

DIGITAL COLLABORATION SERVICES FOR FOSTERING INNOVATION SKILLS IN ICT EDUCATION

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Abstract

Computer Science and Engineering is an innovation sector that fuels economic growth and job creation driven by high demand for digital services in areas that range from education to government and financial management. Digital technology allows anytime, anywhere high accessibility to information, knowledge, and services at a continuously decreasing cost. Given the importance of digital economy for growth, universities have a responsibility to modernize their educational practices for harvesting the sector's innovation potential by developing highly skilled young ICT professionals who will be the problem solvers of tomorrow. Building the innovation capacity of ICT students is crucial for several reasons: it benefits young professionals by providing them the knowledge and skills they need for pursuing successful, long careers in a growing and highly evolving sector; it builds a highly skilled workforce that industry needs for pursuing emerging business opportunities addressing shortages in skilled professionals; it contributes to growth and wellbeing of communities by design solutions that address pressing industry and societal issues. This work presents a learning intervention that aims to enrich the potential of ICT higher education in Asia and Europe to harvest the innovation potential of students, empowering them to bring ideas into action. In addition to developing physical infrastructure and providing instructor training for capacity building purposes, the proposed solution focuses on the design and implementation of a digital collaboration service that deploys design thinking and gamification for promoting student engagement in innovation building activities. The service allows educators to flexibly structure challenges inspired by real-life and share them with peers for supporting collective capacity building on designing learning activities for innovation. It further encourages students to address meaningful problems by sharing and building on each other's ideas in and out of the classroom through a shared digital working space that can be modified and updated by team members concurrently. Gamification elements encourage participation through rewards that allow participants to unlock new features and enrich their working environment.

Keywords: innovation, capacity building, design thinking, collaboration, higher education

1 INTRODUCTION

Computer Science and Computer Engineering are highly innovative sectors that drive economic development and job creation. The high growth of ICT is a result of the rapid growth of networks, which drives high demand for new services and enables supply through the design and implementation of innovative digital solutions in areas that range from education to government and financial management, allowing anytime, anywhere high accessibility to information, knowledge, and services at a continuously decreasing cost.

In educational contexts, the evolution of ICT allows the introduction of practical, workable, financially feasible, and sustainable solutions that allow students to be connected to the world. In the face of rapid evolution of digital technologies, universities have a responsibility to modernize their educational practices for harvesting the sector's innovation potential by developing highly skilled young ICT professionals. Building the innovation capacity of ICT students is crucial for several reasons: it benefits young professionals by providing them the knowledge and skills they need for pursuing successful, long careers in a growing and highly evolving sector; it builds a highly skilled workforce that industry needs for pursuing emerging business opportunities addressing shortages in skilled professionals; it contributes to growth and wellbeing of communities by design solutions that address pressing industry and societal issues.

This work presents a learning intervention for promoting the development of innovation capacity among ICT students, implemented in the context of project ICT-INOV: Modernizing ICT Education for Harvesting Innovation [1]. A digital collaboration service is under development that encourages students to engage in problem-solving in teams anywhere and anytime. The service integrates gamification and design thinking, which fosters the introduction of solutions to complex issues even when none appears

to exist at first glance. This is achieved through a process of problem-discovery that allows designers to put themselves in the position of users either literally, by immersing themselves in the users' environment, or through an engagement process that helps them better understand actual, as opposed to perceived, needs. The process allows for the definition of a more accurate problem statement, which in turn may enable the design of more effective solutions. Design thinking encourages brainstorming for introducing a broad toolset of potential solutions, from which the design team selects the most viable for developing and evaluating prototypes by further engaging users.

Through the learning service under development students work in jointly owned digital workspaces in which they may share their work on problem discovery and understanding, analysis of user needs, problem definition, and solution design. The proposed service is flexible and encourages students to share and build on each other's ideas through small notes posted on a common canvas. The educator has broad flexibility in designing the exercises for engaging students as well as in highlighting specific steps of the design thinking process.

