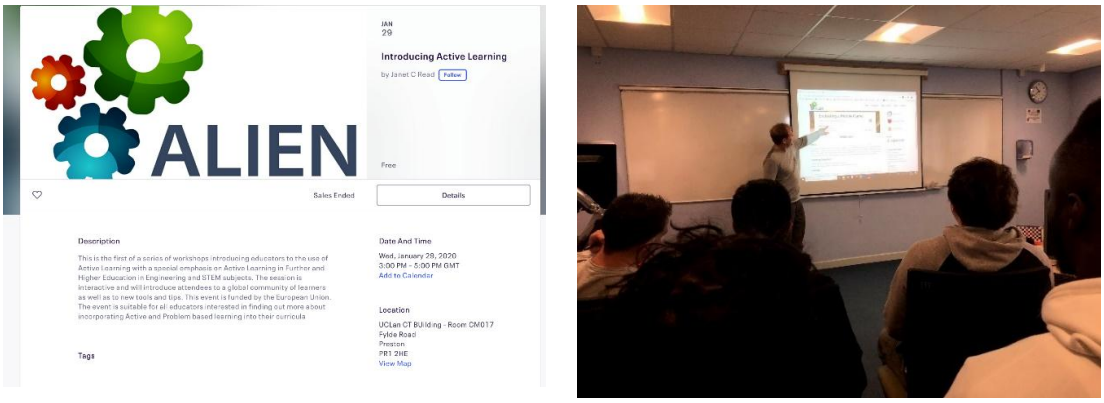

Figure 147. Educators participate in the 2nd instructor training event at University of Central Lancashire on January 29, 2020.

3rd instructor training event, February 5, 2020

This event was attended by 12 educators. The theme was active learning in practice. The event was interactive with groups working together to share ideas and insights.

4th instructor training event, March 1, 2020

14 educators attended this event. The theme was problem-based learning. The organizers introduced attendees to the Snakes activity that is found on the ALIEN problem-based learning platform.

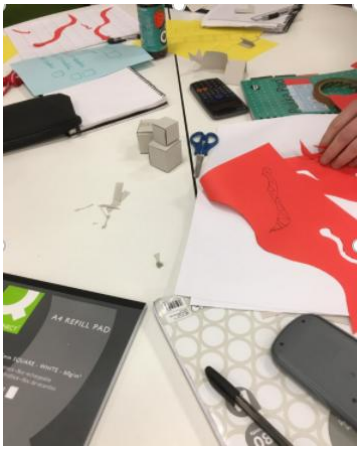

Figure 148. Educators participate in the 4th instructor training event at the University of Central Lancashire on March 1, 2020.

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B4. University of Malaya

1st instructor training event, September 13, 2019

The 1st instructor training event hosted by University of Malaya took place on September 13, 2019 at the Department of Software Engineering. It was attended by 13 educators from the same department. The theme for this first training event was active learning course design with the aim to strengthen the understanding of lecturers on the theory and practice of active learning. The session was purposely held in the Technology-Enhanced Active Learning Spaces (TEALs) laboratory funded through the ALIEN project. This was intentionally done to create awareness on the advantage of using TEALs in creating the best learning environment conducive to teaching software engineering programmers actively.

The training content covered the basic theory of active educational design which includes active, collaborative, and cooperative learning. Educators further reflected on how their role evolves from conveyor of information to facilitator when they use active learning approaches, such as problem-based learning. In addition, the training helped educators become aware that their role will again evolve in the future where active learning approaches will result in them being one of the partners in curating the learning experiences especially in technology-enhanced environments. At that point, educators may need to be ready to act as technology experts in addition to being learning facilitators.

The training further highlighted various active learning methods, such as the basic think-pair-share method, cooperative design including problem-based learning, scenario-based, challenge-based, and project-based. During the training educators became aware of the various tools and documents openly available through the TEALs laboratory to use when implementing active learning methods. The training highlighted additional active learning tools, such as the team contract, reflection guidelines, project brief, Socratic questioning, problem-based learning lesson plan, the FILA form, and assessment plan.

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Figure 149. Educators participate in the 1st training event at the University of Malaya on September 13, 2019.

In the final part of the session, lecturers practiced identifying suitable active learning activities that they may embed in their courses for the current semester. This involved adjusting and redesigning their lesson plan using the university's official form as a guide, using the TEALs facilities and equipment to enrich problem-based learning design. The session ended with discussion and demonstration on best practices in problem-based learning by the facilitator, Dr. Aishah Abu Bakar from the Engineering Faculty.

2nd instructor training event, September 20, 2019

The 2nd instructor training event hosted by the University of Malaya took place on September 20th, 2019, a week after the 1st event. It was attended by 14 educators from the Department of Software Engineering. This session was the continuing session from the 1st event. The objective of the event was to familiarize educators with the actual facilities available in the TEALs laboratory for designing and embedding active learning in courses.

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Figure 150. Educators participate in the 2nd training event at the University of Malaya on September 20, 2019.

The training was fully hands-on. It deployed the gallery-walk approach. Five stations were set up for educators to explore and experience for themselves on how TEALs equipment and facilities can be used to enrich students' learning experiences. The 5 stations demonstrated the Arduino® kit, the Raspberry Pi® kit, the drones, the Autonomous Car®, and the 3D printer. Activities at each station were coordinated by different facilitators, and specifically Dr. Nazean Jomhari, Dr. Asmiza Abdul Sani, Dr. Hazrina Sofian, and Dr. Raja Jamilah Raja Yusof. The session was also assisted by 1 graduate student, Mr. Nabiel Mukarram. This event was indeed a true active learning in nature where educators learned from facilitators and peers at their own pace. Upon completion of one station activity, educators moved on to the next station of their own choice. It was truly a fun and exciting event for all as participants interacted actively, experimenting and experiencing new "gadgets" that can be used to enhance student learning and built experience on how those activities can be embedded into their courses. The session ended with educators having clearer ideas on what active learning is all about, what activities they may design and use in their course, and

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how much learning they themselves experienced from the active learning activities gained from this event.

3rd instructor training event, October 31, 2019

The 3rd instructor training event was held on October 31, 2019. Six educators from the Department of Software Engineering attended this session. The participants teach courses in the Software Engineering program in the semester 1 of the 2019 - 2020 academic year. The educators were selected using as criteria the expected benefit from the integration of active learning using the TEALs laboratory and equipment in their courses. This session was conducted in two parts: the 1st part focused on the preparation for implementing action learning using TEALs and TEALs equipment. The 2nd focused on research aspects of action learning.

Figure 151. Educators participate in the 3rd training event at the University of Malaya on October 31, 2019.

The aim of the 1st part of the discussion was to ensure the smooth running of active learning implementation throughout the semester. During the session participants identified courses, number of students, and pedagogical approaches to be used for the intended active learning activities. The pedagogical approaches ranged from problem-based learning to project-oriented problem based learning and cased study. The class size issue was also discussed. Classes with large size were broken down into smaller groups to ensure effective

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access to the TEALs laboratory facilities. The participants also looked into necessary documents to be used during the implementation phase. Document templates were discussed, including the problem-based learning FILA form, the team contract form, critical reflection write-up guidelines, and assessment rubrics.

The 2nd part of the session was coached by Prof. Dr. Siti Salwah, who led the audience on how to leverage active learning experiences into active research projects. The audience reviewed journals papers related to Software Engineering education. The participants further identified the research aspect, methodologies, and data to be collected. The audience discussed issues and problems that each participant intended to resolve in their courses. The session activities encouraged participants to improve their active learning practices. By reflecting on those issues, the participants fully understood the objectives of active learning and were in a better position to select appropriate related class activities, research methodologies, and data collection approaches. The participants realized that improvement on teaching and learning is effectively achieved through proper research. To ensure that participant experiences benefit others, they also explored a potential journal publication related to this project. At the end of this part, the participants were clearer on the why, what, how, and "what is it for me" in relation to their participation in the project, namely the improvement of student learning experiences and lecturer teaching practice via action research.

4th instructor training event, November 9, 2019

The 4th instructor training event followed mentoring approaches. This mentoring activity started on 9 November 2019. All 6 participating educators from the Department of Software Engineering started by preparing their active learning documents, such as project briefs, rubrics, teamwork contract, and more. The discussion between educators and their mentors took place both face to face and through email.

During this mentoring period, participants learned to write effective project briefs using a specific template. The template contains information that is very similar to the one

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deployed in the ALIEN problem-based learning platform. The learning process took place iteratively, with each submission receiving appropriate and timely feedback from the mentor. The feedback was used to improve the document until it was fit to be released as official active learning instruction for the course. This process was also followed for the assessment rubrics.

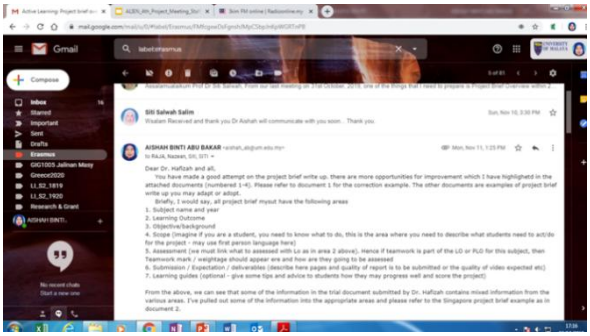

Figure 152. Participants in the 4th training event build knowledge on developing effective project briefs on-line.

At the end of this instructor training period, an appropriate active learning students' instruction sheet, a project brief, was produced and a final problem-based learning monitoring and assessment form were created. These documents were ready for the implementation stage of active learning using TEALs.

5th instructor training event, February 20, 2020

The 5th instructor training event was held on February 20, 2020. Five ALIEN project participating educators from the Department of Software Engineering attended this session facilitated by Dr. Aishah Abu Bakar. Participating lecturers were already in the process of implementing active learning activities using TEALs in their courses. For this reason, this session aimed at looking at the actual implementation issues and guide lecturers on further improvements to be made.

The session started by reviewing the problem-based learning process and criteria for refresh pedagogical approaches already in use. The participants then looked into the deployment of various forms and learning experiences and their practical implementation in problem-based learning. The first document that participants discussed was the teamwork contract.

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Looking at these forms and how they were actually filled up by students, participants noticed that the intended purpose for using the team contract form was not fully realized. Lecturers themselves realized that they themselves never had an experienced using this form for team development purposes. Using evidence and experiences from course delivery, participants reviewed and discussed the purpose of using the form. It was agreed that the purpose of the form was indeed to ensure teamwork amongst team members by making sure each student member identified and understood their role in the group. In addition, through the team contract form students were also trained to be responsible and accountable for their conduct and contribution to the progress and the outcome of the project. At the end of the discussion, it became clear to participants that when the team contract is implemented correctly with proper facilitation by the lecturer, the intended purpose for using the form can be achieved.

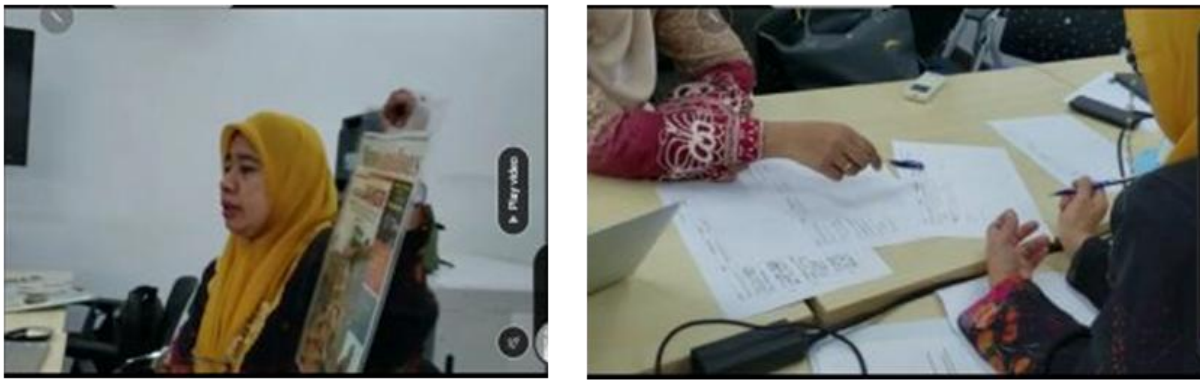

Figure 153. Educators participate in the 5th instructor training at the University of Malaya on February 20, 2020.

The 2nd part of the session focused on how to use the problem-based learning FILA form. Lecturers were asked to engage in actual short problem-based learning activities where they experienced filling in the FILA form themselves. It was indeed a big learning curve for lecturers before they became familiar enough with the FILA form in order to introduce it to students in the context of problem-based learning activities. One of the biggest challenges that participants faced in this session was filling in the 2nd column of the form which involved formulating appropriate questions related to subject content based on the trigger-

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information extracted. Participants understood that formulating questions is the hardest part and that they need to prepare students for filling in the form. One of the approaches to achieve this could be to model “questioning” during lectures and demonstrate this skill in a mindful manner. This allows students to build skills on how to “question” before engaging in related problem-based learning activities in the classroom.

At the end of this training event participants had a rich discussion on how problem-based learning forms and tools can be effectively used to help students achieve the intended learning outcomes and have a meaningful learning experience.

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B5. Universiti Tenaga Nasional

1st instructor training event, September 3 - 4, 2019

The 1st instructor training event took place on September 3 - 4, 2019. The event took place at the problem-based learning laboratory developed through the ALIEN project. The project was presented to 32 lecturers form 4 different colleges that attended the training activity.

A 2-day workshop on active learning titled "Workshop on 21st Century for Engaging Millennials, Part 1: Effective Implementations of Active Learning" was held on September 3 - 4, 2019. This workshop was facilitated by Prof. Dr. Khairiyah Mohd Yusof and Dr. Syed Ahmad Helmi Syed Hassan from Centre for Engineering Education, UTM. Among the modules covered were introduction to student-centered teaching and learning, bookends instructional design and informal cooperative learning structures, and designing and planning an aligned course using active learning.

A survey form was distributed at the end of the training. In general, participants concluded the training as very insightful. The majority requested more training related to active learning to be conducted. In addition, the content of the training was found interesting and met the participants' professional needs.

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Figure 154. Educators participate in the 1st instructor training at the Universiti Tenaga Nasional on September 3 - 4, 2019.

The training gave the participants a new perspective and knowledge regarding active learning. Participants found that a training booklet that was distributed was very useful and effective.

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2nd instructor training event, November 28 - 29, 2019

The 2nd training event took place on November 28 - 29, 2019. The title of the event was "Workshop on 21st Century for Engaging Millennials, Part 1: Effective Implementation of Active Learning". The training was delivered to another group of lecturers than the first group which was held on September 3 - 4. 18 educators participated in the event from 4 different colleges in UNITEN.

The 2-day workshop was delivered by Prof. Dr. Khairiyah Mohd Yusof and Dr. Syed Ahmad Helmi Syed Hassan from Centre for Engineering Education, UTM. Among the modules covered were introduction to student-centered teaching and learning, bookends instructional design and informal cooperative learning structures, and designing and planning an aligned course using active learning. A training booklet was provided to all participants, that was very useful and effective.

