ICT-INOV
MODERNIZING ICT EDUCATION FOR HARVESTING INNOVATION

Sustainability plan

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Executive summary

Digital technology's rapid evolution leads to continuously enriched experiences for users through the introduction of more efficient, user-friendly, flexible, and accessible services and tools that address needs in wide aspects of everyday life, business, and social activity. In this fast-changing environment, higher education's most significant benefit for students is the development of foundational knowledge and soft skills for innovation. Fostering critical thinking, collaboration capacity, and learning-to-learn skills allows professionals to continuously grow and acquire new knowledge throughout their careers, staying at the forefront of their sectors. Recognizing the importance of developing innovation capacity, project ICT-INOV focuses on the design, development, and deployment of a collaborative digital learning intervention that supports students in introducing innovative solutions through design thinking and gamification principles. The digital learning intervention addresses the development of innovation skills among Computer Science and Engineering students through a holistic solution that is based on the development of physical infrastructures in the form of innovative digital labs, the design and development of a digital learning platform and educational activities for fostering innovation skills, and capacity building of organizations to adopt the proposed approach through instructor training and community building that encourages know-how exchange. More specifically, the ICT-INOV digital learning platform allows teams to collaborate in real-time on innovation activities by applying design thinking steps such as problem discovery, definition, ideation, evaluation, and prototyping of ideas. The platform further supports educators in structuring, delivering, and sharing design thinking activities, monitoring student team progress, and providing feedback.

This document constitutes the sustainability plan for the post-project-completion adoption of project outcomes within partner organizations and beyond. The sustainability plan identifies the outcomes that will be supported after the completion of the implementation period, analyzes

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comparative advantages of the ICT-INOV digital learning intervention in relation to competitive or substitute solutions, sets impact indicators, and introduces a comprehensive stepwise sustainability strategy. Recognizing the importance of the newly developed physical labs at partner universities in Asia, the plan further introduces a roadmap for the long-term sustainability of these facilities.

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1. The need for building innovation skills in ICT higher education

Technological innovation drives economic growth [1]. It is hard today to identify any area of economic, educational, or social activity that is not supported by digital technologies. For example, education is facilitated by on-line digital learning services, applications, collaboration tools, simulations, or digital experiments. Social interaction is fostered by digital networks, interest groups, and rich communication channels. Business is boosted through broad and fast connectivity and access to on-line services. Health is supported through the accuracy of digital tools for diagnosis and therapy.

The fast evolution of digital technologies is the result of technological innovation and ever faster networks. Technological evolution fuels user appetite and demand for digital services and tools that are increasingly efficient, friendly, flexible, and accessible. Meeting this demand is made possible through increasingly efficient hardware and software solutions that can support enriched digital user experiences, creating a cycle of digital growth.

The fast evolution of digital technologies introduces challenges for the higher education sector related to the continuous enrichment of educational offerings in order to meet industry demand for emerging skills and competencies. While educational curricula are continuously updated to address new knowledge, this may happen at a pace slower than that of technological progress, as technology that was considered innovative only a few years earlier may today be obsolete, having been replaced by more advanced competitive or substitute digital products and services.

In this context, the most important benefit that higher education can offer to students is developing their capacity for innovation and staying at the forefront of their sectors throughout their careers through continuous learning and professional growth. This can be facilitated through the development of sound foundational knowledge, such as STEM, and innovation skills, such as

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critical and analytical thinking, collaboration, creativity, experimentation, flexibility, resilience, and adaptability.

To address the need for supporting innovation in Computer Science and Engineering higher education, project ICT-INOV focuses on the design and development of a digital collaborative educational intervention that fosters innovative thinking in teams through design thinking and gamification principles [2][3]. The digital learning intervention supports student real-time collaboration in problem-discovery, problem definition, ideation, sharing, evaluation, and prototyping of ideas. It further supports educators in structuring, delivering in the classroom, sharing educational activities for innovation, monitoring student work, and providing feedback.

The ICT-INOV gamified design thinking learning services can be deployed in wider, blended learning contexts for innovation skill building. The ICT-INOV digital learning intervention complements more traditional and widely used eLearning services that support the sharing of learning content and possibly the support of on-line exams. ICT-INOV supports team collaboration in real-time, which is a feature missing from most traditional eLearning platforms.

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2. Target sector needs analysis

Project ICT-INOV targets the higher education sector, aiming to build the capacity of individuals and organizations to innovate and turn ideas into action. The direct stakeholders that stand to gain from project activities are:

Higher education students, who are the direct beneficiaries of the project gamified design thinking methodological learning approach, digital learning services, and educational content for building innovation skills. Students need to develop the knowledge, skills, and competencies that will help them lead successful and rewarding careers for their own benefit as well as the benefit of their communities. They will be the problem solvers of tomorrow, who will deploy digital technologies for addressing 21st century challenges. In addition, students need to develop foundational knowledge and soft skills demanded by industry for improving their employability and their competitive advantage in the job market.

Higher education instructors, who are the direct beneficiaries of project gamified design thinking methodological learning approach, collaborative digital learning services, digital educational resources, and good practice guidelines that help build their capacity to design and deploy in the classroom innovative learning practices for building student innovation skills. Instructors benefit from professional development that contributes to growth and rewarding careers through continuous education. They need to develop skills and competencies related to the deployment of innovative educational design supported by digital technologies in the classroom.

Educational organizations, that aim to modernize and internationalize their practices to better prepare their students for entering the job market and for becoming active citizens that contribute to the well-being of their communities. They benefit from international collaboration towards the design and adoption of innovative pedagogical approaches that enrich student

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educational experiences, help meet educational goals, and develop the knowledge and competencies desirable in the job market. Educational organizations benefit from improved rankings and reputation as a result of enriched innovation and research, internationalization, and collaboration in academia and business.

In addition, the following groups stand to gain indirectly from project activities:

Industry, that stands to gain from the development of a pool of young talented professionals that have the knowledge and competences for supporting the pursuit of emerging business opportunities related to digital technologies. Industry players, both SMEs and larger corporations, benefit from growth based on the development of human capital.

Educational policy makers, who stand to gain from insights and good practices developed during project implementation in relation to the positive impact of innovative learning practices, such as gamified design thinking, on educational quality and on addressing more effectively educational goals. Policy makers can benefit from the results of piloting activities that lead to recommendations on maximizing the benefits of the proposed gamified design thinking digital learning intervention for innovation skill development in higher education as well as other sectors, such as secondary, vocational, and professional education.

Society at large, that benefits from a young generation that is better prepared to address complex issues of the modern world by designing technology-enhanced solutions that better meet the needs of target users, enriching the quality of life in diverse areas that range from education to health, green development, climate change mitigation, clean energy, responsible production and consumption, responsible natural resources management, preservation of biodiversity, equality, elimination of hunger, and more [4].

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3. Competitive services

Tools are available in the market for supporting the design process. These are not educational tools. Rather, their aim is to support design through team collaboration. In this sense, these tools do not constitute direct competition to the ICT-INOV digital learning intervention for innovation skill development, as their objective and market positioning differ. Some of the most successful tools are:

Figma® is a design tool for teams that supports brainstorming, designing prototypes, and building solutions. The product helps teams share content and stay in tune with each other throughout the design process [5]. It offers tools for strategic planning and team collaboration. The tool is aimed to support design teams in their efforts and has a starting cost of 12 Euros per team member per month, which can be higher depending on pricing plans and features, making it an expensive solution for learning purposes and large classes that may involve over 100 students.

Miro® is a collaborative digital whiteboard that helps teams design collaboratively. It offers solutions for ideation, brainstorming, organization, evaluation, strategic planning, project planning, and more. It offers templates for designing mind maps, storyboards, road maps, and customer journey maps, making it a good solution for designing enterprise products. Pricing starts at 9 Euros per team member, which similarly makes it an expensive solution for learning purposes and large classes [6].

Milanote® is an easy-to-use tool that helps teams organize ideas and projects into visual boards. It targets creative professionals, designers, creative projects, and product teams. It supports moodboarding, brainstorming, storyboarding, creative writing, project management, mind-mapping, whiteboarding, and remote working [7].

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InVision® is a visual collaboration platform, mostly used by companies. The product enables organizations to improve their processes and workflows. There are four pricing options, starting with a free option and the availability to work on 1 project, the starter pack for 15 Euros per month for a limited number of projects, while pricing options rise in line with the availability of higher flexibility [8].

Adobe XD® is a vector-based design tool typically used for UI/UX design. The system has collaborative features like shareable libraries and Creative Cloud integration, which lets team members sync changes with the cloud so the whole project updates. Teams often use Adobe XD® for easy designer-developer handoff and prototyping. Starter pack is free, and the user can access limited XD features, which can be higher, making it an expensive solution for larger teams [9].

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4. The ICT-INOV solution

ICT-INOV introduces a holistic digital learning intervention for building innovation skills among higher education students [11].

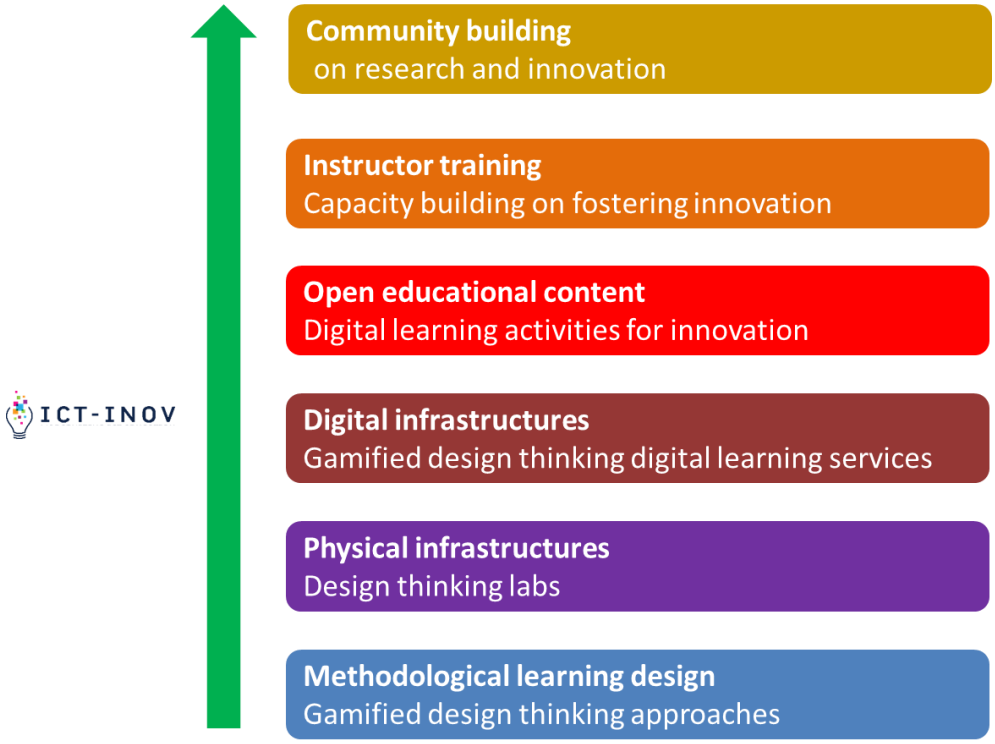

Figure 1. The ICT-INOV holistic digital learning intervention for fostering innovation skills among higher education students.