The work is implemented by a consortium of universities in Greece, Portugal, Italy, Estonia, Malaysia, Vietnam, Pakistan, and Nepal encouraging the exchange of know-how and experiences towards modernizing higher education practices. The work aims to build the capacity of participating institutions on developing innovation skills among students.

2 NEEDS ANALYSIS ON BUILDING INNOVATION SKILLS IN ICT HIGHER EDUCATION

While the countries in focus of this work have diverse growth strengths and face diverse challenges, an analysis of current practices on fostering innovation in ICT education demonstrated some common educational goals related to the development of innovation skills [8]. Innovation capacity is not a single skill. Rather a student needs to build a wide range of competencies in order turn innovative ideas into action, such as critical thinking, flexibility, synthesis, open-mindedness, emotional intelligence, creativity, establishing associations, optimism, resilience, and more. The need to develop innovation skills among higher education students, who will be challenged in the future as professionals to address pressing issues related to sustainable growth [2] is recognized by the researchers at the 12 universities and educational organizations that participated in an analysis of good practices [9], namely the University of Thessaly (Greece), Porto Polytechnic (Portugal), Tallinn University (Estonia), EUTrack (Italy), Universiti of Malaya (Malaysia), Univesiti Tenaga Nasional (Malaysia), ISRA University (Pakistan), National University of Future and Emerging Sciences (Pakistan), Kathmandu University (Nepal), Tribhuvan University (Nepal), Hanoi University (Vietnam), and Non Neumann Institute (Vietnam). In many cases, innovation skills are linked to entrepreneurship. The analysis demonstrated that the methodologies mostly deployed for building innovation skills are based on problem-solving and active learning approaches, through which students learn by doing. Examples of activities include thesis projects that are based on research and development work or through student mobility in the form of practical training in collaboration with industry.

In addition, a questionnaire-based study engaged 368 students with the objective of documenting expectations on innovation skill building and exposure to innovative learning design [6]. The study highlighted the fact that students value innovation skills, identifying problem solving, creative thinking, analytical thinking, data gathering, and thinking out of the box as the most significant. In relation to methodological learning design, students are somewhat less familiar with design thinking in comparison with methodologies such as problem-based, active, and experiential learning. They have been exposed to activities such as learning games, virtual meeting spaces, case studies, simulations, software development, and problem-solving in the context of lab work. In terms of digital supporting tools for learning, students have been mostly exposed to on-line learning systems, simulations and games, collaboration systems, and on-line communities. These findings demonstrate that there is room for improvement towards enriching innovation-building learning experiences through emerging educational design, such as design thinking, supported by digital technology.

3 METHODOLOGICAL LEARNING DESIGN

The ICT-INOV project introduces learning design for building innovation skills based on design thinking approaches integrated with gamification. Design thinking aims to introduce human-centered solutions. It goes beyond the traditional user-centered approaches deployed in the design of services and products, which often involve questionnaire-based studies or interviews. Design thinking develops an

understanding on actual, as opposed to perceived, user needs. This is achieved through observation or immersion that allows designers to understand the user experiences as well feelings from exposure to a proposed solution. For example, if the objective of a design team is to introduce solutions for improving the quality of life of inhabitants in a remote community, designers may opt to live in the community for a period of time to experience the challenges that the inhabitants face. More than anything, design thinking is about innovation. Design thinkers strive to find solutions that are desirable, feasible and viable [3]. Feasibility refers to the functionality that is possible in the foreseeable future. Viability refers to the possibility of a design becoming a sustainable business model. Desirability refers to user actual needs.