At the end of the training, participants gave their feedback through a survey form. In general, they found the training as very insightful and hoped for additional training sessions in the future.




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Figure 155. Educators participate in the 2nd training event at the Universiti Tenaga Nasional on November 28 - 29, 2019.

3rd instructor training event, February 17, 2020

The 3rd instructor training event took place on February 17, 2020. The event took place at the problem-based learning laboratory developed through the ALIEN project. The project was presented to 18 instructors from Universiti Tenaga Nasional (UNITEN) that attended the training activity.

The main focus of this series of training was to use of the ALIEN problem-based learning digital platform for posting and retrieving problems. The objective was to have at least 10 educators register on the ALIEN problem-based learning platform and post educational content. The specific objectives of the training were:

- To explore a web-based platform to be used in implementing active learning and problem-based learning for academic courses.
- To guide the participants on the use of the platform.
- To create a special interest group among lecturers who are interested to implement active and problem-based learning in their courses.

Overall, the participants were able to quickly understand and use the features offered by the platform. They found the activities performed during the training useful and were looking forward to use the platform with their students later on.

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Figure 156. Educators participate in the 2nd training event at the Universiti Tenaga Nasional on February 17, 2020.

4th instructor training event, February 20 - 21, 2020

The 4th training event took place on February 20 - 21, 2020. The event was titled "Effective Implementation of student-centered Learning, Part 2: Developing and Supporting Team-Based Learning Using Cooperative Learning". The training was delivered to educators that

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participated in "Workshop on 21st Century for Engaging Millennials, Part 1". Thirty-one lecturers from 4 different colleges in UNITEN attended the workshop.

This workshop was delivered by Prof. Dr. Khairiyah Mohd Yusof and Dr. Syed Ahmad Helmi Syed Hassan from Centre for Engineering Education, UTM. A training booklet containing modules on formal cooperative learning was provided to each participant. Among the modules covered were different types of formal cooperative learning, the "three pillars" of cooperative learning, and various forms of formal cooperative learning, such as the jigsaw method, student team's achievement divisions, team-games tournament, group investigation, complex instructions, and constructive academic controversy.

At the end of the training participants gave their feedback through a survey form. In general, they found the training very insightful and they are looking forward to part 3 and Part 4 of the workshops.

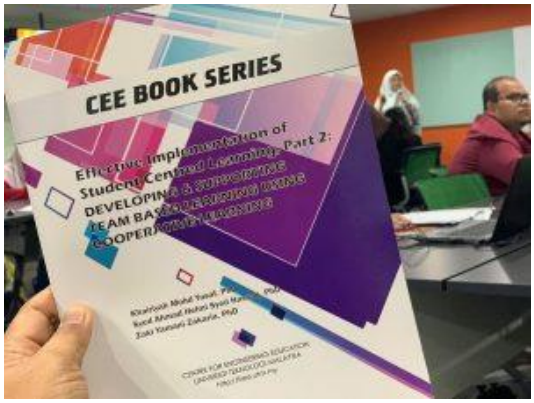

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Figure 157. Educators participate in the 4th instructor training event at the Universiti Tenaga Nasional on February 20 - 21, 2020.

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B6. Isra University

1st instructor training event, August 24, 2019

The 1st instructor training was held on 24th August 2019 for the faculty members of the Department of Computer Science, Isra University, Hyderabad. The event was attended by 20 individuals. This was the 1st of the series of problem-based learning workshops conducted at the Department of Computer Science. The goal of this series of workshops on was to train faculty members on problem-based learning methodologies, building their capacity to develop student skills in demand by industry and facilitating their easy transition into the job market. The purpose of the 1st workshop was to introduce faculty members to problem-based learning and to demonstrate how problem-based learning can be implemented in different subjects being taught by faculty members. It was an informative session highly acknowledged by faculty. The instructor training was conducted by Dr. Mutee u Rahman, Associate Professor, Department of Computer Science, and Dr. Kamran Khowaja, Associate Professor, Department of Computer Science.

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Figure 158. Educators participate in the 1st instructor training at ISRA University on August 24, 2018.

2nd instructor training event, August 31, 2018

The 2nd instructor training was held on 31st August 2019 for faculty members of the Department of Computer Science, Isra University, Hyderabad. It was attended by 20 individuals. This was the 2nd of a series of workshops conducted by the Department of Computer Science in collaboration with ALIEN Project. The purpose of this workshop was to introduce virtual and augmented reality tools to faculty members and provide them with hands-on training of the use of the tools. This was a full-day training session that was conducted by Dr. Mutee u Rahman, Associate Professor, Department of Computer Science, and Dr. Kamran Khowaja, Associate Professor, Department of Computer Science.

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Figure 159. Educators participate in the 2nd instructor training at ISRA University on August 31, 2018.

3rd instructor training event, August 21, 2020

The 3rd instructor training was held on 21st August 2020 for faculty members of Department of Computer Science, Isra University, Hyderabad. It was attended by 20 individuals. The purpose of this session was to introduce the ALIEN platform and demonstrate how it may be used in courses. The training was conducted by Dr. Mutee u Rahman, Associate Professor, Department of Computer Science, and Dr. Kamran Khowaja, Associate Professor, Department of Computer Science.

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Figure 160. Educators participate in the 3rd instructor training at ISRA University on August 21, 2020.

4th instructor training event, September 26, 2020

The 4th instructor training was held on 26th September 2020 for faculty members of Department of Computer Science, Isra University, Hyderabad. It was attended by 20 individuals. The purpose of this training session was to share project updates, review problem-based learning practices, discuss the use of the ALIEN problem-based learning platform, and support faculty members in the creation and uploading of problems on the ALIEN platform. The training was conducted by Dr. Mutee u Rahman, Associate Professor, Department of Computer Science, and Dr. Kamran Khowaja, Associate Professor, Department of Computer Science.

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B7. Tallinn University

1st instructor training event, September 17, 2020

The 1st instructor training event was held on September 17, 2020. Six individuals participated in the event. The individuals that participated were Anni Hõ, Hanna-Liisa Pender, Martin Sillaots, Mikhail Fiadotau, Triinu Jesmin, and Vladimir Tomberg.

Given that instructors at Tallinn University are familiar with active and problem-based learning, all training sessions focused on more technical aspects of how to deploy active learning from a distance using digital supporting tools.

The topics covered during the 1st training started with a getting to know each other session and mapping of topics to be discussed over the entire series of training sessions. Subsequently it focused on how to best deliver hybrid learning, which refers to learning sessions in which some students are on-site and some on-line.

More specifically, participants presented the courses that they teach, the format of each course, and fun facts about their courses and themselves. In fact, the participants addressed a broad range of courses, including Pedagogical and Psychological Factors of Developing Learning Games, Design Theory and Methodology, Game Studies, 2D Game Art, Introduction to DLG, and LIFE, Master's Thesis Seminar. All courses are currently delivered on-line due to the COVID-19 pandemic. The platforms used for delivering the courses include Google Classroom and Google Meet.

The participants discussed issues and topics related to the delivery of their courses in an active learning mode:

Triinu Jesmin commented that her course on Statistics was unexpectedly popular, with 40 students expressing interest to enrol in the class that takes place in the computer laboratory, which has a capacity of 22 seated students. As a result, most of the DLG students were rejected because this course was an elective for them. The solution to the problem was to plan for the delivery of the course on yearly basis to address demand. Notable, the

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course currently takes place every 2 years. To achieve this, another educator is required, and a potential candidate is Vladimir Tomberg.

Hanna-Liisa Pender commented that she deploys prerecorded video presentations during virtual lessons. The challenge that this introduces is keeping student discussions alive. One solution suggested was to create on-line tests for every lesson. Another idea suggested was to ask questions or let students ask questions. Finally, the group commented that delivering and recording real-time video presentations is easier to organize but the quality of the result is lower.

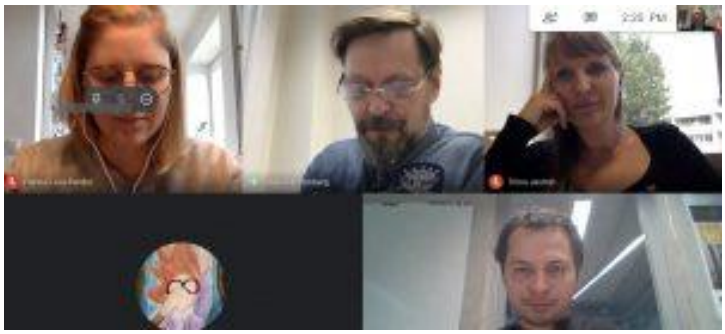

Figure 161. Educators participate in the 1st instructor training at Tallinn University on September 17, 2020.

Vladimir Tomberg, a new doctoral student that focuses on Health Psychology, teaches the WS or LIFE course on designing digital services for behavioural change. Vladimir commented that delivering a fully on-line or fully in-class course is easy; the challenge is to deliver hybrid courses. For example, in hybrid classes it is difficult to have students work in pair in blended learning contexts. He further commented that a defence strategy is required for effective learning delivery.

Mikhail Fiadotau uses graphic tablets as on-line white boards. While this provides a solution in blended learning contexts it also introduces new challenges mostly related to technical issues. For example, sometimes the voice of on-line students is actually coming from the projector. In other cases, students may accidentally take ownership of the recorded video; the easy solution is to ensure that the educator is the first to enter the meeting room.

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Another technical challenge is that sometimes students have difficulties finding the link for connecting to an on-line course.

Finally, the group discussed tools that may be deployed in on-line collaboration contexts. These include:

- Google Jam-board, which is an on-line whiteboard with sticky notes.
- Other on-line whiteboards, such as WhiteBoardFox®, available at https://whiteboardfox.com/.
- Project DesignIT collaborative learning environment, available at https://dt4s.e-ce.uth.gr.
- And more tools, such as Miro, available at https://miro.com/.

2nd instructor training event, October 21, 2020

The 2nd instructor training event took place on October 21, 2020. A total of 16 instructors participated in the event. The event focused on the technical and pedagogical aspects related to the deployment of digital devices for active on-line or hybrid learning. More specifically, it focused on communication and recording devices as well as guidelines for the use of these devices to enrich hybrid learning experiences.

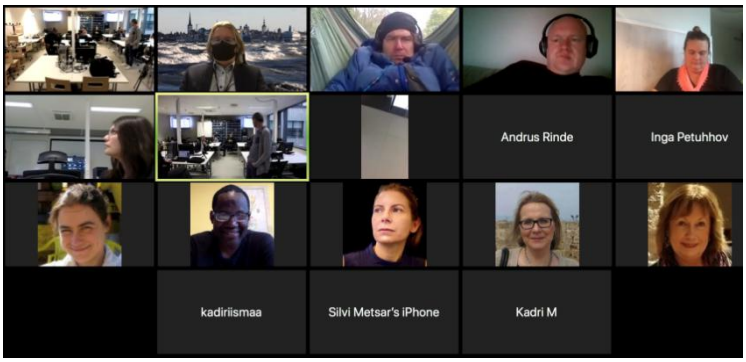

Figure 162. Educators participate in the 2nd instructor training at Tallinn University on October 21, 2020.

The session focused on how to deploy cameras for recording the blackboard, the use of smart devices that follow the educator for recording lecturing, the use of radio microphones for capturing student sound in the classroom, and the use of drawing tables, such as the

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Elgate Creen Deckj®, for creating a virtual blackboard for sharing educational content and ideas.

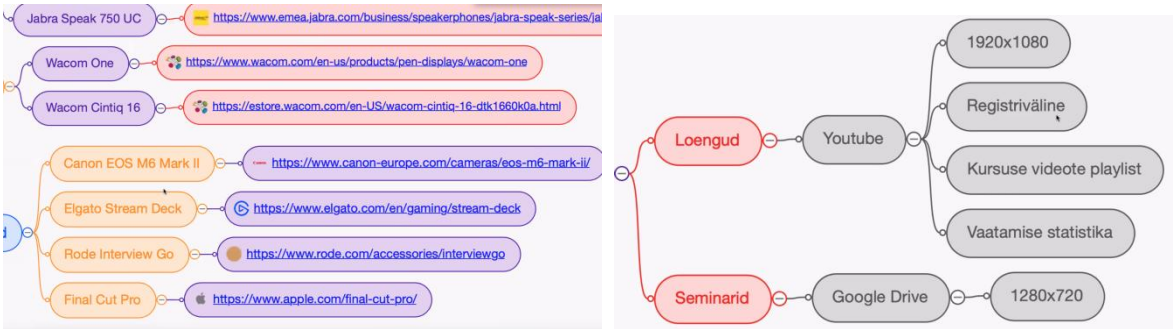

Figure 163. Addressing the use if cameras and recording devices to enrich interaction and virtual presence in hybrid learning during the 2nd instructor training at Tallinn University on October 21, 2020.

The session focused on guidelines on how to maximize the benefit of digital technologies in hybrid learning. It was stressed that the correct installation of the devices is important for learning delivery and that it involves several steps that technical staff needs to follow with precision.

In relation to the use of cameras, installing several camera devices allows a presenter in a virtual meeting to select the one from which image will be streamed.

The discussion subsequently focused on guidelines for creating engaging learning activities and enriched classroom interactivity in hybrid learning. Some examples include:

- Create self-evaluation tests with Google® Forms.
- Divide students in breakout rooms for group discussions. This may take place automatically, manually, or based on students' preferences.
- Create Google® Dock worksheets for supporting teamwork.
- Use Tricider®, an environment for collecting ideas on-line, assessing pros and cons, and voting.
- Use Padlet®, an environment for collecting ideas, which however does not support voting.

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- Use multiple screens to allow the simultaneous presentation of both instructor lectures and practical work, especially during computer laboratory workshops. For example:
    - Use two computers, one for teacher's presentation another for practical activities.
    - For instructors that work from home, connect a computer to the home TV; use the computer for lecture presentations and the TV for showing the participants' gallery.
    - Use a mobile phone for chats; use computers for lecture presentations.
- If the class is mostly presentation-based change views to enrich engagement; for example, use a share screen, talking head, or other format.

Some general recommendations for smooth learning delivery through hybrid models included:

- Communicate upcoming on-line sessions early, with at least 24 hours' notice.
- Ensure that students do not have on-site classes close to the on-line session, either before or after.
- Allow students enough time to find a quite space and to set-up their digital tools.
- If possible, organize several on-line sessions on the same day.
- Check internet speed, light, and audio early enough before the session to allow time for adjustments if necessary.

3rd instructor training event, October 22, 2020

A 3rd instructor training event took place at Tallinn University on October 22, 2020. 5 individuals participated in the event. The event focused on good practices for achieving effective group work on-line.

The session started by recognizing that on-line group work is particularly challenging. Some of the difficulties that educators are faced with include identifying students' previous

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knowledge, designing activities to engage students in, and establishing assessment methods.