4.1 Innovation-building learning design

An experiential methodological learning framework based on design thinking and gamification principles that fosters the development of innovation skills among higher education students in Computer Science and Engineering but also in wider engineering and other principles. The methodology encourages students to go beyond typical human-centered design, which often is practiced through the distribution and filling in of questionnaires by target users for gathering

input. Rather, the proposed methodology encourages designers to put themselves into the shoes of the users through observation or immersion for more accurately documenting real, as opposed to perceived, needs, considering both functional and emotional aspects of a potential solution as well as addressing latent needs that users may not be able to express. In addition, the proposed methodology exploits the power of teams, encouraging collaboration and sharing and building on each other's ideas.

The ICT-INOV methodological learning framework is based on principles of design thinking, which often are expressed as steps of problem discovery and analysis of user needs, problem re-definition based on discovery outcomes, ideation for generating a pool of rich ideas towards a solution, evaluation of ideas, and prototyping. Gamification elements encourage participation in the design process through recognition of work and engagement by peers.

4.2 Physical and digital learning services for supporting innovation

ICT-INOV develops digital learning infrastructures, both physical and on-line, for supporting innovation building activities among higher education students. Specifically, the project develops:

Innovation labs for strengthening the educational infrastructures of partner universities located in Asia. Equipment is purchased and organized into physical labs installed in a single space accessible by students and educators. For each partner, lab configuration considers existing infrastructures, which are complemented and enriched by new devices, planned use of the lab in existing courses in which innovation skills are pursued, and planned use of the lab in future activities related to innovation. Equipment is marked through stickers with the project and Erasmus+ logo, while a plaque is placed at the lab entrance with the same.

A gamified design thinking digital learning service for innovation skill building by exploiting the power of teams is developed and made publicly available to project partners and external organizations that can benefit from it. The digital learning service supports both students and

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educators in innovation building activities based on the project methodological learning framework that exploits design thinking and gamification (see section *4.1 Innovation-building learning design*). Students and educators collaborate in shared team workspaces in which they can exchange and enrich ideas in groups. More specifically:

Services for students include:

- Registration to courses.
- A shared digital team workspace, in which team members can post and edit ideas in notes seen by their peers in real-time.
- Access of the team workspace anytime and from anywhere through synchronous or asynchronous team collaboration.
- Rich description of ideas through text, images, videos, or links.
- Support for idea organization through color coding of notes.
- Organization of activities into steps that can reflect design thinking practices, such as problem discovery, ideation, evaluation, and prototype design.
- Request for feedback by educators.
- Brainstorming with other teams, by opening access to the team workspace to external parties.
- Support of team collaboration through simple avatars through which students become aware of the presence and activity of team members in the shared team workspace in real-time.

Services for educators include:

- A private workspace for creating and managing educational activities and structured courses.

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- A learning activity editor for structuring or updating innovation-fostering projects by using design thinking steps through notes that provide directions for students on executing specific tasks.
- A course creator, which supports the integration of structured learning activities for fostering innovation and the creation of workspaces for individual teams.
- Student activity monitoring.
- Reviews of student work through notes.
- Access to public learning activities for inspiration towards the design of new ones or for direct use in courses.
- Access to a library of design thinking resources and exercises that can be integrated into innovation skill building activities.
- Making activities public for the benefit of peers.
- Duplicating, editing, adapting, and reusing activities publicly shared by peers for addressing the needs of their students.

The educational process is supported through gamification, namely the use of game elements in non-game contexts [3]. To encourage the long-term engagement of students in innovation-building, the platform provides rewards and recognition of participants in the form of “likes” on student posts. Similarly, educators can upvote the work of their peers in the form of “likes” on educational activities.

The platform is accessible to students and educators through a simple registration process. The interface is offered in 9 languages, supporting its use in diverse educational environments.

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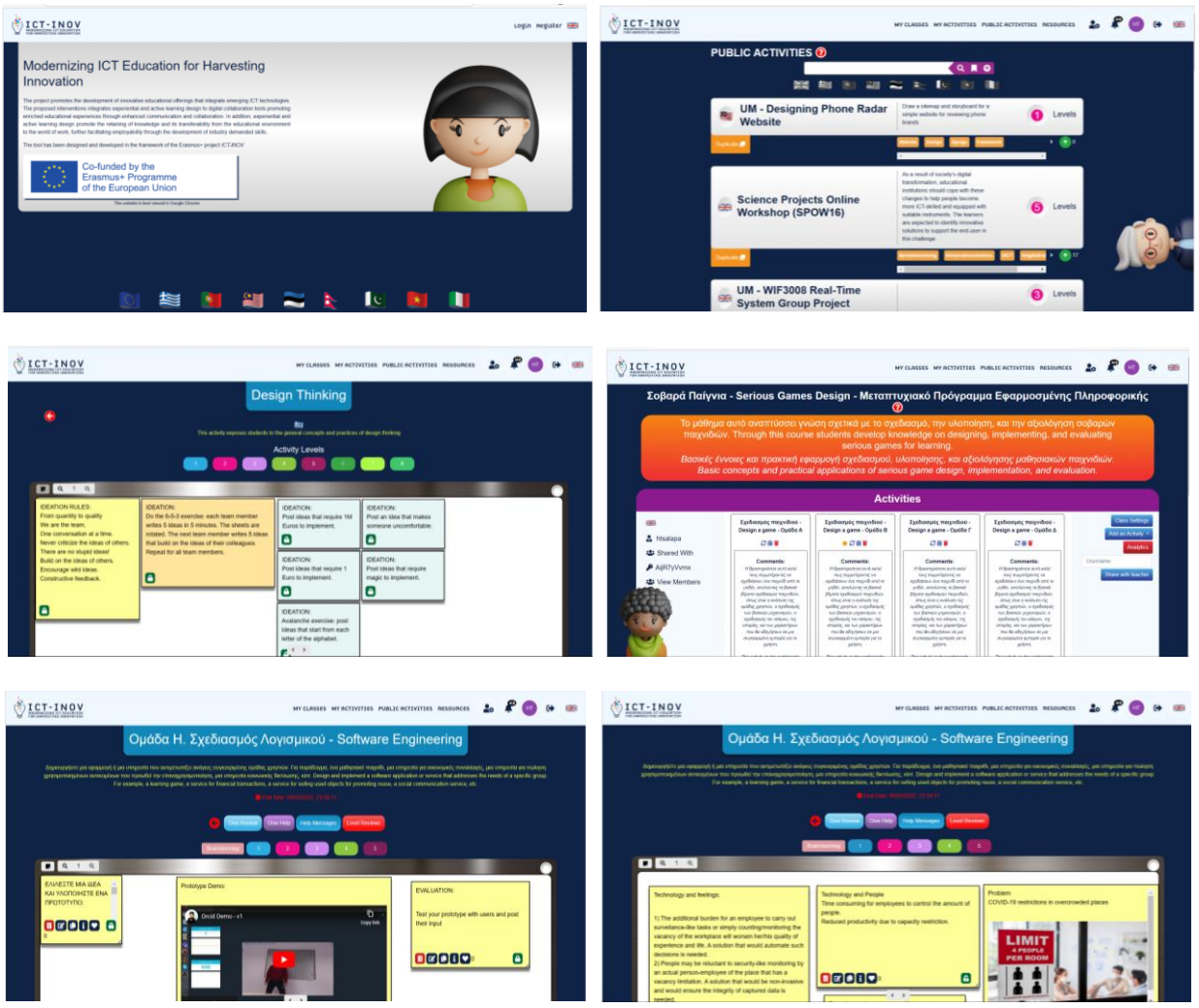

Figure 2. Digital learning platform for innovation. Top row: Login screen (left), educator private workspace (right). Second row: Learning activity structuring (left), a course with student workspaces (right). Third row: Student team workspaces.

4.3 Digital learning activities for innovation

ICT-INOV develops digital learning activities for innovation skill building. The activities are integrated into the collaborative digital learning platform (see section *4.2 Physical and digital learning services for supporting innovation*) and are openly available. Activities are available in English and/or the national languages of project partners, depending on the needs of each

student group. For example, in some educational programs of project partners learning is delivered in the national language, while in others, it is delivered in English. The availability of learning activities in several languages makes them accessible to wider audiences.

Activities can be directly used by interested parties in educational contexts. An educator can duplicate an activity in her personal working space, edit it to address the needs of her students, and integrate it into a course. Existing activities can also serve as inspiration for the design of new ones that address broad learning needs and target diverse groups.

4.4 Good practice guidelines for the adoption of the ICT-INOV digital learning intervention

Good practice guidelines integrate the experience of project partners stemming from the deployment of the ICT-INOV digital learning intervention for fostering innovation, including educational methodologies, physical labs, digital collaborative learning services, and educational activities in actual courses. The good practices cover all aspects of learning design, including preparation, content creation, and classroom deployment. They support educators and other interested parties throughout the adaptation and deployment of the proposed innovation building learning design in their learning offerings. Good practices are publicly available.

4.5 Community building and instructor training activities for promoting the adoption of innovation-building educational practices

In addition to the physical infrastructures, digital learning services, and digital educational content for supporting innovation skill-building ICT -INOV introduces events for promoting the skills of instructors and the capacity of organizations to integrate into educational contexts the proposed digital learning intervention that is based on gamified design thinking and aims at unlocking the innovation power of students. Specifically:

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Instructor training develops the capacity of a critical mass of educators at participating organizations to design and deploy the proposed digital gamified learning framework in classrooms. Instructor training is focused and targeted, building educator awareness on the proposed gamified design thinking learning approach as well as practical skills on the design and use in classrooms of activities that are either already publicly available on the ICT-INOV digital learning platform or designed by the educators themselves for addressing the specific needs of their students. Instructor training takes place at two levels. Plenary events train a core group of educators originating from all partners. They are followed by local events at each partner site, which help reach broader groups of educators.

Community building raises awareness in the higher education sector of the positive impact and benefits of the proposed gamified design thinking approach for innovation through international webinars and local events that reach the target groups of educators, students, and policy makers both within and beyond participating organizations. Community building is manifested through multiplier events that take place at each partner site and a final project conference with the participation of representatives by all partners.

