Gamified Collaborative Learning for Innovation

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Abstract. 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, this work presents a collaborative digital learning platform that supports teams in introducing innovative solutions through design thinking principles and steps. The platform allows teams to work in real-time on problem discovery, ideation, and evaluation of ideas. It further allows educators to structure design thinking activities, monitor student team progress, and provide feedback.

Keywords: Collaborative learning, gamified learning, innovation, design thinking.

1   Introduction

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 activities are fostered by digital networks, interest groups, and rich communication channels. Business is supported 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 updating of educational offerings towards

meeting industry demand for emerging skills and competences. Educational curricula are continuously updated to address new knowledge. However, curricula evolution may take place at a pace slower than that of rapid technological progress, as technology that was considered innovative only a few years earlier may today be obsolete, having been replaced by more advanced competitive digital products and services.

In this context, the most important benefit that higher education can offer to students is developing their capacity for innovation, empowering them to stay at the forefront of their sectors in the long-term 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 critical and analytical thinking, collaboration capacity, creativity, experimentation, adaptability, and ability to work in uncertainty.

This work presents the design and development of a digital collaborative educational service that encourages innovative thinking in teams. The service supports student real-time collaboration in ideation, sharing, and evaluation of ideas. It further supports educators in the structuring and delivery in the classroom of educational activities for innovation, the monitoring of student work, and the provision of feedback.

2   Design for innovation

In the future, all problems will be design problems [2]. This includes the sustainability challenges that society faces in the 21st century, such as fighting poverty and hunger, quality education, health for all, clean and affordable energy, sustainable cities, equality and equity, innovation and infrastructure, climate action, preservation of life on land and in the sea, and more [3].

Addressing these issues effectively can be best achieved through user-centered design, which is the focus of software engineering and other practices [4]. User-centered design aims at effectively understanding needs and desires, allowing the introduction of solutions for positive impact. Often, this is achieved through interviews, questionnaires, or focus groups. Design thinking offers a new approach for understanding user needs through empathy and observation [2]. The process aims to support design teams in understanding real, as opposed to perceived needs, opening new avenues for introducing effective results. The design thinking process follows a series of steps for synthesizing and evaluating outcomes, including:

- Problem discovery, in which designers develop understanding of the parameters of a problem through activities that allow designers to be open-minded and perceptive. To understand real needs, both direct and latent, designers may observe users in their natural environment. They may further put themselves in the shoes of users, pursuing to experience first-hand the challenges that users face. They may further conduct interviews, documenting the needs of a characteristic user in a user persona [5].
- Problem re-definition, in which designers integrate findings from the discovery phase with their own point of view to define a problem from the perspective of users in a manner that allows the introduction of a rich collection of potential solutions.

- Ideation, in which design teams create a rich pool of ideas, ranging from conventional to out-of-the-box that can be synthesized into an innovative result.
- Evaluation, in which designers analyze the idea pool and select one for prototyping based on its desirability and feasibility.
- Prototype design and testing, in which designers create a quick and discardable prototype of their suggested solution with the objective of allowing users to interact with it, documenting feedback on functional and emotional aspects of the solution to determine how it addresses actual needs.

Design thinking offers benefits in entrepreneurship and social entrepreneurship contexts. In the former, it allows the introduction of solutions that best address customer needs. In the latter, it fosters the design of solutions to societal challenges. An often discussed example of design thinking in entrepreneurship involves AirBnb®, which used the process to improve customer experience on its website, leading to significant revenue increase. An example of using design thinking in social innovation involves work by Jerry Sternin and his wife Monique, who used the process to decrease malnutrition in Vietnam by observing practices in food collection and preparation that some families used and training others to follow the same for achieving higher nourishment levels [6].

3 Experiential and collaborative learning for innovation

Innovation skills are in demand in industry and society as they are linked to problem-solving capacity in broad contexts. Educational interventions that aim at innovation capacity building must consider the transferability of these ubiquitous competences from the academic environment to the real world. Students must be able to deploy innovation skills beyond their academic curricula in professional settings.

Educational methodologies such as experiential learning can offer benefits on the transferability of the skills from the academic environment to the world of work. Experiential learning, as defined by Kolb, advocates that learning is triggered by an experience [7]. The learner reflects on the experience, learns from it, and applies the new knowledge in real life. Experiential learning is closely related to problem-based learning, in which learners build knowledge through exposure to a usually non-trivial, open problem inspired by the real world [9].

In addition, innovation most often requires teamwork as the knowledge and skills necessary to synthesize solutions do not lie with a single individual. On the contrary, collaboration allows diverse perspectives and viewpoints. It allows team members to establish associations, to research effectively, to evaluate, and to build on the ideas of others towards achieving a common goal.

A methodological learning design that integrates experiential, collaborative, and problem-based approaches can contribute to the development of innovation skills by encouraging learners to think out-of-the-box, observe, analyze, and synthesize solutions from past experience and new knowledge.

4 A collaborative digital learning platform for innovation

This work presents the design and implementation of a collaborative digital learning platform for fostering innovation capacity among higher education students. The platform aims at fostering team collaboration for innovation through design thinking. The platform deploys collaborative, problem-solving, and experiential approaches to build innovation skills. The goal of the digital platform is to support team real-time collaboration by allowing members to post, organize, and build on each other's ideas in jointly owned group digital workspaces. The platform encourages innovative thinking through brainstorming that takes place anytime, anywhere.