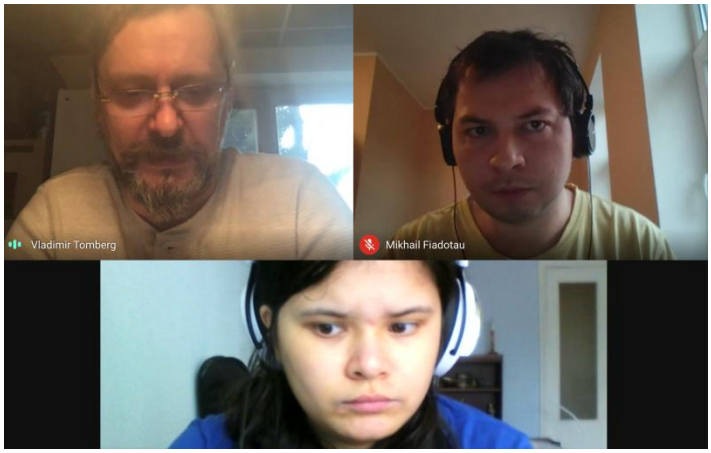

Figure 164. Educators participate in the 3rd instructor training event at Tallinn University on October 22, 2020.

Most teachers use the same methods that they use on-site for on-line sessions. They deliver 90 or 180 minute long presentations. Students loose interest after 20 minutes. To compensate for this, educators may divide their presentations into 20-minute sessions. In between presentation educators may use different types of breaks, such as short tests, question and answer sessions, and more to allow for a change of pace. Another idea is to use applications, such as Kahoot® for engaging students in responding to quizzes in a fun way, although it is not recommended that related activities be tied to the final grade; instead use more structured tools, such as Moodle® or Google® tests for this purpose.

Another good practice is using asynchronous instead of synchronous on-line sessions. For example, educators can use pre-recorded lectures that are not more than 20 minutes long. In addition, educators may allow students to create videos themselves for presenting their results to the class.

In relation to student communication during on-line sessions, educators may use tools, such as the Google® Jamboard environment, which allows the collection of ideas in small groups. Related applications are a good alternative to forums, which are not very popular with students. In hybrid environments, in which some students are on-line and some are on-site,

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discussions may be facilitated by asking all students to use the on-line environment independently of their location. Another option is to use microphones that have the capacity to capture discussions in the entire classroom for the benefit of both on-line and on-site students.

For maintaining high levels of student engagement, educators may use tools, such as a random number generator or wheel of fortune for selecting students that will deliver presentations of their results. Another idea is to use virtual environments in the form of games, such as Second Life®, through which students can communicate in on-line sessions. Furthermore, asking students to turn-on their cameras, promotes active engagement and allows the educator to observe more effectively whether students pay attention and understand content. Educators may also use platforms for making on-line card and table games, such as Roll20®, Figma®, point and click on PowerPoint®, and more.

Finally, educators should be encouraged to give more control to students. Graduate level students, and sometimes undergraduates, should be able to manage their study process. For example, an educator may allow students to decide when to watch videos and conduct tests by minimizing the duration of synchronous on-line activities and using video meetings for question-and-answer sessions only.

4th instructor training event, January 29, 2021

A 4th instructor training event took place at Tallinn University on January 29, 2021. 9 individuals attended the event.

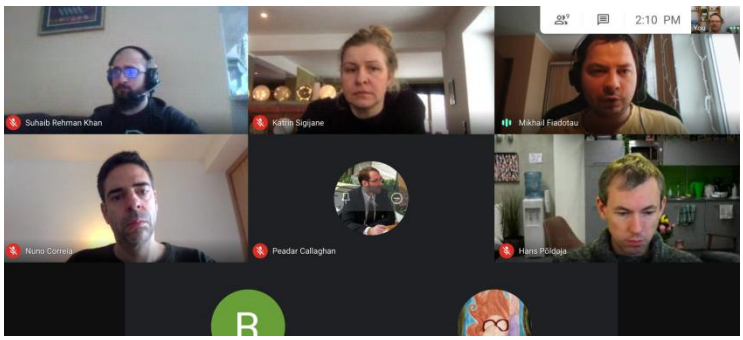

Figure 165. Educators attend the 4th instructor training event at Tallinn University on January 29, 2021.

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The event constituted a round table on engaging teaching and evaluation methods. Participants presented their personal experiences for the benefit of all attendants. The discussion focused on several aspects of teaching including the improvement of course programs, the evaluation of student team work, and the engagement of students in on-line courses. Following are some key outcomes:

Suggestions on how to improve course programmes:

- Educators may think of the course as a game and design it from the perspective of student engagement. Allow more opportunities and less risk for students.
- Carefully design grading criteria.
- Ask colleagues to evaluate a course through a standardized questionnaire for receiving objective feedback.

Suggestions on how to evaluate students' teamwork:

- Students enjoy presenting their work to peers. Provide them with opportunities to present their results.
- Team work evaluation may be organized around 4 tangents: the educator's evaluation, the client's evaluation if applicable, students' pair-assessment, and students' self-assessment.
- Allow students to collect open badges or use a pre-existing badge system, such as the one that is provided by Moodle®.
- Deploy portfolio-based evaluation by using related tools, such as DTI®.
- Avoid classic evaluation models, such as conducing an exam based on 5 articles or a book, as this does not allow educators to provide timely feedback during the semester; rather only a grade is provided at the end of the course not giving students the opportunity to exploit feedback for getting better.

Suggestions on how to engage students during on-line courses:

- Randomly pair students for each assignment.

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- Use a retro game-style meeting environment, such as the one by Gather® that supports conversation rooms, the sharing of videos, and more.
- Deploy flipped classroom learning design. Allow students to read a chapter of a book at home and start the next class with a Kahoot® based on the chapter. This allows the educator to use face-to-face time for collaborative work. This approach works best in a hybrid format; it is less meaningful in an on-line format.
- Allow students to schedule collaborative work and use face-to-face time for presentations and discussions.
- Set-up a forum and initiate open ended but specific questions.
- Use a Wiki® for collecting course-related information. Foster student engagement by gamifying the process, allowing students to earn points for posting relevant information.
- Use blogs for post-class reflection and commenting on fellow students' posts.
- At the beginning of a course co-create with all students a course contract that states learning objectives, resources, strategy, evaluation, and self-assessment.
- Allow students to create short, for example 2 minute, videos on different topics, such as self-introduction.
- Allow students to record their game playing sessions or provide a series of screen shots.

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B8. Technical University of Gabrovo

1st instructor training event, February 24, 2019

The 1st instructor training session took place on February 24, 2019. It was attended by 12 educators. The session involved delivering a presentation on the idea, partnership, objectives and products of the ALIEN project. It further involved delivering a presentation on the most common active learning techniques, such as flipped class room, jigsaw, think-pair-share, and others. Participants discussed the advantages of active teaching and learning methods and the possibilities for implementing it. Audience members participated in a team game that is based on problem-based learning activities, namely building the highest possible tower that can hold a specific weight. Finally, promotional material on the ALIEN project was distributed.

Figure 166. Educators participate in the 1st instructor training event at the University of Gabrovo on February 24, 2019.

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2nd instructor training event, July 10, 2019

The 2nd instructor training took place on July 10, 2019. Ten educators attended the event. The session involved delivering a presentation on the idea, partnership, objectives and products of the ALIEN project. It further involved a presentation on common active learning techniques, such as flipped class room, jigsaw, think-pair-share, and others that was following by a discussion on active teaching and learning methods. The audience selected problem-based cases to be developed. And finally, the audience received promotional material with the project logo, such as pens, block notes, and the project leaflet.


Figure 167. Educators participate in the 2nd instructor training event at the University of Gabrovo on July 10, 2019.

3rd instructor training event, September 13, 2019

The 3rd instructor training event was organized on September 13, 2019. It was attended by 15 educators.


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Figure 168. Educators participate in the 3rd instructor training event at the University of Gabrovo on September 13, 2019.

The event involved a presentation of the idea, partnership, objectives, and outcomes of the project, a presentation of active teaching and learning techniques and their advantages for students and educators, and distributing informational material to participants, such as pencils and block notes.

4th instructor training event, September 8, 2020

The 4th instructor training session took place September 8, 2020. Due to the COVID-19 pandemic, the event took place on-line through Microsoft® Teams. The event was attended by 7 PhD students. The event included a presentation on the idea, partnership, objectives, and outcomes of the project as well as a presentation on active teaching and learning techniques with a focus on advantages for students and educators.

Figure 169. Educators participate in the 4th instructor training event at the University of Gabrovo on September 8, 2020.

The presenter shared his own experience with the PhD students gained while developing a problem for the ALIEN problem-based learning platform, focusing on the advantages of

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active and problem-based learning techniques and their positive impact on students as he experienced it during teaching.

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B9. John Von Neumann Institute - Viet Nam National University Ho Chi Minh City

1st instructor training event on June 17, 2020

The 1st instructor training event took place on June 17, 2020 at Vietnam National University Ho Chi Minh City. The event was attended by 27 educators from 3 universities in the area of Ho Chi Minh City, namely Ho Chi Minh University of Technology, Van Lang University, and Tan Tao University. Training was delivered by Dr. Huy Nguyen, Jon Von Neumann Institute's key member in ALIEN project.

Figure 170. Educators participate in the 1st instructor training event at VNUHCM on June 17, 2020.

The event included a presentation on active learning, problem-based learning, and gamification. It further focused on applying information technology in designing active learning courses deploying gamification. The course was delivered in Vietnamese. The presentations were prepared by Dr. Huy Nguyen from the documents provided by the ALIEN project. Activities concluded with an audience discussion on the benefits of problem-based learning and gamification.

2nd instructor training event on July 8, 2020

The 2nd instructor training event took place on July 8, 2020 at Vietnam National University Ho Chi Minh City. The event was attended by 17 educators from John von Neumann Institute, University of Information Technology, Vietnam National University Ho Chi Minh

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City, University of Natural Sciences Vietnam National University Ho Chi Minh City, and Polytechnic University of Ho Chi Minh City. The training was delivered by Dr. Huy Nguyen, Jon Von Neumann Institute's key member in ALIEN project.

The content of the workshop included an introduction of the ALIEN project, its objectives, and its activities as well as an introduction of active learning, problem-based learning, and gamification. Furthermore, the event included an instruction on how to use the ALIEN digital problem-based learning platform and Kahoot® in building courses more attractive for students.

Figure 171. Educators participate in the 2nd instructor training event at VNUHCM on July 8, 2020.

During the workshop participants designed problem-based learning activities, which they published on the ALIEN digital problem-based learning platform by creating their own accounts. They further designed some Kahoot® games.

3rd instructor training event on December 5, 2020

The 3rd instructor training was held on December 5, 2020 at Ly Tu Trong College. It was attended by 42 educators from Thu Dau Mot University, Vietnam National University Ho Chi Minh City, and Ly Tu Trong College. Training was delivered by Dr. Huy Nguyen, John Von Neumann Institute's key member in ALIEN project.

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Figure 172. Educators participate in the 3rd instructor training event at Ly Tu Trong College on December 5, 2020.

During the workshop, Dr. Huy Nguyen introduced the ALIEN project and presented active and problem-based learning and their benefits. Participants discussed how to apply these methods to help students research more effectively. The session ended with suggestions on problem or capstone project development for integration into courses in the near future. Participants in this event were provided with an attendance certificate.

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Vietnam National University - Ho Chi Minh City
John von Neumann Institute

Certificate of Attendance

John von Neumann Institute certifies that

DANG THANH SANG

For attending the Course Training – Active learning, problem-based learning and Gamification

"WITHIN THE FRAMEWORK OF THE ALIEN ERASMUS+ PROJECT TO COMMUNICATIVE APPROACHES IN ACTIVE LEARNING"

given on December 05th and 19th, 2020 at Ho Chi Minh City - Vietnam

DR. NGUYEN NGOC TRUONG HUY

No.12.01/2020

Figure 173. An attendance certificate for participants in the 3rd instructor training on December 5, 2020.

4th instructor training event on December 19, 2020

The 4th instructor training event hosted by Ho Chi Minh University of Technology took place on December 19, 2020. The event was attended by 38 lecturers from Ho Chi Minh University of Technology, Vietnam, German University, and Eastern International University. Trainer at the event was Dr. Huy Nguyen, John Von Neumann Institute's key member in ALIEN project.

During the workshop Dr. Huy Nguyen introduced the ALIEN project, its objectives, and achievements at John Von Neumann Institute and Vietnam National University Ho Chi Minh City. Dr. Huy Nguyen instructed the participants how to apply the active learning method in courses using problems and games. The idea of a common inventory of problems that can be used in courses was exciting and supported by many lecturers, who recognized that a well-designed problem requires students to work in groups and combine different knowledge and skills from their curricula. Participants in this event were provided with an attendance certificate.

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Figure 174. Educators participate in the 4th instructor training event at Ho Chi Minh University of Technology on December 12, 2020.

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Vietnam National University - Ho Chi Minh City
John von Neumann Institute

Certificate of Attendance

John von Neumann Institute certifies that

DOAN XUAN SON

For attending the Course Training – Active learning, problem-based learning and Gamification

"WITHIN THE FRAMEWORK OF THE ALIEN ERASMUS+ PROJECT TO COMMUNICATIVE APPROACHES IN ACTIVE LEARNING"

given on December 05th and 19th, 2020 at Ho Chi Minh City - Vietnam

DR. NGUYEN NGOC TRUONG HUY

No. 122/2020

Figure 175. An attendance certificate for participants in the 4th instructor training on December 12, 2020.

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B10. Hanoi University

1st instructor training event, December 6, 2019

The 1st instructor training event took place on December 6, 2019. The event was attended by 20 educators from 5 universities in the area of Hanoi, namely the Hanoi Architectural University, Phuong Dong University, the Post and Telecommunication Institute of Technology, the University of Transport and Communication, and the National University of Civil Engineering. Training was delivered by Hariklia Tsalapatas, ALIEN project coordinator, Olivier Heidmann, key staff of the ALIEN project at the University of Thessaly, MSc. Dinh Thi Minh Nguyet, key staff member of project ALIEN at Hanoi University, and Ms. Do Thi Phuong Thao, key staff of the project ALIEN at Hanoi University.

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Figure 176. Educators participate in the 1st instructor training event at the University of Hanoi on December 6, 2019.

The event included a presentation on project- and problem-based learning. It further included a presentation of ALIEN project objectives, activities, and outcomes. Most importantly, the event included a workshop in which participants engaged in problem-based learning activities. Specifically, participants designed spaghetti bridges with the objective of building the strongest bridge that can withstand the highest weight. Activities concluded with an audience discussion on the benefits of problem-based learning.

2nd instructor training event, May 28, 2020

The 2nd instructor training event took place on May 28, 2020. The event was attended by 18 educators from the Faculty of Information and Technology, Hanoi University. The training was delivered by Dr. Thang Nguyen Xuan, Dean of the Faculty, key staff of the project ALIEN

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at Hanoi University and MSc. Nguyet Dinh Thi Minh, key staff member of the project ALIEN at Hanoi University.

The content of the workshops included an introduction of the ALIEN project, its objectives, and its activities as well as an introduction of problem-based learning. Furthermore, the event included a workshop on the use of the ALIEN digital problem-based learning platform.