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5. ICT-INOV comparative advantages

The key advantage of the ICT-INOV gamified design thinking digital learning intervention lies in the educational nature of the proposed digital intervention and the holistic approach adopted on addressing the development of innovation skills among higher education students. While products exist in the market for promoting design or team collaboration, the solutions they offer are tailored to the market, as opposed to educational needs. In contrast, ICT-INOV introduces a digital learning intervention that addresses all aspects of the innovation skill-building process, including physical infrastructures, digital infrastructures, proof of concept educational content, good practice guidelines for adoption, and the development of a community of best practices through instructor training and knowledge sharing events. More specifically, the comparative advantage of ICT-INOV lies in the following:

- ICT-INOV is an **educational learning intervention**, as opposed to a design tool for teams.
- ICT-INOV develops innovation labs for **complementing existing infrastructures** at participating universities, considering existing equipment and departmental curricula for ensuring that the equipment purchased address **real educational needs now and in the future**.
- In addition to physical infrastructures, the project focuses on an emerging pedagogical design by introducing a gamified design thinking approach in educational contexts with the objective of promoting innovation capacity. This fosters the **modernization of educational practices** at participating organizations through innovative educational design that helps build the problem solvers of tomorrow.
- ICT-INOV contributes to the **digital transformation of higher education** by designing and developing digital services and educational content specifically for educational purposes.

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- ICT-INOV, as a learning intervention, introduces services that allow educators to **structure digital educational activities based on design thinking**, something that is not offered by tools aimed to be used for design purposes rather than educational.
- ICT-INOV allows the **sharing and reuse of educational activities by educators** and other interested parties, providing a base library of digital educational material that can be used by external stakeholders either directly in classrooms or as inspiration for synthesizing additional educational content.
- Gamification elements promote the **inherent motivation of students** to **engage in the long term with educational activities** for building innovation skills.
- ICT-INOV offers the proposed digital learning intervention for innovation skill building **open to all interested parties**, promoting open educational resources. In addition, the project aims to allow the **reuse and repurposing of digital services and educational content** through Creative Commons licenses, allowing educators to adapt the solution and content to the individual needs of their students.
- The ICT-INOV digital learning services **interface is available in English and the national languages** of project partners, promoting its wider use in Europe and Asia.
- In addition to the digital implementation, ICT-INOV provides **continued educator support in the form of instructor training and community-building** events, which support interested parties now and in the future in deploying the proposed solution in educational contexts.

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6. SWOT analysis

Following is a SWOT analysis of the ICT-INOV gamified design thinking learning intervention that aims to establish its comparative position as an educational learning intervention for building the innovation capacity of higher education students.

6.1 Strengths

The strengths of the proposed digital learning intervention for building innovation skills in higher education are:

A holistic approach to innovation skill building in educational contexts. The proposed solution addresses all aspects of the educational process, including the establishment of physical infrastructures, the design of digital collaboration services aimed specifically for use in educational contexts, the design of educational content as reference material, good practice guidelines for educators, and capacity building initiatives, including instructor training and networking events.

A repository of reusable educational innovation-building content. The activities are openly available to educators, students, and other stakeholders upon registration to the ICT-INOV digital learning services. They can be directly deployed in classrooms or used as inspiration for the design of new activities.

Encouragement of sharing of educational digital material and experiences. As an educational intervention, ICT-INOV encourages instructors to share their educational content for the benefit of their peers. Educators have the option of making their activities public through the ICT-INOV digital learning platform for others to review or duplicate and adapt for addressing diverse needs.

Support for the deployment of educational activities in organized classes and courses. The ICT-INOV digital learning services go beyond solutions introduced by digital tools that focus on the

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design process. The services allow the creation of on-line class spaces in which teams collaborate on innovation related activities. Educators can monitor student work and provide feedback, helping students connect the cause and effect of their choices and scaffold knowledge.

Support learning through physical design thinking labs. The ICT-INOV design thinking labs developed at universities in Asia are designed specifically to foster the development of the innovation capacity of students and educators through collaboration and high interactivity. Lab configurations take into consideration institutional strategies for fostering innovation, existing infrastructures to which they are complementary, existing curricula that will be enriched through the ICT-INOV physical and digital infrastructures, educational missions, and student needs at each partner site. Lab setups facilitate group collaboration through the selection of highly interactive equipment, such as tablets, and layout that fosters teamwork, such as collaboration islands.

Open access. The ICT-INOV gamified digital learning intervention is openly available to all interested parties, both individuals and organizations. Digital learning services, educational activities, good practice guidelines, scientific articles, informational material, and more are accessible to participants within and beyond the consortium, maximizing the positive impact of project implementation.

In-class and distance collaboration. The ICT-INOV digital learning services allow collaboration of teams in the classroom as well as from a distance through real-time updating of joint digital workspaces owned collectively by team members. This approach allows innovation-building activities to take place anytime and anywhere.

Motivation to engage in learning through gamification. Gamification elements integrated into the ICT-INOV digital learning services, such as “likes”, encourage long-term engagement with learning through rewards in the form of recognition of student and educator contribution.

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6.2 Weaknesses

The weaknesses of the proposed digital learning intervention for building innovation skills in higher education are:

Need for continuous equipment updates. The ICT-INOV physical labs need to be maintained in the medium to long term through equipment repairs and upgrades to be up to date with digital technology advances. Participating organizations need to provide the necessary funds.

Need for technical support staff. The operation of the physical labs and the maintenance of the equipment and software installed requires the support of skilled technical personnel who ensure that the lab hardware and software services integrate emerging technological advances. Participating organizations need to hire and train the necessary staff.

Internet connectivity. The operation of the ICT-INOV digital learning services requires continuous internet connectivity that allows team in-class and distance collaboration. Participating organizations must ensure continuous access to the digital learning solution.

6.3 Opportunities

The opportunities that can pursued by the proposed digital learning intervention for building innovation skills in higher education are:

Modernization of education through emerging approaches on building student innovation skills. ICT-INOV introduces new opportunities for the development of innovation skills among higher education students by integrating design thinking and gamification into openly available digital educational services and content. The proposed solution enriches student experiences and classroom interactivity, encouraging team collaboration and demonstrating how digital technology can be part of solutions to modern challenges.

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Internationalization of research and education. ICT-INOV introduces opportunities for collaboration and know-how exchange between academic organizations in Europe and Asia on enriching innovation-building educational practices. This opportunity extends beyond the consortium, empowering partners to collaborate with universities, professional associations, companies, and research centers in their countries, regions, and beyond on related research initiatives. In addition, it introduces a great opportunity for know-how exchange between Europe and Asia on fostering innovation.

Digital transformation of education. ICT-INOV introduces a holistic digital learning intervention supported by digital technologies, including physical and digital infrastructures and services. The proposed solution helps bring education to the digital era through innovative digital services and tools specifically designed for learning purposes. The open access to the proposed solution by all interested parties further supports the digital transformation of education beyond the consortium.

Entrepreneurial and social innovation. ICT-INOV's gamified design thinking approach to innovation helps develop the competencies and skills that young professionals need to contribute to change in entrepreneurship contexts, for more effectively addressing the needs of customers, as well as social entrepreneurship contexts, for introducing effective interventions to emerging social challenges [2][10].

Multiplier effects. ICT-INOV introduces a digital gamified design thinking educational intervention that helps build higher education student innovation capacity. The solution may be adapted to address educational needs in additional sectors, such as secondary, professional, and vocational education, providing multiplier effects for meeting the educational needs of broad groups.

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6.4 Threats

The threats in the deployment of the proposed digital learning intervention for building innovation skills in higher education are:

Course completion rates. Students must complete the entire educational activity introduced by their educators to get the full benefit of learning towards building innovation skills. Course completion rates are a challenge in all on-line digital learning solutions, such as MOOCs and related services. Similarly, they can be a challenge in the ICT-INOV environment, in which students must perform several stepwise tasks throughout a learning period. Gamification elements integrated into the ICT-INOV digital learning services contribute to student engagement, promoting higher completion rates.

Educator reluctance to use digital learning services. Educators may be reluctant to use a new digital learning service as a result of the need to invest in initial effort for their familiarization with the provided features. Instructor training activities, a reference manual, and a reference video will help alleviate this threat by supporting educators in their initial steps. In addition, openly available proof-of-concept educational activities further support educators in the design and deployment of their own content in classrooms.

Student reluctance to use the digital learning services. Similarly, students may be reluctant to use digital learning services as a result of the initial effort necessary for their familiarization with the provided functionality. Gamification elements, a reference manual, and a reference video will contribute to early student engagement.

Sustainability costs. Participating organizations need to provide the funds for the sustainability of the physical and digital learning infrastructures in the medium to long-term. The sustainability plan discussed in this document helps alleviate this threat.

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7. Outcomes to be sustained after project completion

All project outcomes and activities to be sustained after the completion of the project. Specifically, the following activities will continue beyond project completion:

- The **gamified design thinking methodological learning approach**, which is promoted for wider adoption within participating organizations and beyond with the objective of modernizing educational practices and building student innovation capacity.
- The **physical labs**, which will be available to students and educators for facilitating innovation skill-building educational delivery after the completion of the project.
- The **digital learning services**, which will continue to be used within and beyond partner organizations in the context of blended, technology-supported educational practices for facilitating the design and delivery of learning activities for fostering innovation skill-building based on gamified design thinking approaches.
- The development of additional **digital educational content** for building innovation skills, which will continue post project completion in the context of classroom deployment of project solutions.
- **Capacity building activities** in the form of **instructor training** and **community building** events, which will continue to spread awareness on project outcomes and to reach widely educators and other stakeholders that can benefit from the proposed gamified design thinking approach.

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8. Expected impact

This section analyzes the positive impact of the ICT-INOV gamified design thinking learning intervention on direct and indirect stakeholders.

8.1 Impact on students

The following positive impact is expected for students:

- Enriched **problem-solving and innovation capacity**, including collaboration capacity, working in groups, sharing knowledge, building on each other's ideas, critical and analytical thinking, problem research, interview skills, user analysis skills, and evaluation of potential solutions.
- Enriched **creativity, adaptability, flexibility, and problem-solving skills**.
- Encouragement of **entrepreneurial mindsets**.
- **Adaptability** to a highly evolving digital economy.
- Ability to **turn ideas into action**.
- Access to **digital educational solutions**.
- Exposure to **innovative educational design** based on gamified design thinking approaches, which can **enrich educational experiences** and help **reach learning goals**.
- **Linking ICT education to industry and society** through educational activities inspired by and benefiting communities in the real world.
- **Higher competitiveness in the job market** through the development of industry-demanded innovation skills.

8.2 Impact on educators

The following positive impact is expected for educators:

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- **Enhanced teaching methods** and capacity to **deploy innovative educational design** based on the gamified design thinking approach in the classroom.
- Capacity to **deploy digital educational resources** in learning contexts.
- Support in the **design and implementation of innovative educational activities** based on gamified design thinking through instructor training.
- **Career growth, based on continuous learning** on innovative practices.
- **Increased peer collaboration** through sharing of best practices and reuse of educational content.
- **Curriculum development skills**, through enriched capacity to integrate innovative activities in learning.
- **Leadership opportunities** in their schools and educational communities towards implementing emerging learning design.
- **Adaptability to technological changes** and capacity to integrate technology in learning.
- Participation in an **international network of educators** on innovation through instructor training and community-building events.
- Opportunity to **publish their own activities openly available to peers**.
- **Career growth**, career satisfaction, and **professional development** as a result of instructor training and community building on emerging pedagogical design.