The platform offers learning services for both students and educators. For learners, the platform supports flexible real-time team collaboration. For educators, it supports the structuring of educational activities, the monitoring of student progress, and the generation of feedback.

More specifically, the main functionality of the platform for learners is:

- Registration to courses, which allows learners collaboratively work in teams in digital spaces defined by an educator.
- A shared digital workspace, in which team members can post and edit ideas in notes seen by their peers in real-time.
- Access of the 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 the educator.
- Brainstorming with other teams, by opening access to the team digital 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 workspace in real-time.

The main functionality for educators is:

- A private workspace for managing activities and courses.
- A learning activity creator and editor for structuring innovation-fostering projects by using design thinking steps through notes that provide learners with directions on executing specific tasks.
- A course creator and editor for integrating learning activities into structured courses, creating team workspaces for students, and monitoring student work.
- Monitoring student activity in the team workspaces.
- 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 design thinking steps for building student capacity for innovation.

- Making their learning activities public for the benefit of peers by allowing reuse in the context of additional courses.
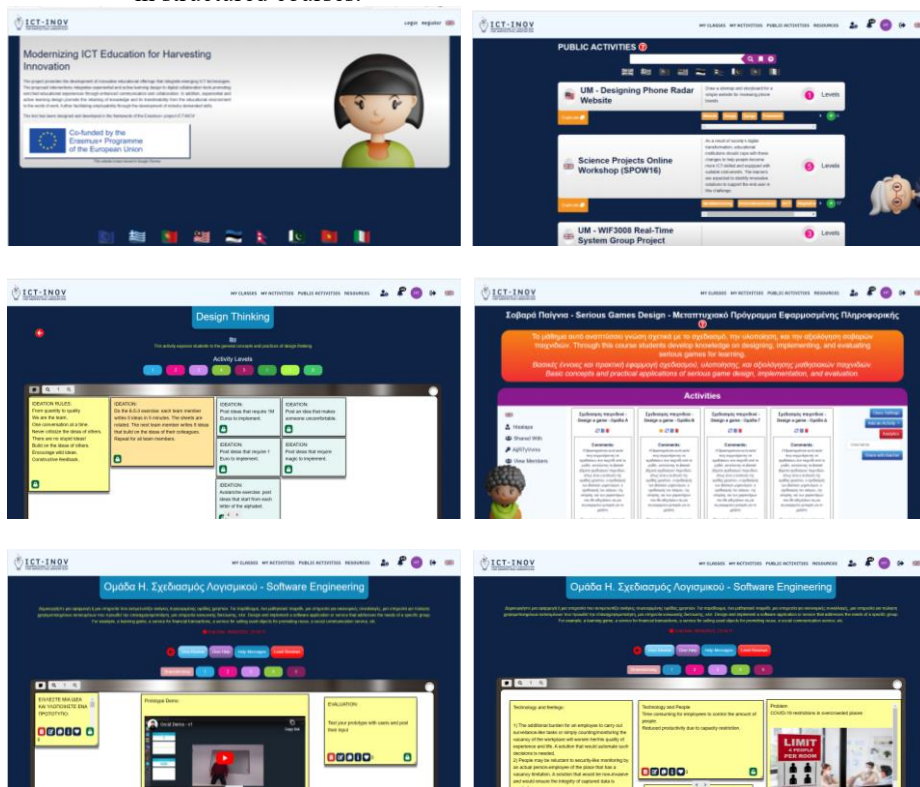- Duplicating in their private workspace, editing, and reusing public activities in structured courses.

Fig. 1. 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.

The educational process is supported through gamification, namely the use of game elements in non-game contexts [8]. To encourage the long-term engagement of students in innovation-fostering educational activities 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 8 languages, supporting its use in diverse educational environments [10].

5   Deployment

The digital learning platform is currently under deployment at 12 universities in Europe and Asia, and specifically in Malaysia, Vietnam, Nepal, Pakistan, Portugal, Estonia,

Italy, and Greece. Over 40 learning activities have been developed using the design thinking paradigm. The services are currently in use by over 2.000 students in the context of engineering courses that are as diverse as game design, software engineering, physics, machine learning, real-time systems, robotics, human-computer interaction, software architecture, product quality, artificial intelligence, and more.

The response of participants to the digital learning services is very positive based on a survey that has been filled so far by 665 individuals. Over 90% of respondents recognize the importance of developing innovation skills among computer science and engineering students as well as the importance of innovation skills for growth. Over 92% of respondents believe that the digital learning services support innovation skill development. Over 92% of respondents find the activities accessible through the platform to be interesting. Over 91% of respondents like using the platform.

Respondents comment that the platform makes education enjoyable, like a game, and reduces stress. It helps users understand the concepts of design thinking. It fosters innovative design by allowing users to publish their ideas without constraints in their line of thought. It supports brainstorming and the generation of a rich pool of ideas. And it supports new ways of thinking by allowing users to note ideas in a non-formal way.

6 Conclusions

This work presented a digital learning platform for fostering innovation in higher education. The digital learning platform has been designed and implemented in the context of Erasmus+ Capacity Building in Higher Education project ICT-INOV: Modernizing ICT education for harvesting innovation (http://ictinov-project.eu) funded by the European Commission. The project at know-how transfer and collaboration among universities in Europe and Asia on building the capacity of higher education institutions to integrate innovation building activities into existing practices. The platform is broadly used in actual educational activities in participating organizations, offering significant improvement in educational experiences on innovation skill development.

7 Acknowledgements

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