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Figure 177. Educators participate in the 2nd instructor training event at the University of Hanoi on May 28, 2020.

During the workshop participants created teacher accounts on the platform, designed, and published problem-based learning activities.

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3rd instructor training event, October 24, 2020

The 3rd instructor training was held on October 24, 2020. It was attended by 21 educators from 5 departments of the Faculty of Information and Technology, Hanoi University. Training was delivered by Dr. Nguyen Xuan Thang, Dean of the Faculty and MSc. Dinh Thi Minh Nguyet, both of whom are key staff members of project ALIEN at Hanoi University.

Figure 178. Educators participate in the 3rd instructor training event at Hanoi University on October 24, 2020.

During the workshop Dr. Nguyen Xuan Thang introduced project ALIEN and presented active learning methods and their benefits. Msc. Dinh Thi Minh Nguyet shared experiences on active delivering learning classes and demonstrated some of the tools and techniques she has used in the past. The session ended with a discussion on effective teaching, and specifically on how to design active learning tasks for students.

4th instructor training event, December 12, 2020

The 4th instructor training event hosted by Hanoi University took place on 12 December 2020. The event was attended by 16 lecturers from all departments of the Faculty of Information and Technology, Hanoi University. Trainers at the event were Dr. Thang Nguyen Xuan, Dean of the Faculty and Msc. Thao Do Thi Phuong, key staff of the project ALIEN, both of whom are key staff for ALIEN at Hanoi University.

During the workshop Dr. Thang introduced the ALIEN project, its objectives, and achievements at Hanoi University. Dr. Thang also revealed a plan by the Faculty of

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Information Technology to apply active and problem-based learning in courses in the coming semester. MSc. Thao Do Thi Phuong shared her experiences on creating activities and problems for her courses, including Special Subject 1, Special Subject 2, and Computer Networks. Participants shared ideas on how to utilize active learning in their next courses.

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Figure 179. Educators participate in the 4th instructor training event at Hanoi University on December 12, 2020.

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B11. University of Battambang

1st instructor training event, July 16, 2019

A 1st instructor training on active learning pedagogy took place on June 19, 2019. 5 faculty members including the Acting Dean, Vice-Dean, and Department Head of the Faculty of Science and Technology participated in the event. The objective of this training was introduced them the ALIEN project, active learning, and problem-based learning to top management staff of the faculty. It also helped faculty members to introduce active and problem-based learning to the faculty's policies and regulations. The participants included: Mr. Chan Sokha, Acting Dean, Mr. Touch Manit, Vice-Dean, Mr. So Vannhoat, Vice-Dean, Mr. Horn Samath, Head of Department, Mr. Em Dara, Head of Depatment, and Mr. Lang Vuthea, lecturer.

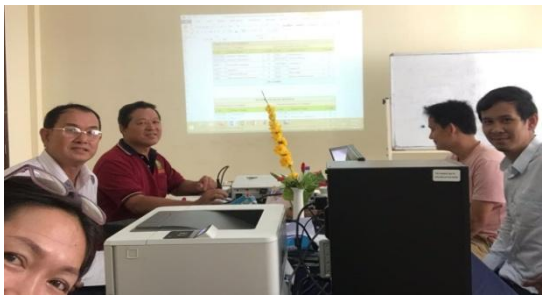


Figure 180. Top faculty members participate in the 1st instructor training event at the University of Battambang on July 16, 2019.

2nd instructor training event, January 4, 2020

A 2nd instructor training and sharing session on active learning pedagogy with top management officers from the Faculty of Science and Technology, Faculty of Business Administration and Tourism, Faculty of Arts, Humanities, and Education, Institute of Foreign Languages, Postgraduate School, and Research and Development Center took place on January 4, 2020. The objective of this training and sharing session was to share the ALIEN project's activities, professional capacity building, and best practices. Participants developed insight on the proposed active and problem-based teaching pedagogy and how it could applied in their respective faculties. Participants subsequently passed on knowledge and

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information acquired through this training to their lecturers and students. Approximately 20 individuals participated in the event.

Figure 181. Educators participate in the 2nd instructor training event at the University of Battambang on January 4, 2020.

3rd instructor training event, April 18, 2020

A 3rd instructor training and sharing session on active and problem-based learning took place on April 18, 2020. The objective of this training was to develop skills among participants on designing active and problem-based learning activities in their course syllabuses and integrating them into teaching practices. Dr. Sam Rany, Mr. Tieng Morin, and Mr. Yoeng Hak, who attended the fourth ALIEN meetings at Hanio University, have shared their knowledge and experiences for the participants. 8 lecturers attended the training.

Figure 182. Educators participate in the 3rd instructor training event at the University of Battambang on April 18, 2020.

Joint instructor training event by the Institute of Technology Cambodia, University of Battambang, and Mean Chey University, June 10, 2021

A joint instructor training event was organized on June 10, 2021 by the University of Battambang, Mean Chey University, and Institute of Technology Cambodia. The objective of the event, which took place virtually, was to share new teaching methods and best practices to new instructors and lecturers at 3 ALIEN Cambodian university partners. More

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specifically, the event focused on active and problem-based learning n higher education provided practical information on integrating these methodologies in learning towards increasing the efficiency of teaching methods.

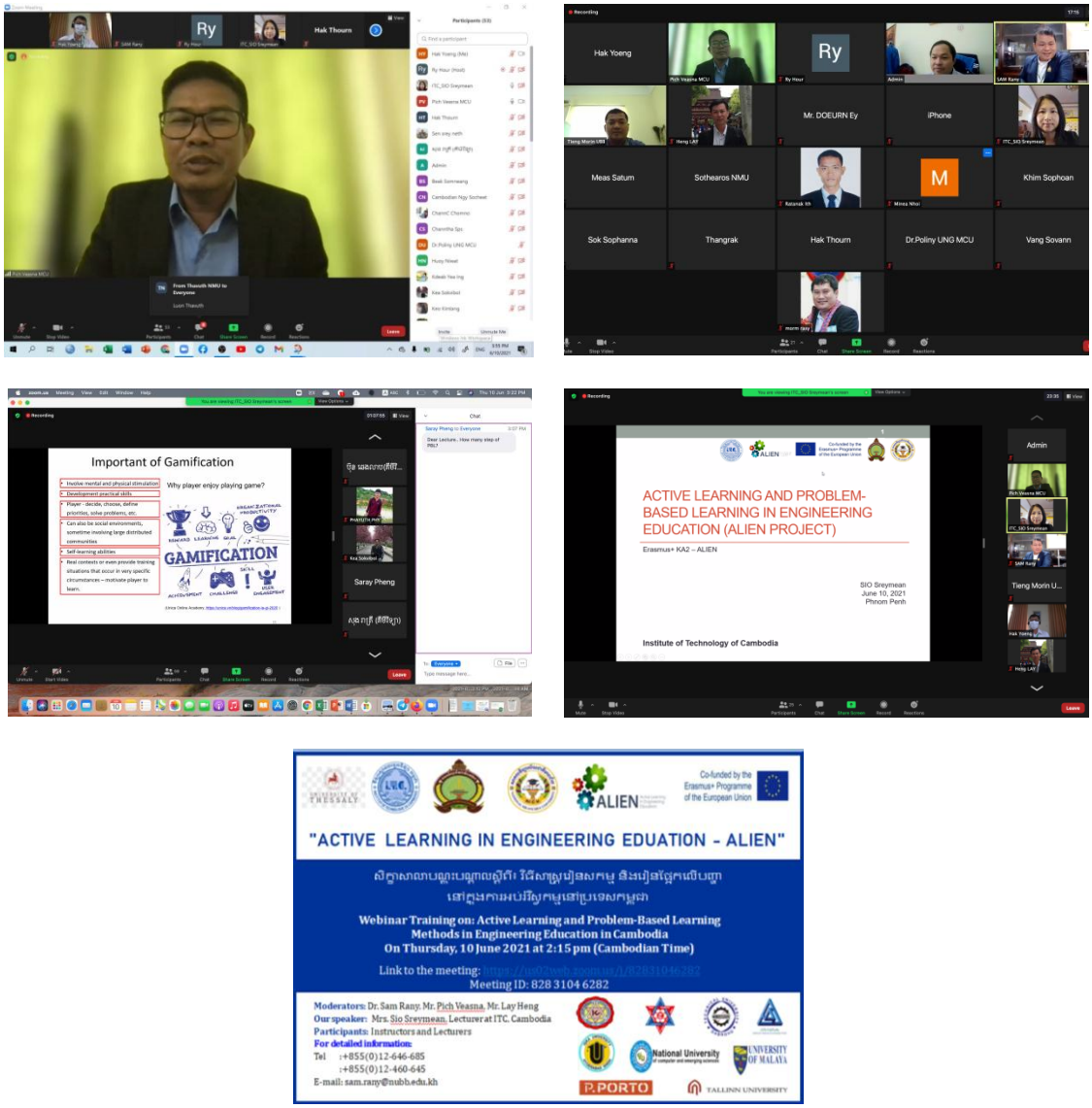

Figure 183. Educators participate in the joint training event organized by the University of Battambang, Mean Chey University, and Institute of Technology Cambodia on June 10, 2021.

Moderators of the event were Dr. Sam Rany from the University of Battambang, Mr. Pich Veasna from Mean Chey University, Mr. Lay Heng from Institute of Technology Cambodia. The main speaker of the event was Ms. Sio Sreymean, lecturer at the Institute of Technology Cambodia. 60 individuals participated in the event.

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B12. Institute of Technology of Cambodia

1st instructor training event, September 20 - 21, 2018

The 1st instructor training event took place on September 20 - 21, 2018. The title of the event was "Active Learning and Professional Development Stage 1". The workshop aimed at introducing emerging teaching methodologies and professional development toolkits to educators at the Institute of Technology Cambodia. The workshop was attended by 15 participants.

Figure 184. Educators participate on the 1st instructor training event at the Institute of Technology Cambodia on September 20 - 21, 2018.

The content of the training included participatory learning, work readiness skills, learner center assessment, facilitation skills, instructional design, and blended learning.

2nd instructor training event, December 22 - 23, 2018

The 2nd instructor training event took place on December 22 - 23, 2018. The event was titled "Active Learning and Professional Development Stage 2". This workshop was a continuation

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of the 1st event that took place in September. The event was attended by 11 educators from the Institute of Technology Cambodia.

Figure 185. Educators participate in the 2nd instructor training event at the Institute of Technology Cambodia on December 22 - 23, 2018.

Lecturers shared their experience in implementing active learning and professional development toolkits in their classroom. Furthermore, participants provided feedback with the objective of improving each other's teaching capacity.

3rd instructor training event, September 24, 2020

The 3rd instructor training event took place on February 24, 2020. It was a full-day training workshop on active and problem-based learning. The event was attended by 30 educators from 5 different faculties.

The training aimed at improving the teaching and learning approaches at the Institute of Technology Cambodia by encouraging instructors to apply active and problem-based learning in their classroom. Various tools and platforms were introduced to assist instructors

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in designing class activities. ALIEN project participants shared their knowledge on deploying active and problem-based learning, including the ALIEN digital problem-based learning platform, Kahoot®, which is a digital tool that makes learning fun, and Google Classroom®, which is a virtual on-line learning environment.

In addition, to demonstrate how problem-based learning works, participants engaged in a workshop in which they competed in group towards building the strongest spaghetti bridge.




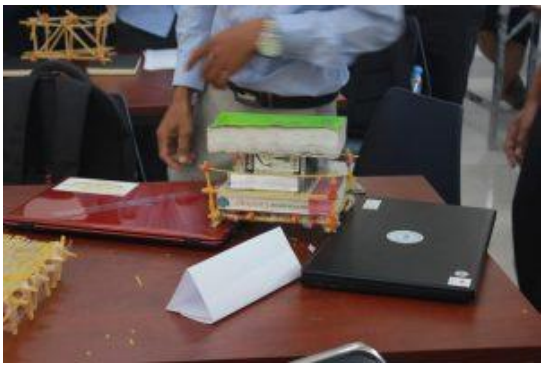


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Figure 186. Educators participate in the 3rd instructor training event at the Institute of Technology Cambodia on September 24, 2020.

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B13. Meanchey University

1st instructor training event, May 12 - 13, 2020

The 1st instructor training event took place on May 12 - 13, 2020. The event focused on diverse active learning methods that instructors may deploy in their teaching, such as using quizzes through the learning session, using student centered methods, applying theory in practice in the ALIEN problem-based learning laboratory. The event was attended by 16 lecturers. The event took place in the ALIEN problem-based learning laboratory.

Figure 187. Educators attend the 1st instructor training event at Meanchey University on May 12 - 13, 2020.

2nd instructor training event, July 7 - 8, 2020

The 2nd instructor training event took place on July 7 - 8, 2020. The event focused on active learning, and more specifically on designing a new tool kit of practical activities. It was

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attended by 11 lecturers. The event further focused on sharing experiences and teaching practices among educators from different faculties of Meanchey University. Prior to the event, the participating lecturers primarily deployed traditional, lecture-based instruction. The event helped lecturers integrate active approaches in their instruction. Participants discussed ways for improving student group work and building student self-confidence. The event took place in the ALIEN problem-based learning laboratory.

Figure 188. Educators participate in the 2nd instructor training event at Meanchey University on July 7 - 8, 2020.

3rd instructor training event, October 23, 2020

The 3rd instructor training event took place on October 23, October, 2020. The event lasted an entire day. Participants engaged in active and problem-based learning activities. The event was attended by 12 individuals from different faculties of Meanchey University. 5 of them attended the training in the ALIEN problem-based learning laboratory and 7 attended virtually due to COVID-19 restrictions.

The event aimed at improving the participants' teaching through active learning best practices. There was a focus on on-line teaching due to the volatile situation as a result of COVID-19. The participants were encouraged to find different ways for delivering instruction on-line. They were encouraged to use Google® Classroom, on-line assignments, and follow-up on student work. Lecturers exchanged their experiences. They discussed how they designed problems, encouraging students to solve them. Some of the participants had very little experience on on-line instruction. After the completion of the training they were in a better position to use on-line tools for sharing documents with students as well as

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platforms, such as Zoom® and Google® Meet. The event took place in the ALIEN problem-based learning laboratory.

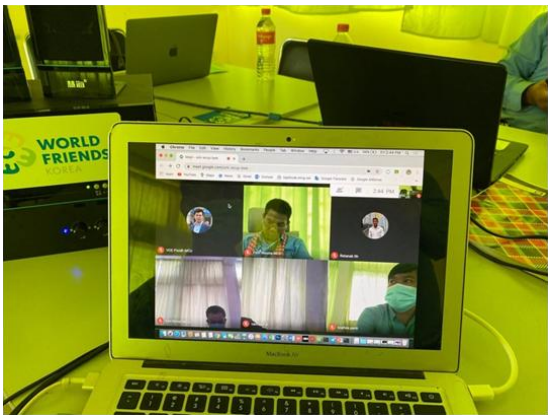

Figure 189. Educators participate in the 3rd instructor training event at Meanchey University on October 23, 2020.