8.3 Impact on educational organizations within the consortium

ICT-INOV had a very positive impact on participating educational organizations, including:

- **Infrastructure development**, both physical and digital.
- **Modernization of learning**.
- **International collaboration on innovation**.
- **Increased competitiveness** through innovative learning design.

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- **Enriched student opportunities for employment** through innovation skill building.

Following are highlights of positive influence generated by the project for each partner organization, as this is identified by the project partners themselves:

University of Malaya:

- **Promotion of innovation** in the years to come.
- **Contribution to the improvement of economic status** in various fields.
- **Infrastructure devevelopment**, both physical and digital.

University Tenaga National:

- **Fostering innovation skills** among teachers and students.
- **International and regional collaboration**.
- **Infrastructure devevelopment**, both physical and digital.

ISRA University:

- **Infrastructure devevelopment**, both physical and digital.
- **Improvement of student performance**.
- **Educator capacity building for innovation**.

National University of Future and Emerging Sciences:

- **Modernization of teaching and learning** through design thinking with positive impact on students.

Kathmandu University:

- **Modernization of learning** through emerging pedagogical design.
- **Internationalization of learning**.
- **Promotion of research** collaboration.

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- **Infrastructure devevelopment**, both physical and digital.

Tribhuvan University:

- **Modernization of ICT education** through design thinking approaches.
- **Infrastructure devevelopment**, both physical and digital.

Hanoi University:

- **Introduction of innovative, student-focused learning**.
- **Enrichment of collaboration** for **research and innovation**.
- **Infrastructure devevelopment**, both physical and digital.

John Von Neumann Institute:

- **Innovation capacity building** through student and educator training.
- **International collaboration with industry and academia** on innovation.
- **Infrastructure devevelopment**, both physical and digital.

EUTrack:

- **Establishment of a design thinking-driven lab** to feed creativity and innovation, mainly in STE(A)M education, aiming to generate new ideas and transform them into tangible prototypes by using, e.g., a 3D printer to support innovation skills development.

Tallinn University

- **International collaboration** towards innovation in learning.
- **Updating of the Sustainability Micro-Degree program** through design thinking.

Porto Polytechnic:

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- **Enhanced reputation** as a leader in educational practices, improved student engagement, strenthened research.

8.4 Impact on the higher education sector

The following positive impact is expected for higher education organizations:

- Support of the **digital transformation of educational processes** through the development of physical and digital infrastructures.
- **Enrichment of educational facilities** through digital and physical infrastructures.
- **Improved student outcomes**, through innovation skills development.
- **Attracting and retaining talent** as a result of innovative approaches in education.
- **Responsive curriculum development**, reflecting the latest knowledge and skills needed in the workplace.
- **Resource efficiency** through the joint use of the ICT-INOV digital learning platform.
- **Adaptability to change in the education sector**, which is constantly evolving as a result of technology advancements, changing societal needs, and new pedagogical insights.
- **Modernization of educational practices** through innovative gamified design thinking learning design that fosters innovation.
- **Internationalization of educational and research practices** through networking with other higher education institutions in Europe and Asia in the context of innovation-building activities.
- **Increased international collaboration** in an international network of universities.
- **Educator continuous training** on emerging pedagogical approaches, such as design thinking.
- **Elevated academic excellence** through modernization and internationalization of learning.

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- Better **placement of educational offerings in the international educational market** through the upgrading of educational methodologies and learning delivery.
- Better **placement of graduates in the job market** as a result of building industry-demanded innovation skills.
- **Enriched reputation** through innovative learning design and modern physical and digital infrastructures.
- **Higher competitiveness** through modern learning offerings supported through physical and digital infrastructures.

8.5 Impact on society

The following positive impact is expected for society:

- A **better-prepared young generation** to address the difficult challenges of the 21st century through innovation skills.
- **Growth based on the development of human capital** through education and training of students and instructors.
- **Encouragement of social entrepreneurship** through the deployment of gamified design thinking for addressing complex technical and social challenges of communities.
- Promotion of **entrepreneurial capacity** and support of SMEs and larger corporations through **highly skilled professionals that can support the pursuit of emerging growth opportunities**.
- **Quality of life** through the design of services and solutions that better address societal and community needs.
- **Technological integration** of digital solutions into everyday activities in a human-centered way that helps address real, as opposed to perceived needs, in all aspects of business and social life, including education, health, transportation, energy, climate change, resource

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management, green development, and more, as a result of deploying gamified design thinking in educational contexts.

- **Reinforcing the economic resilience of communities** through innovation capacity.
- **Promoting innovation capacity** beyond urban centers to rural areas.
- **Civic engagement** through enriched awareness and competencies on addressing entrepreneurship and social entrepreneurship challenges through innovation.
- **Social cohesion** as a result of sustainable economic growth.

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9. Project result sustainability goals

The ICT-INOV sustainability strategy aims at the promotion of the adoption of project outcomes both within and beyond partner organizations for the benefit of the higher education sector. Following is a discussion of the project long-term sustainability objectives.

9.1 Project result sustainability goals within partner organizations

The project internal sustainability strategy within partner organizations aims at the wide adoption of project outcomes among consortium members in a manner that ensures impact and promotes the modernization and internationalization of learning design and delivery. Specifically, the goals of the medium-term internal adoption of project outcomes are:

- **Modernize educational offerings** by **integrating the proposed gamified design thinking approaches** in a critical mass of courses.
- **Deploy widely the digital learning platform** for building innovation skills through digital collaboration in a critical mass of courses.
- **Generate additional educational activities** to be published through the ICT-INOV digital learning platform aiming at creating additional educational activities.
- **Deploy the physical labs** for design thinking and other innovation activities in critical mass courses.
- **Continue instructor training and community building** for awareness raising and educator skill development on gamified design thinking educational approaches.
- **Extend partner collaboration** through new joint initiatives on modernizing educational practices.

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- **Broaden the network of international collaboration** by reaching universities beyond the consortium, promoting the adoption of project outcomes for innovation skill development.

9.2 Project result sustainability goals beyond the consortium

The project's external sustainability strategy aims at promoting awareness on and adoption of project outcomes by educational organizations beyond participating organizations, ensuring that the implementation of the project benefits the higher education sector in countries in which the consortium has partners.

Partners pursue **dissemination**, **community building**, and **training** activities targeting educators at additional universities, aiming to disseminate project outcomes for wide use.

A network of over 30 universities in 10 countries in Europe and Asia is being created towards which project outcomes are actively promoted for broad uptake, ensuring that project results impact not only participating organizations but additional higher education institutions in Europe and partner countries.

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10. Sustainability plan

Based on the above analysis, the ICT-INOV sustainability plan for the post project completion adoption of project outcomes is presented in this section.

The overall obhective of the sustainability plan is to promote the use of project results within and beyond the consortium.

10.1 Open access to all project outcomes through the project portal

It is important to sustain the project portal indefinitely, as it provides free and open access to project objectives, activities, and outcomes, including technical reports, scientific articles, informational material, dissemination content, lab descriptions, piloting events, community building events, press releases, internet articles, and more.

To contain portal sustainability costs, the service will be maintained on the internal servers of the coordinator indefinitely through the support of existing technical staff. This approach will ensure that the costs on the portal maintenance will be limited to the updating of the domain name, which costs up to 10 Euros yearly, a cost that will be covered through internal operational resources.

10.2 Continued support of the ICT-INOV digital learning platform

The ICT-INOV digital learning platform will be sustained indefinitely on the internal servers of the coordinator. Access to the platform will be provided openly to all interested parties, including project partners and other universities, through a simple registration process following current practices.

The digital learning platform has been developed for web access. This ensures minimum technical requirements on behalf of users for accessing the services for educators and for students.

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Notably, all supporting software packages for supporting the development of the digital learning platform are open. As a result, no costs are foreseen for software licenses in order to maintain digital learning services.

In terms of staffing and financial support, the digital learning platform software and installation will be maintained by the project implementation team as well as internal programming professionals who will work on necessary updates for compatibility with upcoming versions of supporting software packages.

The domain name of the digital learning services has been provided by the coordinator and no additional cost is expected to maintain it.

10.3 Sustaining the innovation labs

The ICT-INOV innovation lab equipment is described in detail and with precision in D2.2 Institutional Strategies for Promoting Innovation in ICT Education [12]. The maintenance in the medium to long term requires institutional support at the high level, funding for updating the equipment and software installed, technical support staff with adequate expertise, and funding for staff payments. To achieve those, partners will pursue lab maintenance:

- In terms of financial support, through:
  - Internal funding from their organizational budget.
  - External funding through competitive calls and national sources.
- In terms of staffing, through existing technical personnel.
- In terms of institutionalization, by integrating the labs into the organograms of the respective universities.

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Furthermore, ICT-INOV lab equipment is integrated into the equipment inventories of project partners, for which each partner has internal policies and organizational practices for maintenance, support, and upgrading.

Following is a description of organizational planning for the future funding of physical labs at each partner site.

10.3.1 University of Malaya

Integration of the lab in the university's organogram

The Design Thinking lab established through the project organizationally belongs to the business port of the Faculty of Computer Science (FSKTM Technovation).

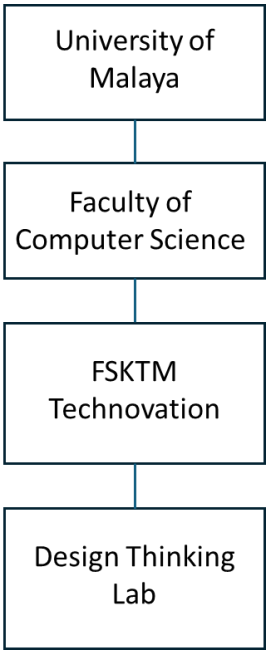

Figure 3. ICT-INOV Design Thinking Lab on the University of Malaya Organogram.

Staffing and financing plans

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The university will seek additional funding through Erasmus+ and national sources. In addition, in the future, the university plans to use the lab for revenue generation activities related to the organization of workshops by FSKTM Technovation staff in collaboration with other University of Malaya lecturers.

10.3.2 University Tenaga Nasional

Integration of the lab in the university's organogram

The Design Thinking lab (DT Lab) established through the project organizationally belongs to the College of Computing and Informatics, Information Resource Center.