Design thinking may be deployed in diverse ways. Some key steps that designers follow include problem discovery, problem-statement definition, ideation, prototyping, and evaluation [4][5]. Problem discovery refers to the process of researching a project, establishing associations, and understanding actual needs through immersion, interviews, and observation of users in their everyday activities. Once designers have a better understanding of a problem and its parameters, they work on the definition, or re-definition, of a problem statement. The process of problem-statement definition involves using the information collected in the problem discovery phase integrated with the designer's understanding of the analysis to create a point of view statement. The accurate definition of a problem may allow the design team to introduce solutions to difficult problems, even if none may appear to exist at first glance. The next step in the process is ideation, which refers to generating as many ideas that can contribute to the design of a solution as possible. It is important to be open-minded in this process, welcoming a range of solutions, from mainstream to out-of-the-box. From these, the design team selects one solution that is turned into a prototype that users can engage with and provide feedback. If user feedback demonstrates that a solution is not optimal, the process may be repeated until the needs of users are addressed.

Design thinking encourages students to engage in a journey that is focused on addressing user needs in a feasible manner by considering constraints on available resources, solutions that have worked in similar situations, or solutions that were effective in other contexts and can be adapted to solve the problem at hand [3]. The design process is very creative, and is a motivating factor for student engagement. To further motivate students, design thinking may be integrated with gamification, namely the deployment of gaming elements in non-game contexts, including learning. Gamification aims to encourage intrinsic motivation in learners through elements such as clear missions, rules and structure, a sense of affiliation, rewards, penalty avoidance, immersion, a sense of progress and achievement, immersion, socialization, feedback, social recognition, and more. In wider design thinking practices [11][12], gamification elements may reward student active engagement, team spirit, innovative thinking, lateral thinking, providing and accepting feedback, and ultimately addressing user needs.

4 A LEARNING INTERVENTION FOR BUILDING INNOVATION SKILLS

The ICT-INOV project introduces a learning intervention that helps build student capacity to synthesize innovative and entrepreneurial solutions in business and social entrepreneurship contexts to create value for individuals and communities, enrich life quality and address the complex challenges of the 21st century. This is pursued through active learning design in which learners will be challenged to design interventions by thinking out of the box, working in teams, brainstorming, synthesizing ideas, and evaluating solutions.

ICT-INOV aims develop innovation skills by fostering collaboration in design thinking contexts both in and outside of the classroom through a digital learning platform that promotes teamwork, brainstorming, and building on each other's ideas from anywhere and anytime. Student engagement is further motivated through gamification elements that reward creativity and introduce a sense of achievement.

The ICT-INOV learning intervention is vertical, comprehensively addressing challenges related to the development of innovation capacity, including the lack of physical and digital infrastructures and the need for instructor training. Specifically, the project develops [7]:

Design thinking physical labs at partner universities located in Asia. The labs include equipment that supports student collaboration in the context of innovation capacity building activities.

A digital design thinking platform for facilitating student collaboration in and outside of the classroom, face-to-face or in distributed teams, promoting group work towards innovation.

Instructor training and community building in an ongoing manner with the objective of developing the capacity of educators and educational organizations to adopt learning methodologies that promote

innovation skills among students through design thinking approaches by sharing experiences and good practices.

4.1 A digital platform form promoting collaboration in design thinking

The ICT-INOV digital platform promotes collaboration in design thinking through services for students and educators. The platform supports teams in working together on a digital workspace, sharing ideas and building on each other's input for synthesizing solutions.

For educators, the platform introduces a service through which they can structure in a personal working space learning challenges following the stepwise solution creation paradigm of design thinking. Recognizing the fact that design thinking may be applied in diverse ways, the platform allows flexibility to educators in defining the number of steps they wish to include in an activity as well as the name of each step. For example, an educator may wish to structure an activity including the steps of empathy, problem statement definition, ideation, prototyping, and testing; another educator may wish to deploy the steps of problem discovery, problem statement definition, brainstorming, problem statement re-definition, prototyping, and evaluation. Educators can share instructions for the implementation of each step by posting them in the form of notes on a working canvas. Subsequently, the educator can create a course, which is a learning activity with a specific start and end date. In the context of the course, the educator can define student teams, assign the same or different challenges to each, follow team progress, and provide feedback upon the request of students.