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B14. Tribhuvan University

1st instructor training event, December 15, 2019

The inauguration of the ALIEN problem-based learning laboratory and introductory training was held on December 15, 2019 at the Centre for Energy Studies, Institute of Engineering. The Dean of the Institute of Engineering, Tribhuvan University Prof. Ram Chandra Sapkota was the Chief Guest of the event. The event was attended by 18 participants including invited officials and faculty members. The main aim of the program was to provide information on the ALIEN project and as well as to introduce the newly established facilities of the problem-based learning laboratory that was funded by ALIEN. The event was coordinated by Dr. Shree Raj Shakya, Director of Centre for Energy Studies.


Figure 190. Educators participate in the 2st instructor training event at Tribhuvan University on December 15, 2019.

2nd and 3rd Instructor training event, March 2, 2021

On March 2, 2021 the Centre for Energy Studies, Institute of Engineering held 2 training sessions. The 1st focused on the support, maintenance, and troubleshooting of the problem-based learning laboratory developed through the ALIEN project. The 2nd focused on the use of the laboratory for active learning. The event was attended by 8 participants from different departments of the university who actively deploy problem-based learning approaches in their instruction.

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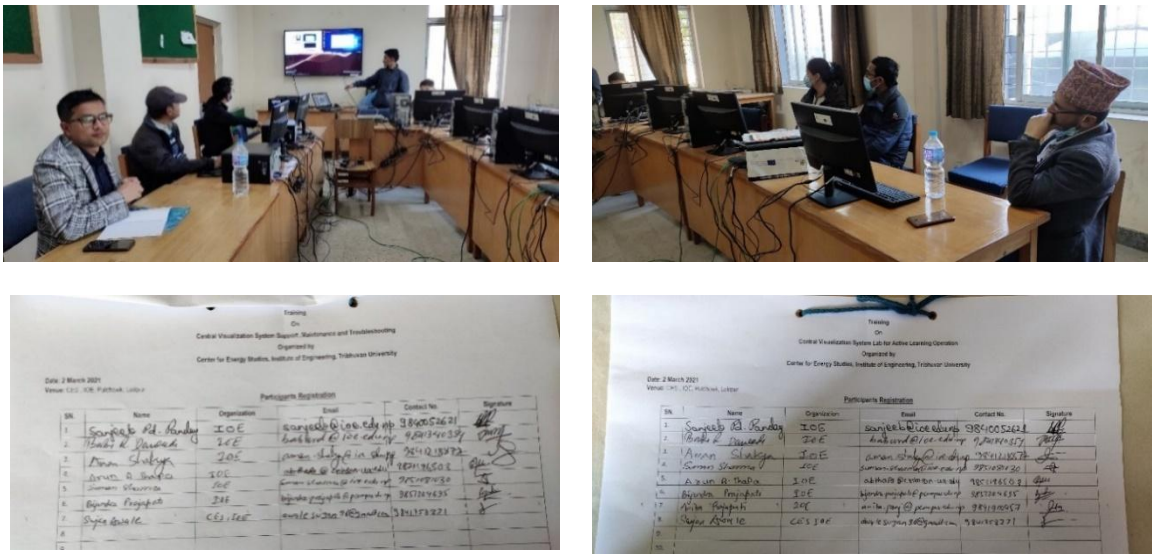

Figure 191. Educators participate in the 2nd and 3rd instructor training events at Tribhuvan University on March 2, 2021.

4th Instructor training event, March 10, 2021

A 4th instructor training event was held on March 10, 2021. The event focused on how use the ALIEN problem-based laboratory hardware and software in problem-based and active learning in various courses in the Institute of Engineering, Tribhuvan University.

Demonstrations and hands-on practice were conducted in groups in multiple workstations in the laboratory space. A number of presentations were also delivered. The event was attended by 20 participants, including instructors and teaching assistants mainly from the department of Electronics and Computer Engineering of the Pulchowk Campus, Institute of Engineering, Tribhuvan University.

Figure 192. Educators participate in the 4th instructor training event at Tribhuvan University on March 10, 2021.

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5nd instructor training event, March 19, 2021

A 5th training event took place at the Centre for Energy Studies, Institute of Engineering, Tribhuvan University. It was attended by 9 educators from engineering disciplines. Dr. Aman Shakya from the Department of Electronics and Computer Engineering, Pulchowk Campus conducted the training.

The training was on the deployment of simulation games in learning. Simulation games have been used as part of authentic assessment in Engineering Education in many academic institutions. The training demonstrated the benefits of simulation games on developing knowledge and skills among students that can be replicated in the field. Instructors further shared their experience on the deployment of simulation games as assessment tools in professional activities.

Figure 193. Educators participate in the 5th instructor training event at Tribhuvan University on March 19, 2021.

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Figure 194

B15. Kathmandu University

1st instructor training event, June 21, 2020

The 1st instructor training event was held on June 21, 2020 at the School of Science and School of Engineering. The event highlighted the fact that due to the global pandemic of COVID-19, education is one of the major fields which are affected. Physical classroom discussions and physical meetings for teaching learning activities are not possible due to possibility of transmission of the virus. For the effective semester level education, it is essential to intact the academic calendars. Online education is the only option to make the academic calendar intact, where students get involved in their regular academic activities residing in different geographical locations.

Department of Computer Science and Engineering and Active Learning Lab Member Mr. Sameer Tamrakar conducted a session on "Getting Started with on-line classroom" for the instructors and academicians to be familiar with different options that can be used as an option for taking on-line classes using active learning modality.

The program was attended by 60 participants from the School of Science and the School of Engineering, Kathmandu University.

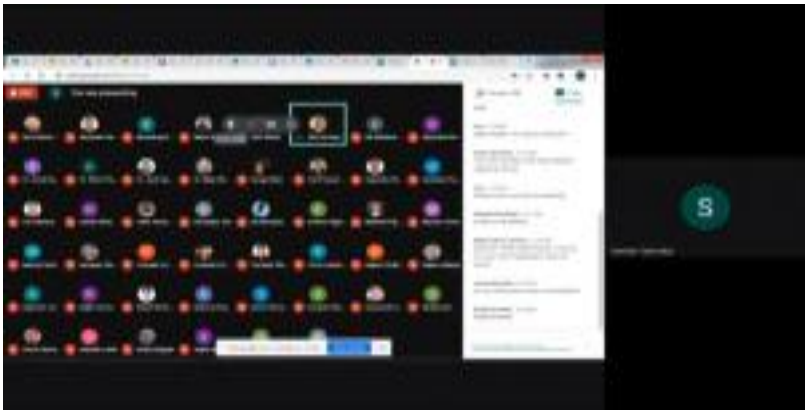

Figure 195. Educators participate in the 1st instructor training event at the University of Kathmandu on June 21, 2020.

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2nd instructor training event, September 10, 2020

The 2nd instructor training event was held on September 10, 2020 at the School of Science and the School of Engineering. The training session was conducted for the instructors and academicians to take on-line evaluation and assessment of their students. The session was dedicated to familiarizing the audience with different options that can be used for the on-line evaluation of students. The program was attended by 40 participants from the School of Science and the School of Engineering, Kathmandu University.

The training program was conducted by Mr. Sameer Tamrakar, Active Learning Lab Member and Mr. Manish Joshi from Department of Computer Science and Engineering Conducted the Training Program.

Figure 196. Educators participate in the 2nd instructor training event at the University of Kathmandu on September 10, 2020.

3rd instructor training event, February 19, 2021

The Department of Computer Science and Engineering and Active Learning Lab conducted a workshop on active learning for science on February 19, 2021. The workshop was attended by 19 faculty members from different departments of the School of Science. The workshop focused on how the concept of active learning can be implemented in regular classes.

The workshop started with the opening remarks from Dr. Bal Krishna Bal, HOD from the Department of Computer Science and Engineering. He highlighted the importance of active learning in today's learning and encouraged the participant faculties to use the resources

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provided by the ALIEN Active Learning Lab and make the students learning process more effective. Prof. Dr. Manish Pokharel, PI, Active Learning in Engineering Education project (ALIEN), discussed the project and the importance of problem-based learning in 21st century learning.

The 1st session of the workshop was delivered by Prof. Dr Deepak Prasad Subedi from the Department of Physics. He highlighted the importance of active learning in today's education and focused on how the use of Active Learning can turn traditional classes into interactive ones where students get more involved in their learning. He also shared his experiences from working as UNESCO Active Learning Training facilitator. He showed good examples of how learning and fun can be carried out simultaneously.

The 2nd session was delivered by Mr. Dhiraj Shrestha, CO-PI, ALIEN. He discussed the resources available in the ALIEN Active Learning Lab, presented its set-up, and discussed how the set-up can be used for conducting the courses in using problem-based learning modality. Then he described the ALIEN problem-based learning platform that is used by 17 universities in Asia and Europe and presented its benefits by demonstrating its functionality.

The final session was delivered by Mr. Sushil Shrestha, Mr. Sameer Tamrakar and Mr. Satyendranath Lohani. In this session, the participants were divided into 4 groups. Each group was asked to create and publish a problem on the ALIEN problem-based learning platform.

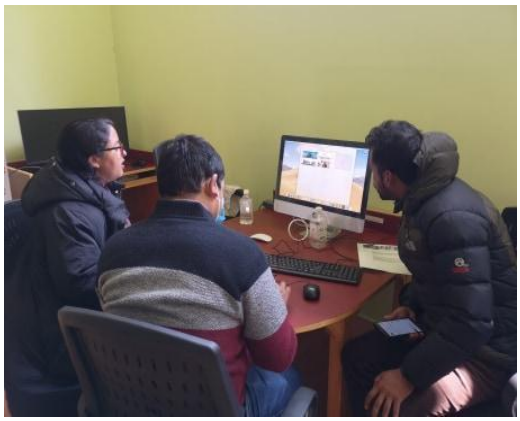

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Figure 197. Participants collaborate during the 3rd training session by Kathmandu University on February 19, 2021.

4th instructor training event, February 21, 2021

The Department of Computer Science and Engineering and the ALIEN Active Learning Lab delivered a workshop on active learning in engineering on February 21, 2021. The workshop was attended by 17 faculty members from different departments of the School of Engineering. The workshop focused on how the concept of active learning can be implemented in regular classes.

The workshop started with the opening remarks from Dr. Bal Krishna Bal, HOD Department of Computer Science and Engineering. He highlighted the importance of active learning in today's learning for engineering students and encouraged the participants to use the resources provided by the ALIEN Active Learning Lab to increase the effectiveness of the student learning process.

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The 1st session of the workshop was delivered by Prof. Dr Manish Pokharel from Department of Computer Science and Engineering. He highlighted the importance of active learning in 21st century learning. He discussed how the importance of problem-based learning has increased after COVID-19.

The 2nd session was delivered by Mr. Dhiraj Shrestha, CO-PI, ALIEN. He discussed the resources available in the ALIEN Active Learning Lab, presented its set-up, and discussed how the set-up can be used for conducting the courses in using problem-based learning. Then he described the ALIEN problem-based learning platform that is used by 17 universities in Asia and Europe and presented its benefits by demonstrating its functionality.

The final session was delivered by Mr. Sushil Shrestha, Mr. Sameer Tamrakar, and Mr. Satyendranath Lohani. In this session, participants were divided into 4 groups and each group was asked to create and publish a problem on the ALIEN problem-based learning platform.

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Figure 198. Participants collaborate during the 4th training session by Kathmandu University on February 21, 2021.

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B16. National University of Computer and Emerging Sciences

1st instructor training event, March 2, 2020

The National University of Computer and Emerging Sciences conducted the 1st instructor training event on March 2, 2020. The topic of the instructor training was "Game Design Principles". Due to COVID-19 restrictions, the training was conducted virtually through Google® meet.

The training was delivered by Dr. Irum Inayat, Associate Professor at the School of Computer Sciences, NUCES. She was assisted by Hassan and Tabasum Fatima in preparing the material and coordinating the session. A total 75 individuals participated in this on-line training. The participants were lecturers, laboratory instructors, and graduate students from multiple universities from Islamabad and other cities. The training was well received by game-design enthusiasts. The training focused on design principles of games in general as well as the specifics of serious games.

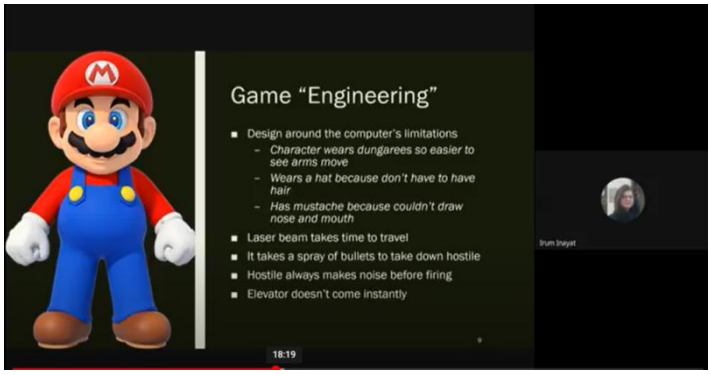

Figure 199. Screenshot of the first instructor training event conducted by NUCES on March 2, 2020.

2nd instructor training event, June 13, 2020

The National University of Computer and Emerging Sciences conducted a 2nd instructor training event on June 13, 2020. The topic of the instructor training was "Problem-Based Learning in Software Engineering Education". Due to COVID-19 restrictions, the training was conducted virtually through Zoom®.

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The training was delivered by Dr. Irum Inayat, Associate Professor at the School of Computer Science, NUCES. She was assisted by Hassan and Tabasum Fatima in preparing the material and coordinating the session. A total of 19 participants participated in this on-line training. Participants were lecturers and graduate students of the National University of Future and Emerging Sciences. The training focused on the use of problem-based learning in software engineering education. Specifically, the event focused on problem design and execution in the class and on how specific software engineering material that can be transformed into problems. During the training, software engineering related problems were published on the ALIEN problem-based learning platform and were demonstrated as examples.

Figure 200. Screenshot of the second instructor training event conducted by NUCES on June 13, 2020.

3rd instructor training event, October 14, 2020

The National University of Computer and Emerging Sciences conducted a 3rd instructor training event on October 14, 2020. The topic of the instructor training was "Game Design Principles". Due to COVID-19 restrictions, the training was conducted virtually through Google® meet.

The training was delivered by Dr. Irum Inayat, Associate Professor at the School of Computer Science, NUCES. She was assisted by Hassan and Tabasum Fatima in preparing the material and coordinating the session. A total of 63 participants participated in this on-line training. Participants were lecturers, laboratory instructors, graduate, and undergraduate students from multiple universities from Islamabad and other cities. The training was well received by

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game-design enthusiasts. The training focused on design principles of games in general as well as the specifics of serious games. The design principles were demonstrated through practical examples on existing games. The participants were engaged in small, hands-on tasks during the training session.