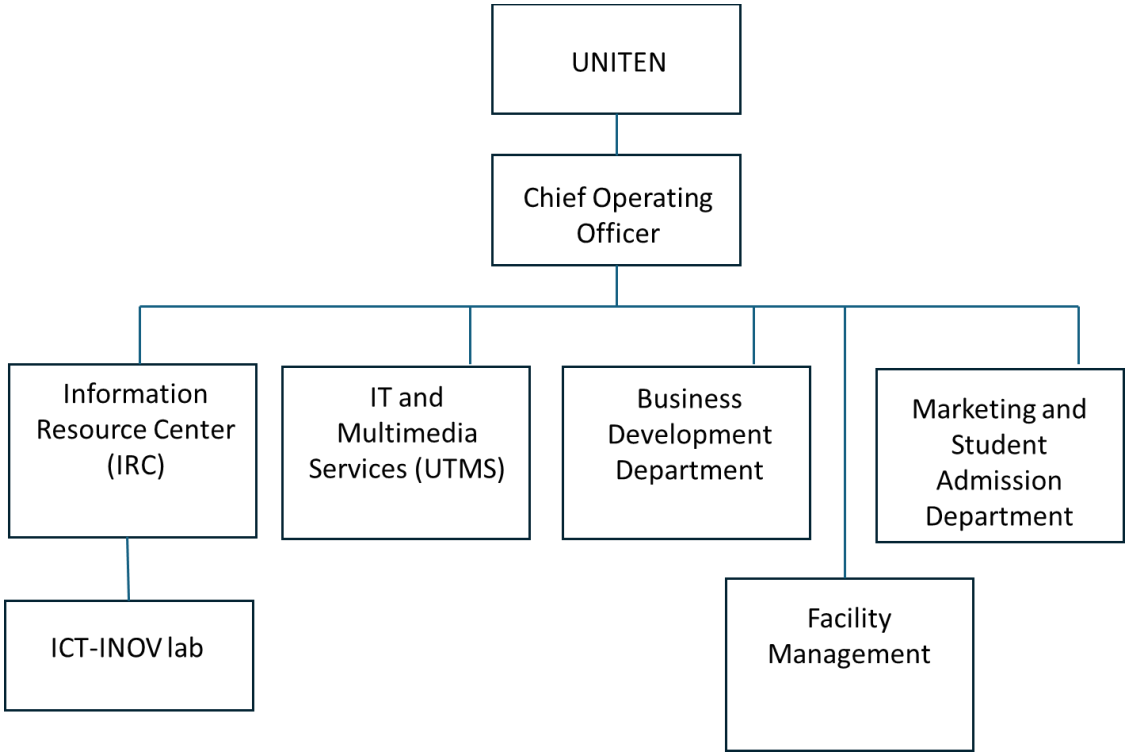

Figure 4. ICT-INOV lab in the organogram of UNITEN.

Staffing and financing plans

Co-funded by the Erasmus+ Programme of the European Union

The Design Thinking Lab developed through project ICT-INOV, is situated at UNITEN Information Resource Centre (IRC). The required capital expenditure (CAPEX) and operational expenditure (OPEX) for maintaining lab will be covered by the different business units in the university as follows:

- Staff costs will be covered by UNITEN's Human Resources. In this regard, no dedicated staff is expected to be hired to man the lab. Existing staff will be used with the additional job specification to look after the lab. For example, IRC staff currently handles the record of the lab's usage.
- Upgrading of furniture and equipment, where and if necessary, will be covered by the Facility Management, Safety, and Security Department.
- Upgrading and updating of hardware and software will be handled by the IT and Multimedia Services (ITMS) Department following the existing procedures.

The main purpose of the lab will be maintained for design thinking class activities. However, at times when it is not being used for design thinking, it can also be used by other instructors and students for other learning activities. This will continue for as long as the lab is relevant and current. As is often the case, the lab will have a relatively short lifespan and all computers in the lab will have to be replaced after obsolescence. Related financial resources can also be pursued through external research grants.

10.3.3 ISRA University

Integration of the lab in the university's organogram

ISRA University has 3 campuses in Hyderabad, Karachi, and Islamabad with the main campus in Hyderabad. The Hyderabad Campus has 4 faculties, namely Faculty of Medicine & Applied Medical Sciences, Faculty of Dentistry and Allied Sciences, Faculty of Commerce, Economics and

Management Sciences, and Faculty of Engineering, Science and Technology (FEST). The ICTINOV lab has been established under the Faculty of Engineering, Science and Technology (FEST).

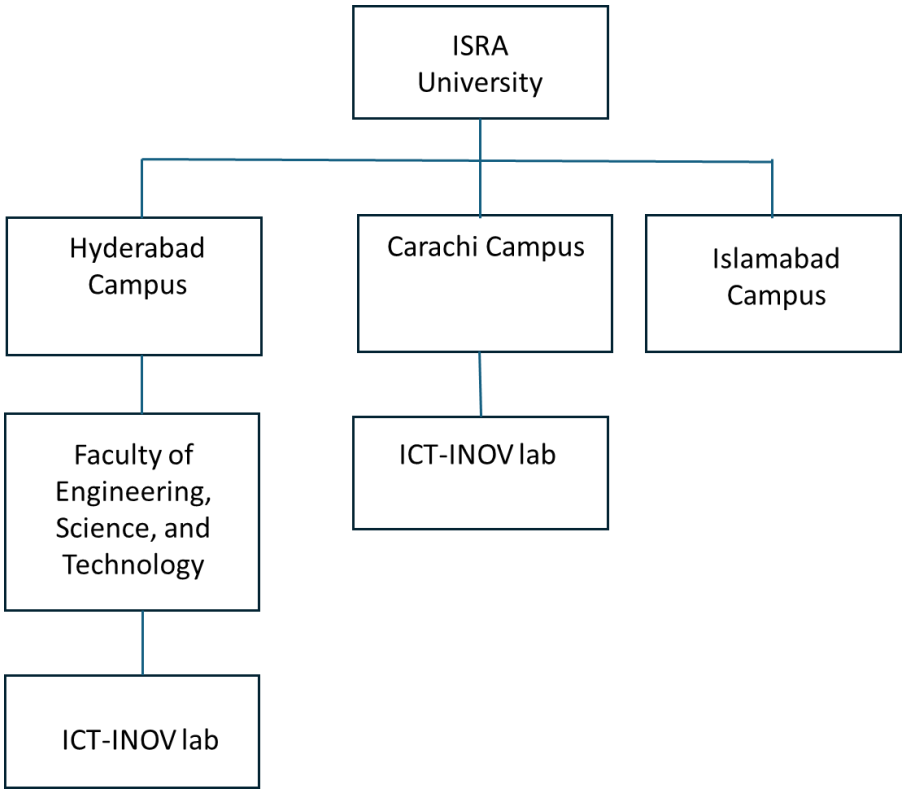

Figure 5. ICT-INOV lab on the organogram of ISRA University.

Staffing and financing plans

The lab will be managed by existing department technical support staff, namely the ITServ group of the Faculty of Engineering, Science, and Technology, with the budget allocated to the ITServ through the university organizational budget.

10.3.4 National University of Future and Emerging Sciences

Integration of the lab in the university's organogram

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The ICT-INOV lab organizationally belongs to the Department of Computer Science.

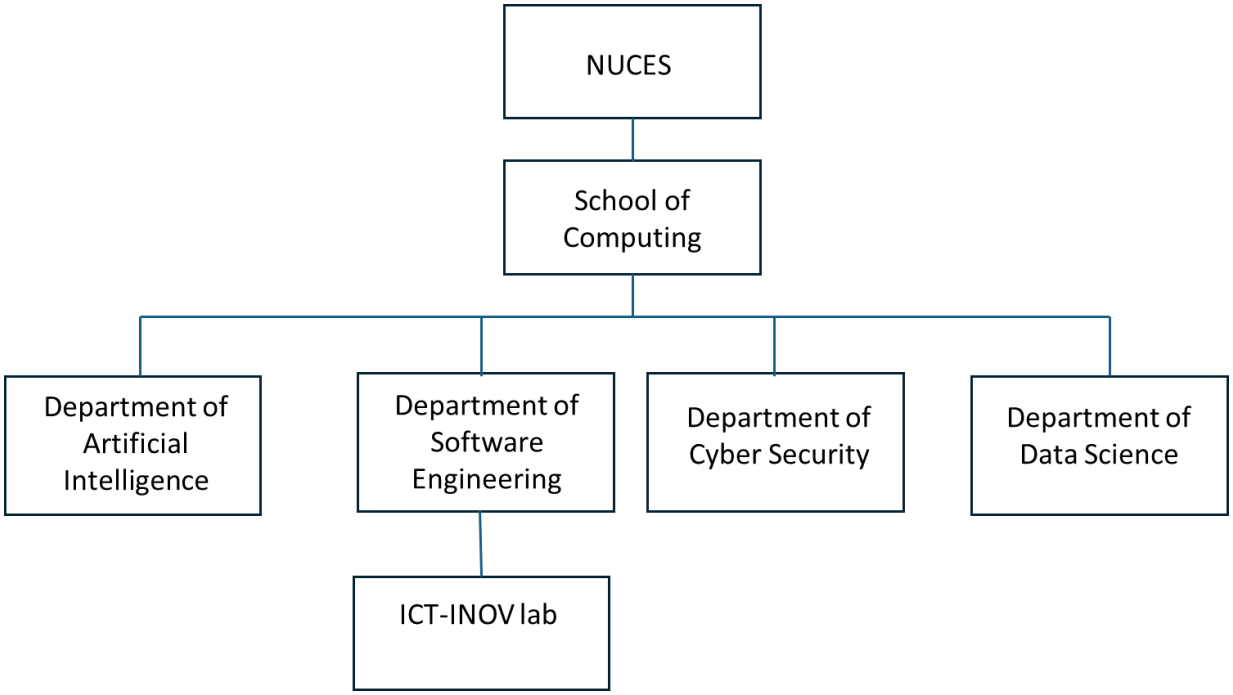

Figure 6. ICT-INOV lab on the organogram of the National University of Computer and Emerging Sciences.

Staffing and financing plans

The ICT-INOV lab will be sustained through internal university funds and through regional and national funds, which will be pursued to support both equipment upgrades and maintenance and staff payments.

10.3.5 Kathmandu University

Integration of the lab into the university's organogram

The ICT-INOV lab organizationally belongs to the School of Engineering of the university.

Staffing and financing plans

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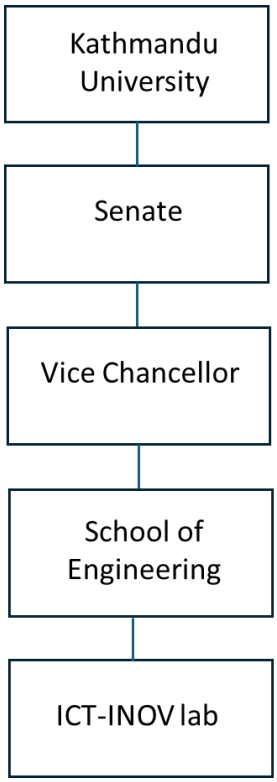
Maintenance, updates, and technical support of the lab will be achieved through the School of Engineering organizational budget.