When educators feel that a challenge is well-designed, they have the option of making the challenge public. Public challenges are visible by peers in a public library of content. They can be reused directly without modification or cloned in the personal working space and modified to address the specific needs of a different course. The sharing of content supports the capacity building objectives of the project. Educators that are new to design thinking to start using the ICT-INOV service, developing experience to gradually design activities of their own. In other words, the design offers a low floor high ceiling approach in engaging and in designing challenges.

For students, the platform supports collaboration for designing a solution to the challenge introduced by the educator. Upon the assignment of a challenge by the teacher, each team has access to the challenge instructions through a dedicated team joint digital workspace. Students follow the instructions in each step and share ideas by posting notes that are visible and editable in real time by all team members, whether they are in the classroom or not. The result is a rich canvas of ideas related to the analysis performed by students in each design thinking stage included in the learning activity. It is a showcase of student work, demonstrating their creativity and innovative thinking. Students have the option of asking the educator or peers to review their work and provide insight. By doing that, they provide access to other in the digital workspace, allowing them to post as if they were members of the team. This allows collaboration not only among team members but also across teams [13].

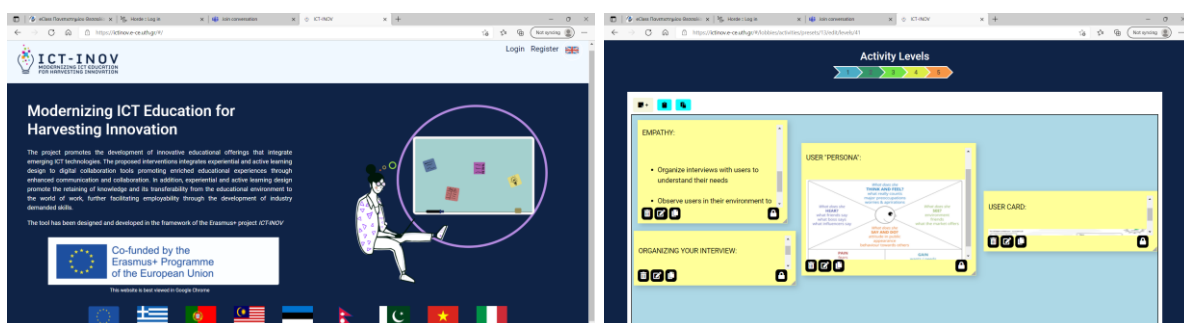


Figure 1. Early design of the ICT-INOV digital collaboration platform for design thinking. The login screen (left) and activity design (right).

The ICT-INOV platform integrates gamification elements to encourage student and educator participation by rewarding active engagement. Two elements of gamification are deployed: points and experience.

In relation to points, participants can upvote or downvote the contributions of peers. Students can upvote or downvote the notes of other students. Educators can upvote public challenges. When an individual receives a certain number of upvotes, they gain the right to engage in the upvoting and downvoting process.

On the other hand, participants gain experience by engaging in design thinking activities through the platform, such as posting notes, reviewing the notes of others, asking for help by peers, and more. Students can use experience points to unlock features such as the support of different colours of notes that allow them to organize their ideas, different board styles, different avatar background colours, and different avatar text colours.

5 CONCLUSIONS

This work presented an early design of a learning intervention that aims to promote the development of innovation skills among higher education students through an integration of design thinking and gamification. The work is implemented in the context of the ICT-INOV project funded with the support of the CBHE Erasmus+ program. The intervention aims at capacity building in Europe and Asia towards the development of innovation skills in higher education. In addition to the development of physical labs and instructor training, a digital service is under development that supports team collaboration on the design of solutions to challenges inspired by real life. The proposed digital learning platform is currently being piloted in 12 universities in Europe and Asia in the context of several courses. Piloting helps inform platform design, which will continue to evolve throughout the project implementation to address the needs of participating universities on modernizing educational practices for harvesting innovation.

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