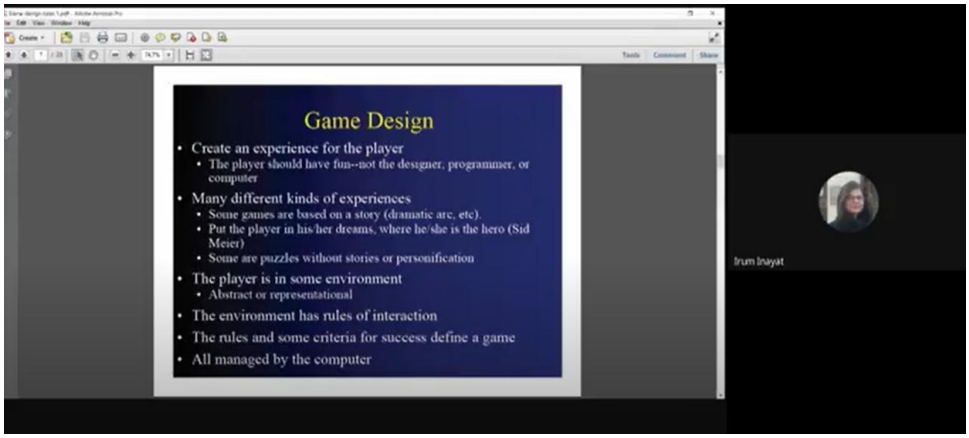

Figure 201. Screenshot of the 3rd instructor training event conducted by NUCES on October 14, 2020.

4th instructor training event, November 4, 2020

The National University of Computer and Emerging Sciences conducted the 4th instructor training event on November 4, 2020. The topic of the instructor training was topic "Active Learning in Software Engineering Education". Due to COVID-19 restrictions, the training was conducted on-line through Zoom®.

The training was delivered by Dr. Irum Inayat, Associate Professor at the School of Computer Science, National University of Future and Emerging Sciences. She was assisted by Hassan and Tabasum Fatima in preparing the material and coordinating the session. A total of 80 participants participated in this on-line training. Participants were lecturers and graduate students at the National University of Future and Emerging Sciences. The event focused on the basic theory of active learning, which includes active, collaborative, and cooperative learning, as well as the use of problem-based learning in software engineering education. The focus remained on problem design and execution in the class. During the training,

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software engineering-related problems were published on the ALIEN problem-based learning platform and were demonstrated as examples.

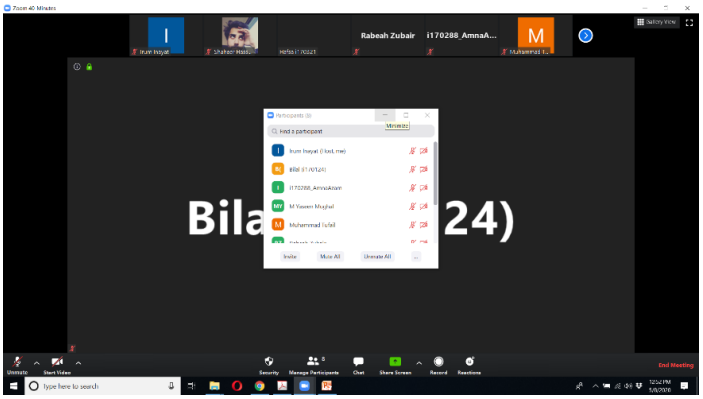

Figure 202. A screenshot from the 4th instructor training event conducted by NUCES on November 4, 2020.

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B17. Hanoi University of Science and Technology

1st instructor training event, October 12, 2020

The 1st instructor training event was hosted on October 12, 2020. The event was attended by 25 individuals, all of whom were educators and researchers at the Department of Computer Science and Department of Communications and Computer Networks, School of Information and Communication Technology, Hanoi University of Science and Technology. It was further attended by educators from other universities working towards their PhD degree at the Department of Computer Science and the Department of Communications and Computer Networks.

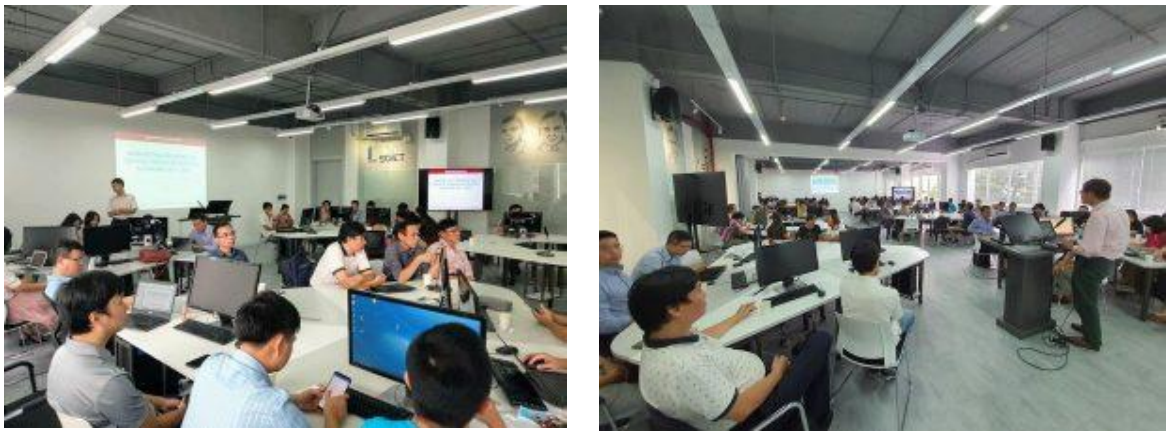

Figure 203. Educators participate in the 1st instructor training event at Hanoi University of Science and Technology on October 12, 2020.

Trainers at the event were Prof. Huynh Thi Thanh Binh, Vice Dean of School of Information and Communication Technology, Hanoi University of Science and Technology and coordinator of ALIEN project at the Hanoi University of Science and Technology, Prof. Nguyen Linh Giang, Head of Department of Communications and Computer Networks, and Dr. Pham Dang Hai, Head of Department of Computer Science.

The main activities of the event included an introduction by Dr. Vu Van Thieu of project ALIEN and the ALIEN problem-based learning laboratory. In addition, the event included a presentation of Dr. Vu Van Thieu on active and problem-based learning design. Furthermore, the event included a presentation by Prof. Nguyen Linh Giang on the syllabus

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of the engineering program in the Communication and Computer Networks major and a presentation by Dr. Pham Dang Hai on the syllabus of the engineering program in the Computer Science major. Finally, educators and researchers discussed good practices on the design and deployment of problem-based learning activities.

2nd instructor training event, September 9, 2020

The 2nd instructor training event took place on September 9, 2020. The event was attended 30 individuals, all of whom were educators and researchers at the Department of Computer Science and Department of Communications and Computer Networks, School of Information and Communication Technology, Hanoi University of Science and Technology. It was further attended by educators from other universities working towards their PhD degree at the Department of Computer Science and the Department of Communications and Computer Networks.

Figure 204. Educators participate in the 2nd instructor training event at Hanoi University of Science and Technology on September 9, 2020.

Trainers at the event were Dr. Vu Van Thieu, Department of Computer Science, a key member of the ALIEN project at Hanoi University of Science and Technology, Dr. Nguyen Thanh Hung, Vice Dean of School of Information and Communication Technology, Hanoi University of Science and Technology, a key member of the ALIEN project at Hanoi University of Science and Technology, Dr. Nguyen Binh Minh, Head of Department of Information Systems.

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The main activities of the event included a presentation by Prof. Huynh Thi Thanh Binh on project ALIEN, the ALIEN problem-based learning laboratory, and active and problem-based learning design. The activities included a presentation by Prof. Nguyen Thanh Hung of the syllabus of the engineering program in the Software Engineering major and a presentation by Prof. Nguyen Binh Minh on the syllabus of engineering program in the Information Systems major. Finally, educators and researchers discussed good practices on the design and deployment of problem-based learning activities.

3rd instructor training event, October 1, 2020

The 3rd instructor training event took place on October 1, 2020. The event was attended by 30 individuals, all of whom were educators and researchers from the School of Information and Communication Technology, Hanoi University of Science and Technology.

Figure 205. Educators participate in the 3rd instructor training event at Hanoi University of Science and Technology on October 1, 2020.

Trainers at the event were Prof. Ta Hai Tung, Dean of School of Information and Communication Technology, Hanoi University of Science and Technology, Prof. Cao Tuan Dung, Vice Dean of School of Information and Communication Technology, Hanoi University of Science and Technology, and Prof. Huynh Thi Thanh Binh, Vice Dean of School of Information and Communication Technology, Hanoi University of Science and Technology, coordinator of the ALIEN project at Hanoi University of Science and Technology.

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The main activities of the event included a presentation by Prof. Ta Hai Tung on the strategy of Hanoi University of Science and Technology for curriculum improvement towards enhancing student autonomy. Prof. Ta Hai Tung further discussed the increase in the number of subjects that deploy problem-based learning design. Prof. Huynh Thi Thanh Binh introduced the ALIEN project and the ALIEN problem-based learning laboratory. She further discussed active and problem-based learning design. Prof. Cao Tuan Dung introduced the syllabus of the new curriculum, in which many courses deploy active and problem-based learning methods. Finally, educators and researchers discussed good practices on and implementing and applying problem-based learning.

4th instructor training event, October 10, 2020

The 4th instructor training event took place on October 20, 2020. The event was attended by all teachers and researchers from the Faculty of Mathematics, Mechanics, and Informatics at the University of Science, Hanoi National University.

Figure 206. Educators participate in the 4th instructor training event at Hanoi University of Science and Technology on October 10, 2020.

Trainer at the event was Prof. Huynh Thi Thanh Binh, Vice Dean of School of Information and Communication Technology, Hanoi University of Science and Technology, coordinator of the ALIEN project at Hanoi University of Science and Technology.

During the event Prof. Huynh Thi Thanh Binh introduced the ALIEN project as well as active and problem-based learning design. Educators and researchers discussed good practices on

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applying active and problem-based learning. Furthermore, they discussed methods for designing courses that are based on problem-based learning approaches.

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PART C. QUESTIONNAIRE-BASED EVALUATION

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C0. Introduction

Project ALIEN implemented a questionnaire-based evaluation in which students were asked to provide their feedback on their experience of participating in courses in which the ALIEN active learning intervention, including the physical laboratories and the digital problem-based learning platform and content, were deployed.

As of April 13, 2021 the questionnaire had been filled-in by 494 individuals at all partner sites as demonstrated by the following figure. The goal was to collect 20 responses from each partner organization, which was mostly achieved, although some partners collected a number that was significantly higher.

The participants in the evaluation were students that enrolled in the courses described above in this report.

C1. ALIEN questionnaire-based student evaluation

Following is a presentation of the participant responses to each of the questionnaire questions. As demonstrated in the following figure, the total number of responses received was exactly 494 as of April 13, 2021. This number increased to exactly 500 on June 2, 2021.

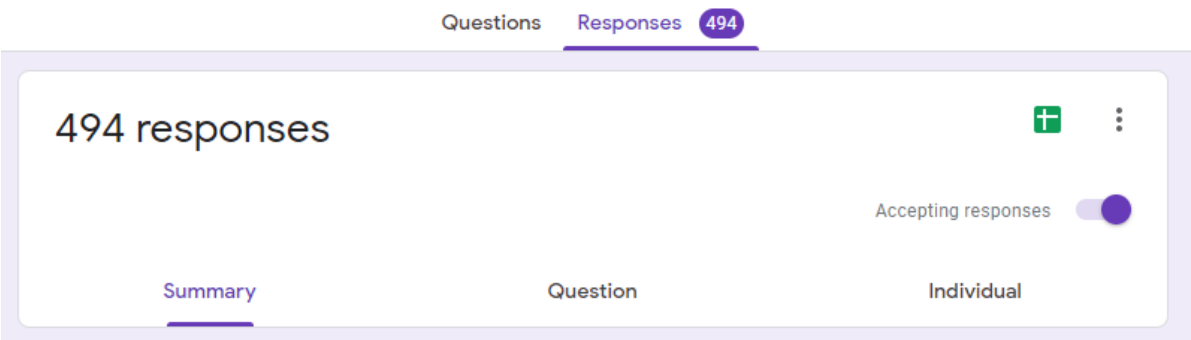

Figure 207. 494 individuals had responded to the ALIEN evaluation questionnaire as of April 13, 2021.

Question 1: What country are you located in?

The first question documents the country of origin of the responder for statistical purposes.

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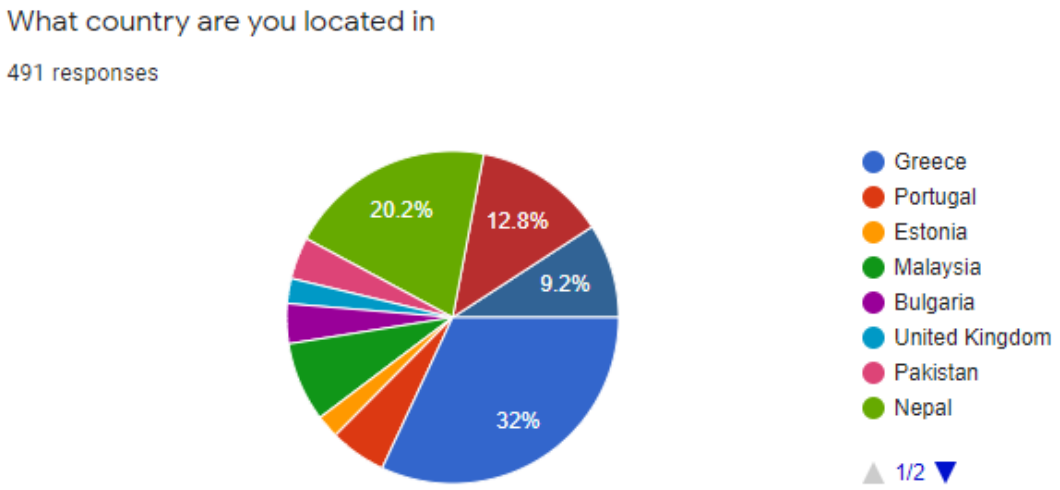

Figure 208. Question 1: What country are you located in?

Question 2: Problem-based learning helps build engineering skills.

Participants responded on a scale of 1 to 5, with 5 being the highest or most favourable response. As the following figure shows, the vast majority of participants responded that problem-based learning helps or greatly helps in engineering education, having responded 3 or higher. This demonstrates that project methodologies are perceived as relevant in engineering education by participants.

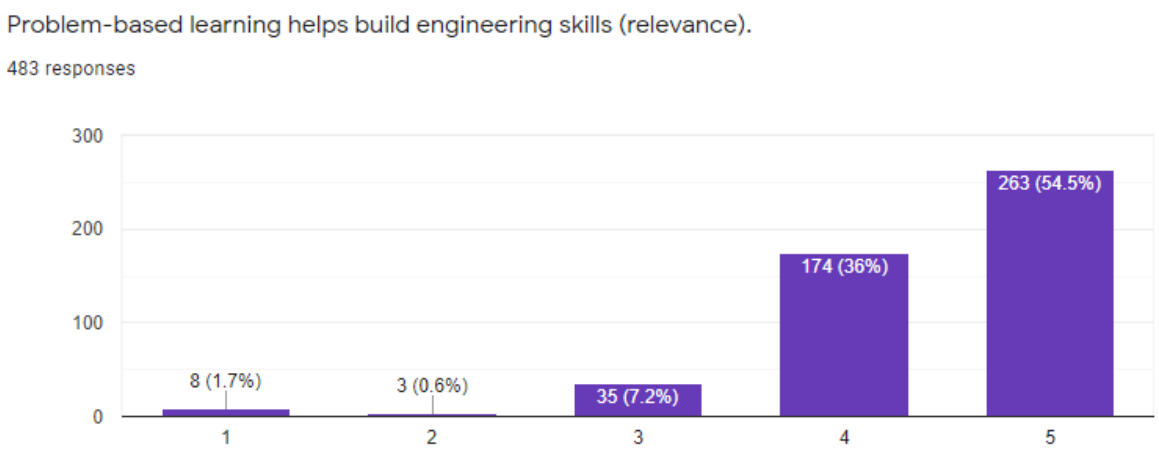

Figure 209. Problem-based learning helps build engineering skills.