10.3.6 Tribhuvan University

Integration of the lab into the university's organogram

The ICT-INOV Design Thinking Lab organizationally belongs to the Center of Energy Studies.

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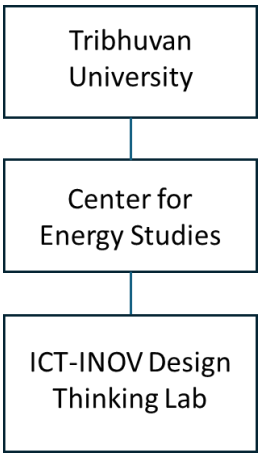

Figure 7. ICT-INOV Design Thinking Lab on the organogram of Tribhuvan University.

Staffing and financing plans

Lab resources are integrated into the university inventory. In terms of funding, repair and maintenance, staff allocation for technical support, equipment upgrades, and training of new staff will be facilitated by the university through existing budget. In addition, the lab operations can be financially supported through future funding from sources like the revenue from the service provided by the lab itself, University Grants Commission (UGC) of Nepal, and other national and international development partners.

In terms of staffing, the lab will be supported by technicians employed by the Center for Entergy studies, including lab manager, store-keeper, office administrator, and others.

10.3.7 Hanoi University

Integration of the lab into the university's organogram

The ICT-INOV lab organizationally belongs to the Faculty of Information Technology of the university. It is used by the faculty's departments, namely the Department of Math and Computer

Science, the Department of Information Technology, the Department of Information Systems, and the Department of Networking and Communication.

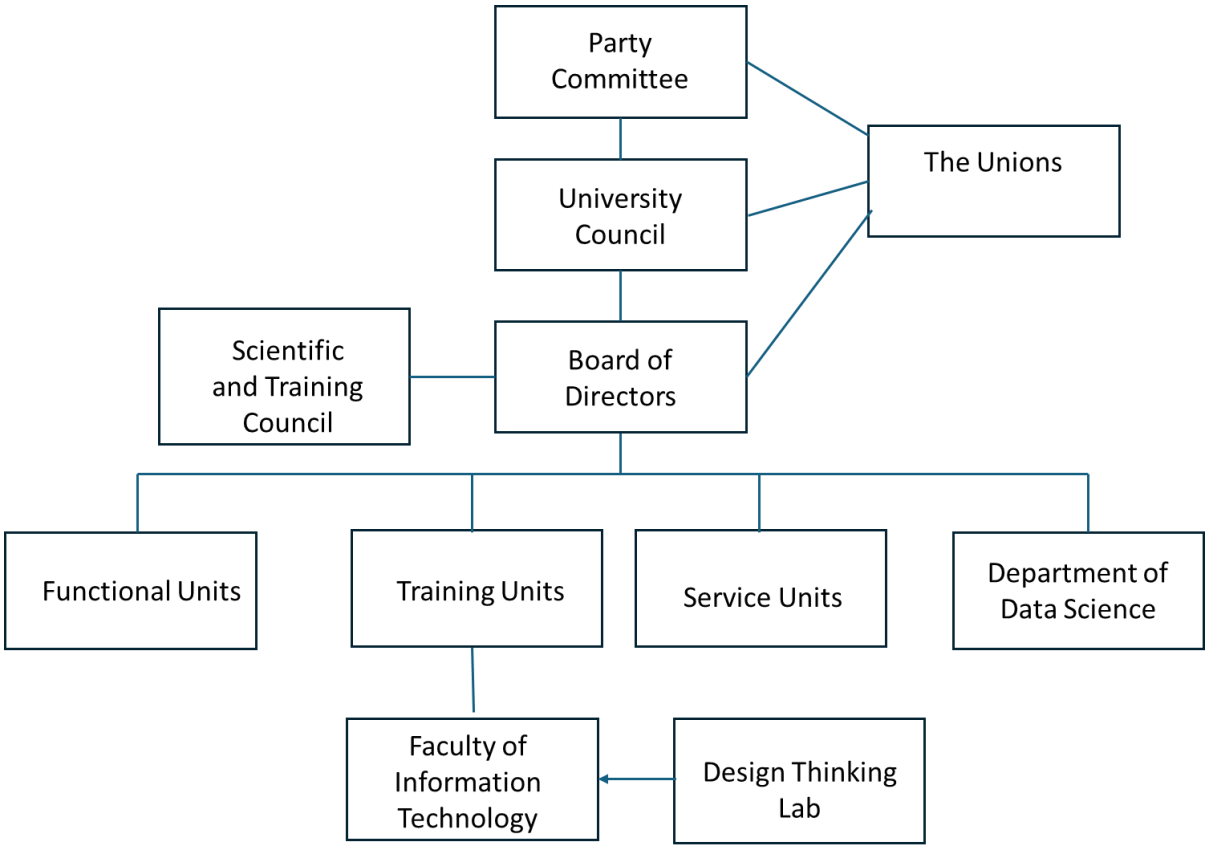

Figure 8. ICT-INOV Design Thinking Lab on the organogram of Hanoi University.

Staffing and financing plans

Lab sustainability requires the support of 2 technicians responsible for equipment maintenance as well as equipment updates and repairs. These expenses will be covered through university tuition revenue and through sponsorships by companies such as IPCOMS, FPT Corporation, or Flinters Vietnam.

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10.3.8 John Von Neumann Institute

Integration of the lab into the university's organogram

The ICT-INOV lab belongs to the John Von Neumann Institute.

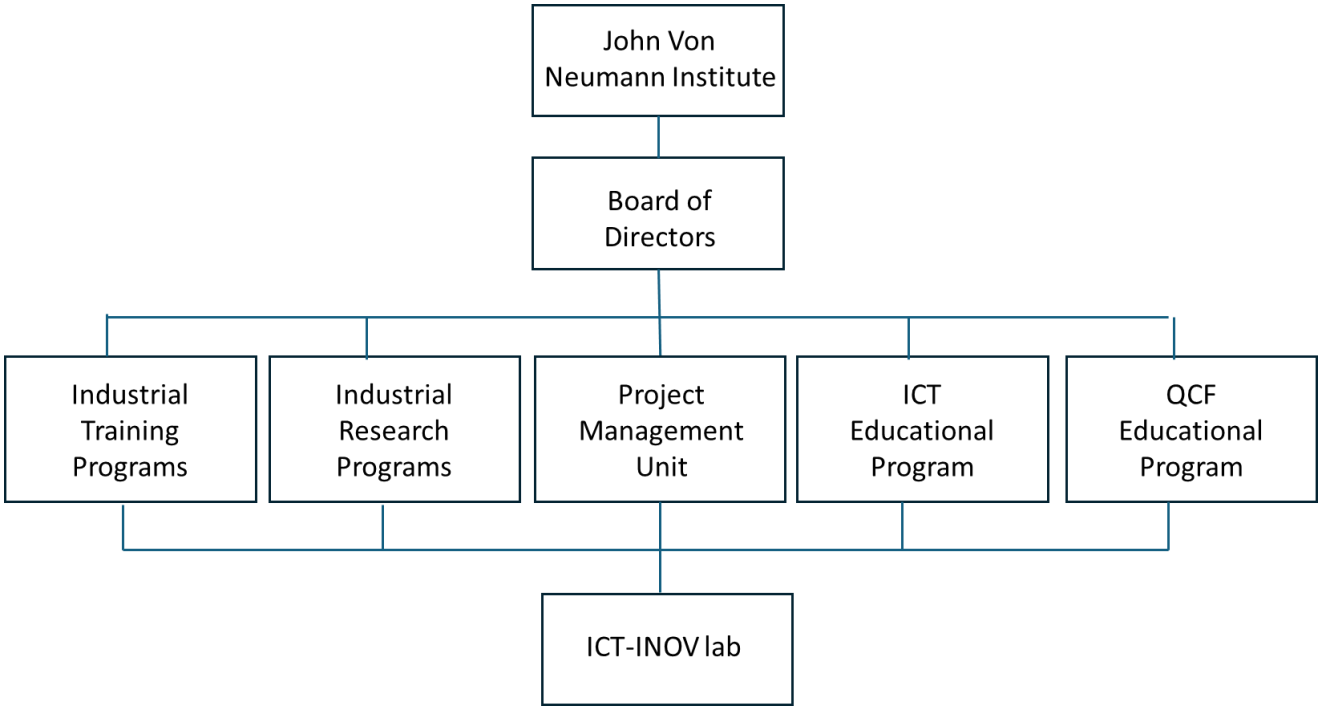

Figure 9. ICT-INOV innovation lab on the organogram of John Von Neumann Institute.

Staffing and financing plans

The organization plans on investing 5 to 10k Euros per year for upgrading and repairing lab equipment. In addition, the organization will fund 1 researcher to support students using the lab and 1 technical staff member to maintain equipment in good condition for exploitation. Staff costs are foreseen to be 10 to 12k Euros per year. The funds will originate from internal organizational resources.

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10.4 Sharing through Creative Commons

The ICT-INOV consortium makes all project outcomes available to interested parties through Creative Commons licenses, which support the reuse of software, educational content, technical reports. The type of Creative Commons license adopted by the ICT-INOV project is CC-BY-NC-ND. This license allows reusers to copy and distribute the material in any medium or format in unadapted form only, for noncommercial purposes only, and only so long as attribution is given to the creator. The license includes the following elements:

- BY: Credit must be given to the creator.
- NC: Only non-commercial uses of the work are permitted.
- ND: No derivatives or adaptations of the work are permitted.

Making project outcomes openly available through Creative Commons maximizes the impact of project implementation by facilitating the reach of additional educational organizations, students, educators, and other stakeholders, addressing diverse learning needs and helping reach broader educational goals.

10.5 ICT-INOV ambassadors

Instructor training during project implementation created a pool of educators and other staff members at partner organizations that are familiarized with the proposed gamified design thinking learning approach for building innovation skills. These individuals form a core team at partner sites that supports the continuation of training of peers beyond project completion. They are the ICT-INOV project “ambassadors” that facilitate the post-project sustainability of project results within their organizations and beyond. Notably, each partner has trained at least 30 educators and other staff members during the project implementation period, with this number having been significantly exceeded. The number of educators trained at all partner sites exceeds 800 individuals.

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10.6 Institutionalization through continued instructor training

Instructor training activities will continue through their integration into the on-going educator professional development initiatives of project partners.

Following is a high level description of instructor training planning for sustainability, developed by University Tenaga National and used as reference by all partners.