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Question 3: Please comment on your answer above.

285 responses were received to this question. Overwhelmingly, students commented that problem-based learning is relevant in engineering education, which is inherently an active learning activity. This is demonstrated in the comments below:

"Engineering is inherently a problem-solving activity. Problem-based learning builds the skills and competences needed for addressing the challenges of the 21st century".

"Problem-based learning helps in the deeper understanding of concepts and contributes to experiential learning for engineers".

"Especially in engineering, students must learn to be good at solving problems".

"In a great extent problem based learning helps with engineering skills as it supports creativity, critical thinking and the ability to judge a situation a based on your advantages".

"Engineering is based on solving problems so incorporating problem solving exercises in the curriculum helps familiarize the student with this kind of thinking".

Some students highlighted the fact that while active learning is positive in engineering education in some subjects, such as mathematics, theoretical learning based on traditional methods is also important:

"I believe that some subjects can benefit from it e.g. programming, but others like mathematics should focus on just teaching the essentials using the traditional approach".

"I do agree that problem based learning helps build engineering skills. But still I cannot totally agree on that because facts and concepts are also important in building engineering skills".

This demonstrates that problem-based and active learning can be integrated into existing educational practices, enriching student experiences.

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Question 4: The ALIEN platform helps build problem-solving skills.

Participants responded on a scale of 1 to 5, with 5 being the most favourable response. As the following figure shows, the vast majority of participants responded that problem-based learning helps or greatly helps in engineering education, having responded 3 or higher, while approximately 4 out of 5 students highly agreed with the positive impact of the ALIEN learning intervention.

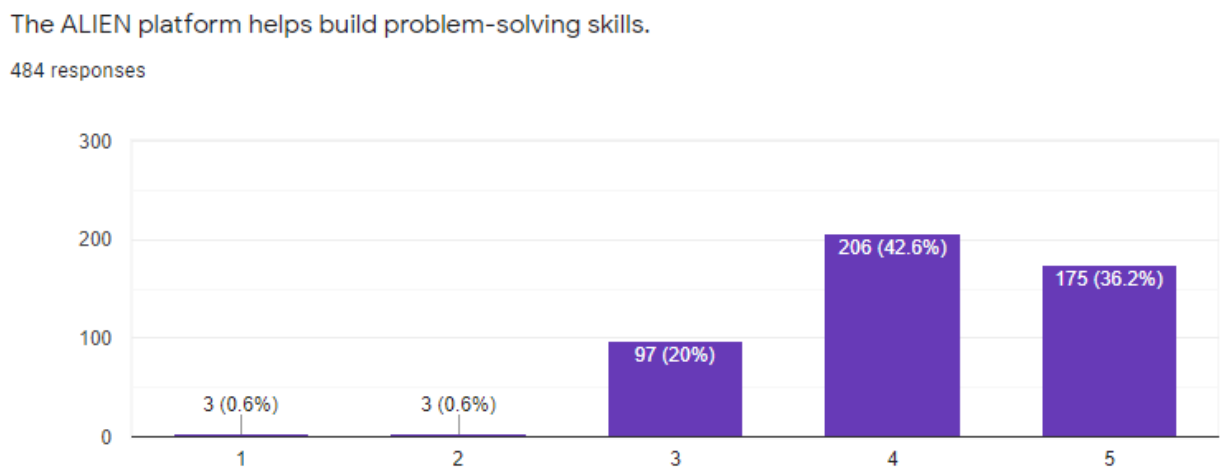

Figure 210. The ALIEN platform helps build problem-solving skills.

Question 5: Please comment on your answer above.

262 responses were received to this question. Some of the responses follow:

"Yes it is really good for helping students improved their skill and research".

"ALIEN provides interaction to real-world problems like Spotify® artist manager, coding defence, interactive calculator and much more. Because of this it helps build problem-solving skills".

"Yes because it promotes student collaboration in active and problem-based learning contexts towards developing problem-solving capacity".

"Lots of tools the platform have help us understand how to solving problems".

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"The ALIEN platform provides a wealth of educational activities that help build problem-solving skills".

"Having a great array of people posting about problems, gives students the chance to solve even more problems helping them with all of their solving skills".

"Dealing with these problems presented in the ALIEN platform the student inevitably develops problem solving skills because he is forced to think in an effective way".

"Alien platform provides great help for students to gain PBL skills. There are interesting problems and articles for every taste".

"ALIEN platform focuses on collaborative and training based approach to build problem solving skills. This is of great help as in order to improve our problem solving skills, it is important to continuously learn from others and improve our knowledge and skills".

"Engineering is one of the fastest changing fields that can benefit from active learning. Engineering involves or even better yet is (!), the art of solving problems, and since the ALIEN platform provides active learning methods, we strongly agree".

Question 6: Digital games and simulations increase interactivity in the classroom.

Participants responded on a scale of 1 to 5, with 5 being the most favourable response. As the following figure shows, the vast majority of participants responded that digital games and simulations are beneficial in engineering active learning, having responded 3 or higher, while approximately 4.5 out of 5 students highly agreed with the positive impact of games and simulations in learning.

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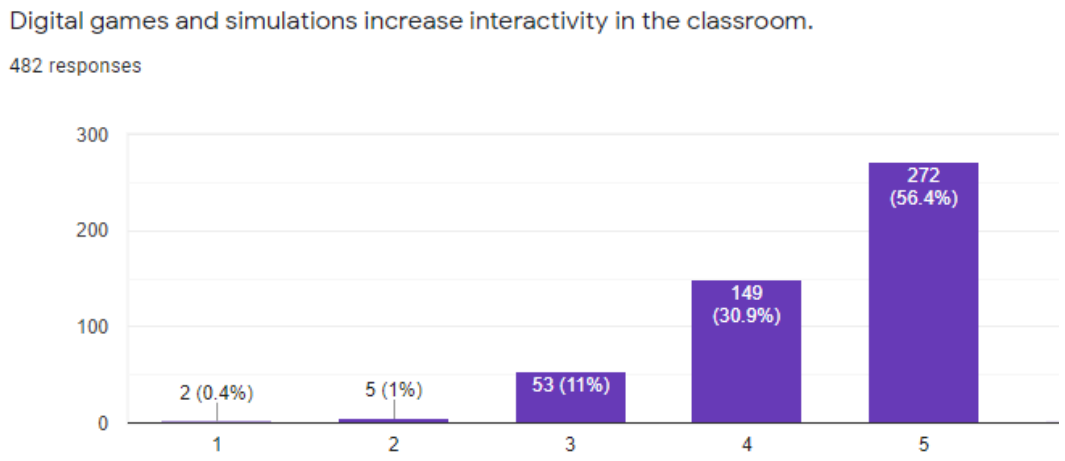

Figure 211. Games and simulations increase interactivity in the classroom.

Question 7: I would like to use this platform frequently.

Participants responded on a scale of 1 to 5, with 5 being the most favourable response. As the following figure shows, the vast majority of participants responded that they would like to use the ALIEN platform frequently, having responded 3 or higher, while approximately 3 out of 4 students highly agreed.

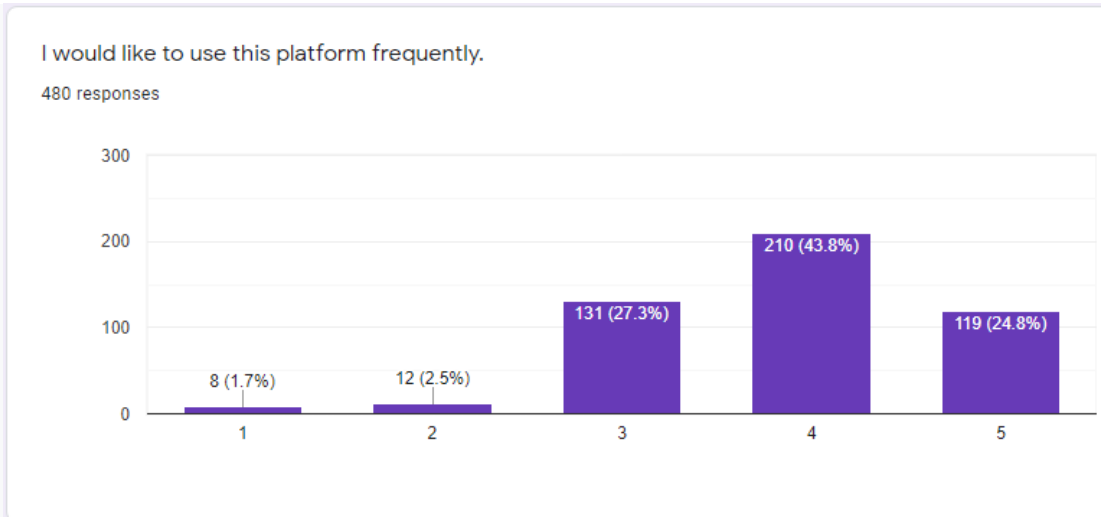

Figure 212. Question 7: I would like to use this platform frequently.

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Question 8: I found the platform easy to use.

Participants responded on a scale of 1 to 5, with 5 being the most favourable response. As the following figure shows, the vast majority of participants responded that they found the platform easy to use, having responded 3 or higher, while approximately 3 out of 4 students highly agreed.

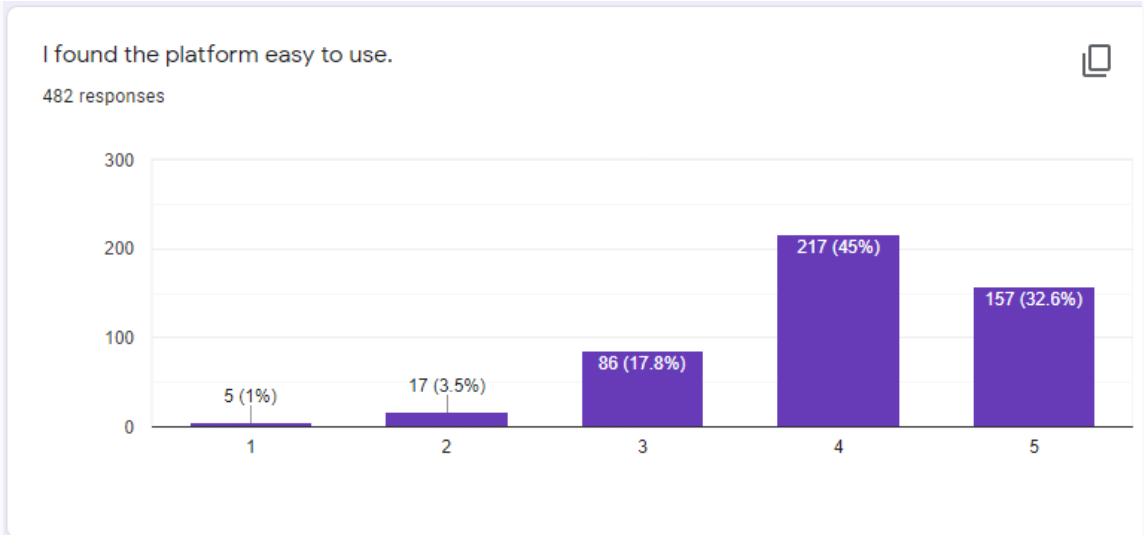

Figure 213. I found the platform easy to use.

Question 9: I found the platform complex.

Participants responded on a scale of 1 to 5, with 1 being the most favourable response.

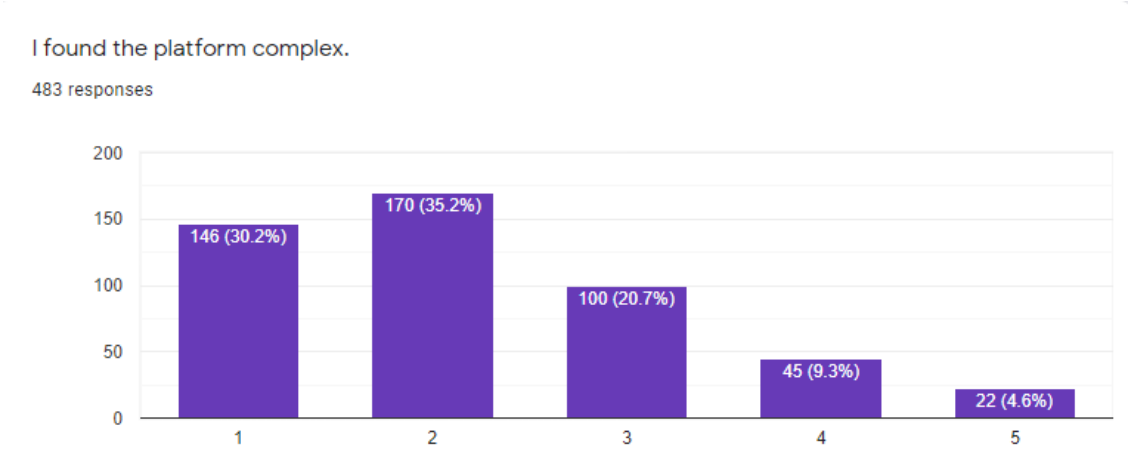

Figure 214. I found the platform complex.

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As the following figure shows, the vast majority of participants responded that they found the platform easy to use, having responded 3 lower, while approximately 3 out of 4 students highly agreed. Approximately 50 individuals had some difficulty using the platform. The responses demonstrate that the platform is overall easy to use.

Question 10: I needed the support of a technical person to use this platform.

Participants responded on a scale of 1 to 5, with 1 corresponding to the most favourable response. As the following figure shows, the vast majority of participants responded that they found the platform easy to use, having responded 3 or lower, while approximately 3 out of 4 students highly agreed. 94 individuals responded that they would need some technical support to use the platform. The responses demonstrate that the platform is overall easy to use.