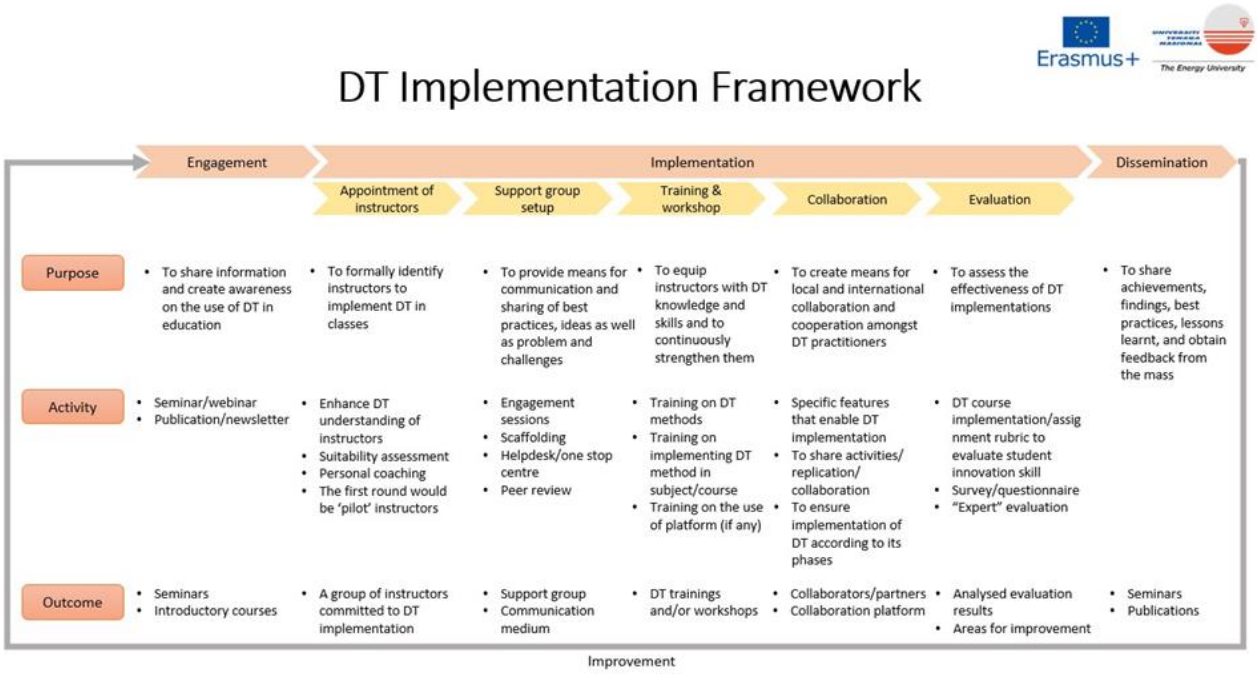

Figure 10. ICT-INOV instructor training plan developed by UNITEN, used as reference by all partners.

Specifically, the following are foreseen:

University of Malaya

Instructor training will be integrated into the Train the Trainer program organized in collaboration with the external company Technovation, which is a private spin-off company, and the Academic Development and Enhancement Centre.

University Tenaga Nasional

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The institutionalization of design thinking implementation through its use in courses is important for ensuring the sustainability of project outcomes in the long-term. The coordination of wide deployment of project outcomes in courses needs to be driven university management through the Teaching and Learning Centre (TLC). To support long-term project outcome integration, the implementation team has developed a framework for sustainable design thinking use shown below. The plan is comprised of the phases of engagement, implementation ,and dissemination. The implementation phase further consists of instructor appointment, support group setup, training, collaboration, and evaluation sub-phases. The framework can serve as a reference point for continuous engagement, appointment, and training of new instructors after the completion of the project.

ISRA University

Design thinking training will be integrated into newly hired educator orientation. After orientation, new faculty members will be associated with senior faculty that will support newcomers in the use of design thinking in courses.

National University of Future and Emerging Sciences

In-house training will be organized and funded by internal resources. The training will ensure that capacity building on innovation skill development will continue in the future without disruption.

Kathmandu University

The ICT-INOV lab will be sustained through internal resources of the university earmarked for training. Furthermore, the university will pursue funding from the University Grant Commission, National Academy of Science and Technology.

Tribhuvan University

Instructor training will be organized and delivered through organizational resources.

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Hanoi University

Instructor training will be held at least yearly, at the beginning of each academic year. All lecturers and staff will be trained in the use of the ICT-INOV lab and digital learning platform to implement design thinking in their courses.

John Von Neumann Institute

Instructor training will continue on a yearly basis. The organization will provide 1 to 2 instructor training courses for partners to expand the application of design thinking and innovative ideas on how to improve the courses syllabus and how courses are delivered to students. Each year, the organization will collect and summarize data regarding the application of design thinking in partner courses and how the methodology improves course quality and student innovation skills.

University of Thessaly

Instructor training will be delivered yearly by staff of the Creative Technologies Learning Lab to educators in the Engineering School of the University of Thessaly as well as other departments and universities.

Tallinn University

The need for training in design thinking is on the rise. Instructor training on the deployment of gamified design thinking will continue after the project has been completed through internal organizational resources.

Porto Polytechnic

Instructor training will be delivered every semester through existing organizational resources, with continuously updated content.

EUTrack

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Training will be delivered through the establishment of a permanent design thinking lab for instructors and students. In addition, training delivery will be pursued through Erasmus+ KA1.

10.7 Institutionalization through wider deployment in courses

Partners aim to integrate the proposed gamified design thinking approach widely in courses in order to ensure a critical mass of educational activities being modernized and internationalized through the proposed gamified design thinking approach for building innovation skills.

Following is an indicative list of courses in which project outcomes are already applied or will be applied in the medium term:

University of Malaya

- Advanced Algorithms.
- Computational Thinking.
- UX Design Studio.
- Real-Time Systems.
- Information Systems.
- Information Systems Control and Security.
- Thinking and Communication Skills.
- Human Computer Interaction.
- Algorithm Design and Analysis.
- Software Modelling.
- Software Verification and Validation.
- Software Testing.
- Software Process and Quality.
- Software Maintenance and Evolution.

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- Software Requirements Engineering.
- Advanced Internet of Things.
- Final Year Project.
- Robotics.
- Data Science Project.
- Cloud Computing.
- Architecting Software Systems.
- Mathematics of Networking.

University Tenaga Nasional

- Software Quality.
- Digital Business.
- Fundamental of Data & Information.
- Business Process Reengineering.
- Programming I.
- Software Engineering Principles.
- Multimedia Interface Design.
- Final Year project in Software Engineering.
- Object-Oriented Programming.
- Programming II.
- Introduction to Problem Solving and Basic Computers.
- Data Structures and Algorithms.
- Software Project Management.
- Critical Infrastructure Security.
- Advanced Web Application Development.

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- Digital Game Design.
- Enterprise Architecture.
- Technology Entrepreneurship.

ISRA University

- Software Project Management.
- Visual Programming.
- Final Year Project-I.
- Final Year Project-II.
- Formal Methods in Software Engineering.
- Operating Systems.
- Object-Oriented Programming.
- Discrete Mathematics.
- Introduction to Computing.
- Programming Fundamentals.
- Applied Physical.
- Data Structures and Algorithms.
- Database Design and Management.
- Design and Analysis of Algorithms.
- Machine Learning.
- Natural Language Processing.

NUCES

- Software Engineering.
- Introduction to Software Engineering.
- Human Computer Interaction.

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- User Experience.
- Software Quality Assurance.
- Advanced Requirements Engineering.
- Software Metrics.
- Algorithm analysis.
- Deep learning.
- MLops.

Kathmandu University

- Computer Architecture and Organization.
- Computer Graphics.
- Operating Systems.
- Artificial Intelligence.
- Combined Engineering Projects.
- Combined Computer Projects.
- Algorithms and Complexity.
- Computer Programming.
- Cloud Computing.
- System Analysis and Design.

Tribhuvan University

- Knowledge Engineering.
- Information Visualization.
- Machine Learning.
- Computer Programming.

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- Database Management Systems.
- Bachelor Program in Computer Engineering.
- Bachelor Program in Electronics, Communication, and Information Engineering.
- Master's Program in Communication and Knowledge Engineering.
- Master's Program in Computer Engineering- specialized in Data Science and Analytics.
- Database Management Systems: Bachelor in Computer Engineering.
- Master's Program in Energy Systems Planning and Management.

Hanoi University

- Systems Analysis and Design.
- Special Subjects I.
- Information Systems Design and Implementation.
- Human Computer Interaction.
- Enterprise Information Systems.
- Programming Design.
- Project Management.
- Distributed Systems.
- Databases.
- Special Subject II.
- Software Engineering.
- Marketing.
- Communication Theory.
- Visual Communication.
- Database Management Systems.
- Multimedia.

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John Von Neumann Institute

- Agile Software Project Management.
- Business process engineering.
- Security Systems Design.
- Business Process Analysis.
- Management Information Systems.
- Requirements Engineering.

University of Thessaly

- Discrete Mathematics.
- Game Design and Development.
- Serious Game Design.
- Technology in Education.
- Design Thinking in Information Technology.
- Design Thinking.
- Physics.
- Machine Learning.
- Advanced Software Engineering.
- Operating Systems.
- Special Subjects I.
- Special Subjects II.

Tallinn University

- ELU (LIFE) course.
- Project day in Tallinna Saksa Gümnaasium 18.04.22 (30 students).

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- Microdegree course on Environmental Innovation and Communication.
- Second ELU (LIFE) course.
- Design Thinking course in Rakvere Riigigümnaasium.

Porto Polytechnic

- Game Design course in the Master's in Computer Engineering program.
- Multimedia Application Development in the Master's in Computer Engineering program.

EUTrack

- EduRobot, Exploring, Creating, and Constructing.
- Enhancing Student Learning through Research-Based Approach.
- Robotics.
- Multimedia Learning Environments.
- Augmented Reality.
- STEM through Arts and Minigame Design.

10.8 Developing a network of universities, other educational organizations, and industry partners on innovation

Project partners will pursue the development of a network of universities for the promotion of the proposed gamified design thinking approach. The goal is to create a rich professional network for promoting innovation-building activities in higher education.

Following is an indicative list of universities, other educational organizations, and businesses beyond the consortium which project partners have established contacts with the objective of fostering wide uptake of results.

In Malaysia

- Universiti Malaysia Pahang, reached by the University of Malaya.

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- Universiti Kebangsaan Malaysia, reached by the University of Malaya.
- Universiti Teknologi PETRONAS, reached by University Tenaga National.
- Universiti Kuala Lumpur, reached by University Tenaga National.

In Pakistan

- University of Sufism and Modern Sciences, reached by ISRA University.
- Bhitshah College of Modern Sciences, Hyderabad, reached by ISRA University.
- Bahria University, reached by National University of Computer and Emerging Sciences.
- National University of Modern Languages, reached by National University of Computer and Emerging Sciences.
- National University of Technology, reached by National University of Computer and Emerging Sciences.
- Sindh Higher Education Commission, reached by ISRA University.
- Sindh Agriculture University, Tando Jam.
- Mehran University of Engineering and Technology.
- Sindh University.
- Superior University, Lahore.

In Ireland

- University of Cork, reached by National University of Computer and Emerging Sciences.

In China

- North-western Polytechnical University China, reached by National University of Computer and Emerging Sciences.

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In Nepal

- Pokhara University, reached by Tribhuvan and Kathmandu Universities.
- Purbanchal University, reached by Tribhuvan and Kathmandu Universities.
- Kathmandu Engineering College, reached by Tribhuvan University.
- Kantipur Engineering College, reached by Tribhuvan University.
- Padmakanya Multiple Campus, reached by Tribhuvan University.
- Nepal College of Information Technology, reached by Tribhuvan University.
- St. Xavier's college, reached by Tribhuvan University.
- Paschimanchal Campus, Pokhara, reached by Kathmandu University.
- Nepathya College, Manigram, reached by Kathmandu University.
- Kantipur City College, reached by Kathmandu University.
- Asian Institute of Technology amd Management, reached by Kathmandu University.
- Kathmandu University Technical Training Center, reached by Kathmandu University.
- Aspire College, reached by Kathmandu University.
- Sindhuli Community Technical Institute, reached by Kathmandu University.
- School of Management, Kathmandu University, reached by Kathmandu University.
- School of Science, Kathmandu University, reached by Kathmandu University.
- Pokhara Engineering College, reached by Kathmandu University.
- Lumbini Engineering College, reached by Kathmandu University.
- Gandaki University, reached by Kathmandu University.
- Gandaki College of Engineering and Sciences, reached by Kathmandu University.

In Vietnam

- Foreign Trade University, reached by Hanoi University.
- International School, Vietnam National University Hanoi, reached by Hanoi University.

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- FPT BTEC college, reached by Hanoi University.
- FPT University, to which seminars on design thinking are being delivered, reached by Hanoi University.
- Hanoi Architectural University, reached by Hanoi University.
- Posts and Telecommunications Institute of Technology, reached by Hanoi University.
- University of Transport Technology, reached by Hanoi University.
- FPT BTEC college, reached by Hanoi University.
- IpComs company, reached by Hanoi University.
- FPT software company, reached by Hanoi University.
- Avada group, reached by Hanoi University.
- HCL Vietnam, reached by Hanoi University.
- International University - Vietnam National University of Ho Chi Minh City, reached by John Von Neumann Institute.
- University of Science Ho Chi Minh City, reached by John Von Neumann Institute.
- Thu Dau Mot University, reached by John Von Neumann Institute.
- Saigon University, reached by John Von Neumann Institute.
- Polytechnique University - Vietnam National University of Ho Chi Minh City, reached by John Von Neumann Institute.
- Van Lang University, reached by John Von Neumann Institute.
- University of Economic and Finance, reached by John Von Neumann Institute.
- Hoa Sen University, reached by John Von Neumann Institute.
- Hong Bang University, reached by John Von Neumann Institute.
- Ho Chi Minh University of Technology reached by John Von Neumann Institute.
- Vietnam Germany University reached by John Von Neumann Institute.
- Thu Dau Mot University reached by John Von Neumann Institute.

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- Eastern International University reached by John Von Neumann Institute.
- Information and Mass Communication Institute of Ho Chi Minh City, reached by John Von Neumann Institute.
- Ho Chi Minh Cadre Academy, reached by John Von Neumann Institute.
- Tran Dai Nghia High School for the Gifted, reached by John Von Neumann Institute.

In Uganda

- Makerere Institute of Social Research, reached by EUTrack.

In Indonesia

- Binus University Jakarta and Bandung, reached by the University of Malaya.

In Marroco

- Mohammed V University in Rabat, reached by EUTrack.

In Taiwan

- National Cheng Kung University, Tainan, reached by the University of Malaya.

In Greece

- University of the Aegean, and specifically the Industrial Design Department, reached by the University of Thessaly.
- Hellenic Open University, which offers degrees in a wide range of disciplines, reached by the University of Thessaly.
- Aristotle University of Thessaloniki, reached by the University of Thessaly.
- 2nd Evening Vocational High School of Volos, reached by the University of Thessaly.
- Educational authorities of the area of Magnesia and the wider area of Thessaly, reached by the University of Thessaly.

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- The IEEE Student Branch, reached by the University of Thessaly.
- The Music High School of Volos, reached by the University of Thessaly.
- The High School of Argalasti, Magnesia, reached by the University of Thessaly.

In Estonia

- University of Tartu, reached by Tallinn University.
- Estonian University of Life Sciences, reached by Tallinn University.
- Rakvere Riigigümnaasium, reached by Tallinn University.
- Tallinna Saksa Gümnaasium, reached by Tallinn University.
- Eesti Maaülikool, reached by Tallinn University.
- Tartu Observatoorium, reached by Tallinn University.
- Saue Riigigümnaasium, reached by Tallinn University.
- TalTech, reached by Tallinn University.
- SOL, reached by Tallinn University.
- Liviko, reached by Tallinn University.
- Roheline Vald MTÜ, reached by Tallinn University.
- Tallinna Linnavolikogu Katselei, reached by Tallinn University.

In Portugal

- University of Minho, reached by Porto Polytechnic.
- University of Aveiro, reached by Porto Polytechnic.
- Polytechnic of Leiria, reached by Porto Polytechnic.
- Polytechnic of Bragança, reached by Porto Polytechnic.

In Spain

- Universidad de Vigo, reached by Porto Polytechnic.

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In Italy

- Università degli Studi La Sapienza, reached by EUTrack.
- Università degli Studi di Cassino, reached by EUTrack.
- I.C. Maria Montessori, reached by EUTrack.
- ITS Arturo Bianchini, reached by EUTrack.
- I.C. Milani, reached by EUTrack.
- Liceo Leonardo Da Vinci, reached by EUTrack.
- I.C. Aspri, reached by EUTrack.
- Università la Sapienza di Roma, reached by EUTrack.
- Associazione “Le Colline” Di Santo Stefano, reached by EUTrack.
- I.C. San Felice Circeo, reached by EUTrack.
- GC-FS Alumni, reached by EUTrack.

In Germany

- FOS in Freising, reached by EUTrack.
- Lutherschile, reached by EUTrack.

In Sweden

- City of Goetebord, reached by EUTrack.

In Lithuania

- Kauno R. Domeikavos Gimnazija, reached by EUTrack.

In Romania

- Colegiul National Mircea cel Batran, reached by EUTrack.
- Proeuro-cons Association, reached by EUTrack.

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In Poland

- CRH Akademos sp. z o.o, reached by EUTrack.

In Belgium

- Go! Lennih, reached by EUTrack.

In Latvia

- Latvia Culture College, reached by EUTrack.
- BA School of Business and Finance, reached by EUTrack.

In Slovenia

- Univerza V Ljublajani, reached by EUTrack.
- UPI Ljudska univerza Žalec, reached by EUTrack.
- Zasavska ljudska univerza, reached by EUTrack.
- Ljudska univerza Jesenice, reached by EUTrack.

In Turkey

- Bafra Ilçe Milli Egitim Mudurlugu, reached by EUTrack.
- Yildiz Technical University, reached by EUTrack.

Notably, this list is only indicative to demonstrate the networking potential of the consortium towards maximizing the impact of project outcomes in the higher education sector. Additional universities, educational organizations, or professional associations will be reached by consortium partners for promoting the adoption of results.

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10.9 Signing a memorandum of understanding among project partners for continued collaboration

A memorandum of understanding has been signed by ICT-INOV consortium members. The memorandum aims to establish a framework for the continued collaboration of project partners on innovation building activities through research and development. More specifically, the memorandum foresees partner collaboration in the following aspects:

The exchange of information on their respective educational systems and policies to assist in ongoing education reform and to facilitate the adoption of emerging learning design;

- The exchange of information on their respective educational systems and policies to assist in ongoing education reform and to facilitate the adoption of emerging learning design.
- The exchange and professional development of officials, academics, scholars, teachers, experts, students and administrative staff.
- Collaboration in joint delivery and research programs, activities, and publications, including exchange of research materials, publications and educational literature, or any other activity of mutual interest.
- Joint conferences, exhibitions and symposia on matters in common areas of interest; and other forms of cooperation in mutually determined and targeted areas.
- Exploration of collaboration at the educational course and program level.

In terms of implementation of the above objectives, the partners have agreed that the cost of cooperative activities may be funded as mutually determined, with cooperative activities under the memorandum of understanding being subject to the availability of funds and with each partner bearing the costs of its participation.

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11. Reaching the higher education market

The ICT-INOV sustainability strategy aims at reaching the higher education market bottom-up.

Initially, steps are taken to ensure that access to the ICT-INOV digital learning solution is effectively installed and accessible through the Internet to all interested parties, including students, educators, educational organizations, and other stakeholders.

Figure 11. Reaching the higher education market bottom-up.

The solution is deployed internally at partner organizations through institutionalization initiatives that include instructor training, technical support on the use of digital learning services and labs, creation of new educational activities in the digital learning platform, and deployment in courses.

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The solution is made openly available to external parties through Creative Commons licenses that encourage reuse in broad educational contexts. It is shared with external organizations through simple processes that involve a straightforward registration to digital learning services.

Finally, community events help promote project outcomes to a network of educational organizations. This activity initially involves reaching organizations that partners have working relationships with regarding the adoption of project results (see section *10.8 Developing a network of universities*). These organizations in turn, will contribute to the extension of the network, which will gradually expand.

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12. Impact indicators for monitoring sustainability in the short and medium term

Following are impact indicators with concrete targets for the adoption of project outcomes consortium-wide and beyond. The table includes:

- Proposal targets.
- Targets achieved upon project completion, which demonstrate that proposal targets have been exceeded.
- Projections of targets 3 years and 5 years after the completion of the implementation period based on current performance indicators.

Impact indicator	**Proposal target**	**Achieved by project completion**	**Projected 3 years after completion**	**Projected 5 years after completion**
Number of courses enriched	60	69	120	144
Number of educational activities created	45	150	200	300
Number of students engaged in educational activities	1,200	4,200	5,000	6,000
Number of instructors trained	360	900	1,000	1,200
Number of participants in community building events	600	1,500	1,700	2,400

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Number of universities beyond the consortium reached for promoting the adoption of the proposed gamified design thinking approach for innovation		24	48	72

Table 1. Sustainability indicators.

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Conclusions

This document presents the sustainability plan of project ICT-INOV. The plan identifies activities and outcomes that will be sustained after the completion of the implementation period. In addition, it provides a discussion of tailored steps that will ensure the medium to long-term adoption of project outcomes within and beyond partner organizations. The sustainability plan is based on providing open access to project outcomes for maximizing positive impact not only for partners but for interested external to the consortium organizations, fostering the institutionalization of project results among project participants, ensuring necessary instructor training, and developing a network of universities that will contribute to the sharing of experiences on student innovation skill development through emerging gamified design thinking digital learning approaches.

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