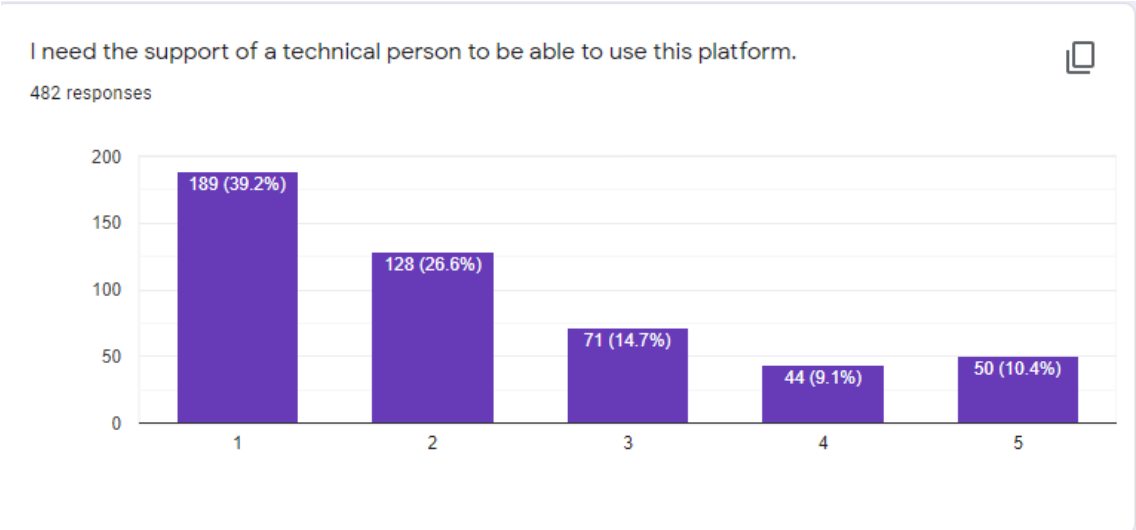

Figure 215. I need the support of a technical person to use this platform.

Question 11: The various functions of this platform were well integrated.

Participants responded on a scale of 1 to 5, with 5 being the most favourable response. As the following figure shows, the vast majority of participants responded that they found the platform well integrated, having responded 3 or higher. Approximately 3 out of 4 individuals

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responded that the platform was very well integrated. This demonstrates that perceptions on the platform implementation are positive.

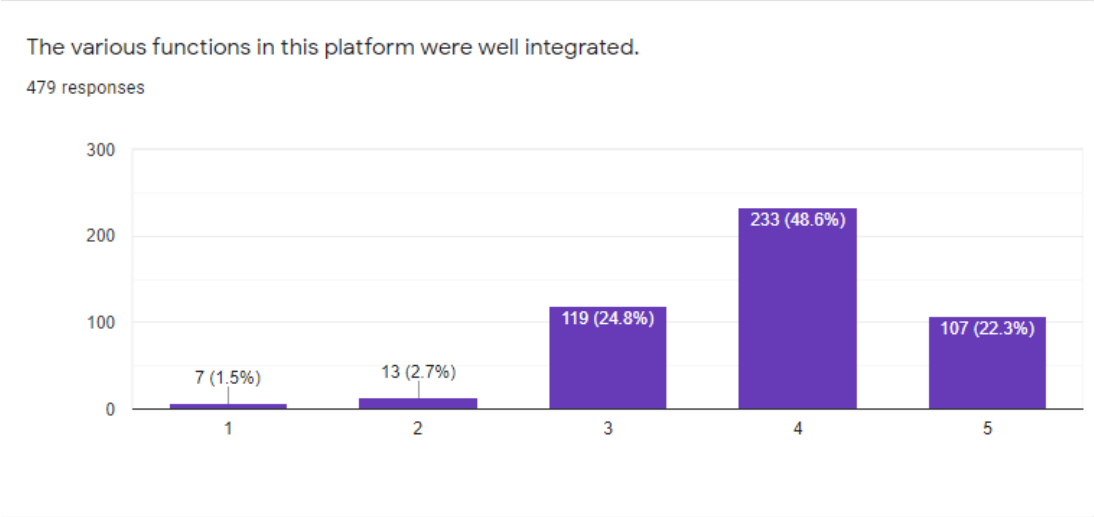

Figure 216. The various functions of this platform were well integrated.

Question 12. There was too much inconsistency in this platform.

Participants responded on a scale of 1 to 5, with 1 being the most favourable response. As the following figure shows, the vast majority of participants responded that they found the platform to be consistent, having responded 3 or lower.

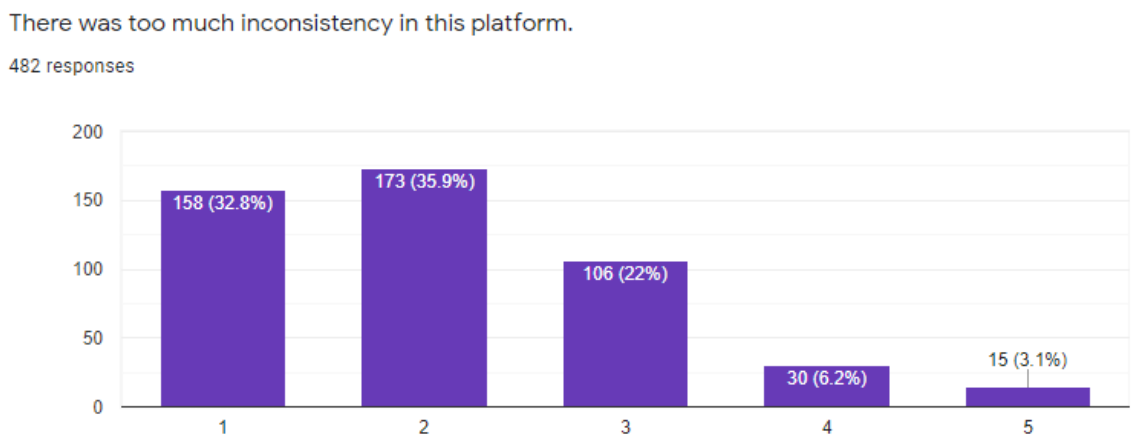

Figure 217. There was too much inconsistency in this platform.

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Approximately 3 out of 4 individuals responded that the platform was highly consistent. This demonstrates that perceptions on the quality of the implementation are positive.

Question 13: Most people would learn to use the platform very quickly.

Participants responded on a scale of 1 to 5, with 5 being the most favourable response. As the following figure shows, the vast majority of participants responded that they perceived that it is easy to learn how to use the platform, having responded 3 or higher. Approximately 3 out of 4 individuals responded 4 or higher. This demonstrates that participants perceive that the platform is easy to use.

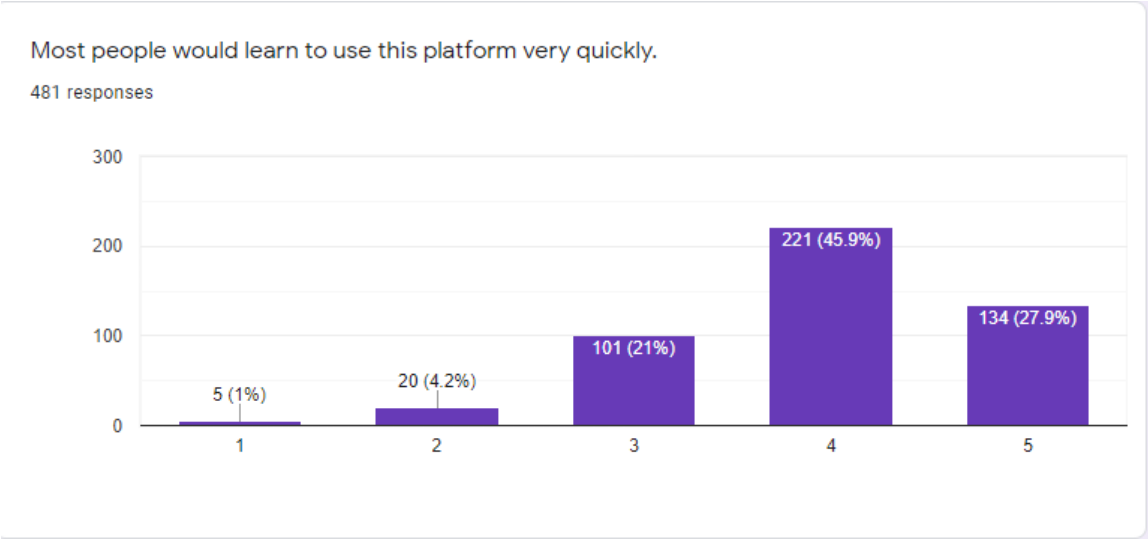

Figure 218. Most people would learn to use this platform very quickly.

Question 14: The platform was very cumbersome to use.

Participants responded on a scale of 1 to 5, with 1 being the most favourable response. As the following figure shows, the vast majority of participants responded that they perceived the platform is NOT cumbersome to use, having responded 3 or lower. This demonstrates that participants perceive that the platform is easy to use.

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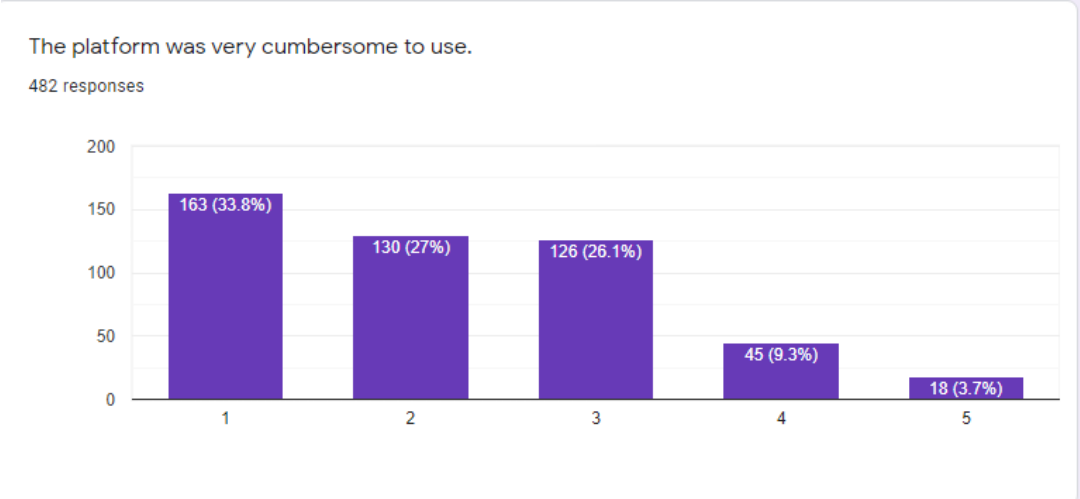

Figure 219. The platform was cumbersome to use.

Question 15: I felt very confident using the platform.

Participants responded on a scale of 1 to 5, with 5 being the most favourable response. As the following figure shows, the vast majority of participants responded that they felt confident using the platform, having responded 3 or higher. This demonstrates that participants perceive that the platform is easy to use.

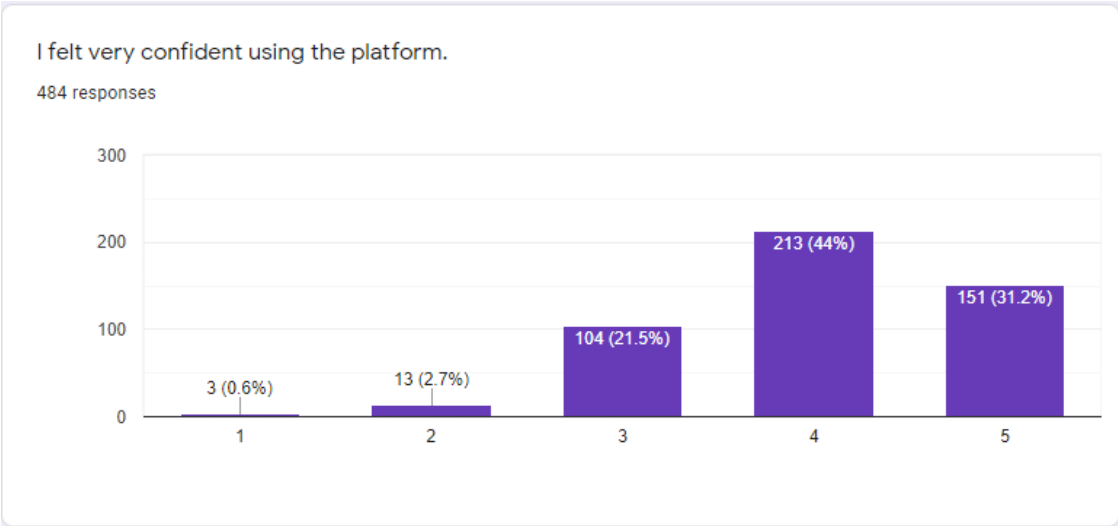

Figure 220. I felt very confident using the platform.

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C2. Analysis of questionnaire responses

The ALIEN project conducted a wide research over 17 organizations and 10 countries collecting 494 responses by students that engaged in the use of the ALIEN digital problem-based learning platform and content.

The responses were highly favourable. In terms of relevance (questions 2 - 4), participants responded that the ALIEN active and problem-based approach is highly relevant in engineering education and contributes to the development of problem-solving skills. Participants responded that problem-based learning can help engineering students to learn how to think. They further responded that the ALIEN platform offers a broad number of problems posted by a broad group of individuals. The problems are inspired by real-life and are relevant in diverse contexts. The platform fosters collaboration and encourages students to learn from each other. It provides a new perspective in engineering problem-based learning. The published problems help students establish links between theory and practice and make problem-based learning enjoyable and satisfying, while they help increase student performance. The simulation and games help students experiment with and visualize concepts hands-on. They further help students build practical skills.

In terms of usability (questions 7 - 10 and 13 - 15), participants responded that the platform is in general easy to use, requires limited technical support, is not cumbersome, and is easy to learn.

Finally, in terms of quality of implementation (questions 11 - 12), participants responded that the platform is well integrated and provides consistency.

Taking into account the high number of responses, it can be concluded that the ALIEN digital problem-based learning platform, which is part of the wider ALIEN active and problem-based learning, has achieved its objective of promoting problem-based approaches through the support of digital tools, such as simulations and games, on which wider learning activities have been structured that simulate the use of engineering knowledge in real-life contexts.

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CONCLUSIONS

This report presented the results of the evaluation of the implementation phase of the ALIEN project, which focused on the deployment of project outcomes by students and educators at 17 universities in Malaysia, Vietnam, Nepal, Cambodia, Pakistan, Greece, Portugal, Bulgaria, Estonia, and the UK.

The project outcomes, namely the ALIEN physical problem-based learning laboratories and the digital problem-based learning platform and content were widely used during the project implementation. They were used in over 130 courses in activities summarized in this report. The total number of students that participated in the courses over a period of 2 years exceeds 12.000, surpassing the proposal target of 1.500.

In addition, the consortium organized a wealth of instructor training activities, targeting 4 - 5 activities per partner. The number of instructor training events organized exceeded 65. The number of instructors reached through these event exceeded 1.200, surpassing the proposal target of 510.

The above demonstrate the wide adoption of the project outcomes and their positive impact to students and educators at participating organizations. The positive effect of the project is also evident in the responses of 494 individuals that participated in a questionnaire-based evaluation, which demonstrated highly positive perceptions towards the ALIEN active- and problem-based learning intervention and significant benefits stemming from the proposed learning approach that is supported by physical problem-based laboratories and a digital problem-based learning platform.

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