Work-in-Progress: Soft-skills Development for Higher Education Engineering and Economic Students using HERA Collaborative Serious Games

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***Abstract*— This paper presents the objectives and developments in the scope of the HERA project, an Erasmus+ initiative whose purpose is to address the interdisciplinary soft skill needs in the fields of engineering and economics. HERA deploys active learning to expose Higher Education students to complex challenges, the solution to which requires the integration of interdisciplinary knowledge in engineering and economics in a manner that emulates real-world problem-solving processes. The article describes the HERA serious game environment and proposes the game dynamics, scenarios and challenges, showing how they can be used to achieve the project goals.**

***Keywords*— Serious games, soft-skills, collaborative project-based.**

I. INTRODUCTION

21st century societies face complex challenges: responsible management of natural resources, mitigation of climate change, addressing natural risks, fighting poverty, informing global health, etc [1][2]. These challenges require solutions that weave skills and knowledge from diverse subject areas and sectors towards introducing integrated, viable, and sustainable solutions. As such, these solutions do not stem from the deployment of knowledge from a specific area, but they require the integration of knowledge from diverse fields. In particular, these solutions are rooted in a combination of engineering and economic principles.

Therefore, the biggest challenge that Higher Education (HE) faces today is to support students in the solution of these complex challenges [3]. HE must then be re-engineered in order to build the soft skills and mindsets that young adults need to become leaders and innovators in designing integrated, effective, and equitable solutions [4]. HE needs to shape young adults to be problem solvers, high level and critical thinkers, innovators in the face of rapid evolution of technology and business processes, effective collaborators in multiple social contexts and large groups, and capable of learning independently throughout their lives in order to remain at the forefront of their fields [5].

As an attempt to contribute to support the development of the competences demanded by the current challenges, the HERA Erasmus+ project proposes to address the interdisciplinary soft skill needs of HE in the fields of engineering and economics. HERA introduces an active learning proposal that helps build the foundations of engineering and economics knowledge but also critical, analytical, entrepreneurial mindsets and the capacity of young scientists to work across borders and fields.

HERA aims to achieve the above objectives by introducing an active, gamified and experimental learning approach that will challenge learners to collaborate, think entrepreneurially, and weave diverse knowledge towards introducing solutions to non-trivial problems inspired by 21st century needs. Digitally enabling the problem-solving process will effectively increase class communication, knowledge exchange, peer learning, and collective skill building, contributing to the development of desirable transversal skills. Gamifying the problem-solving process will promote active student engagement in learning through a sense of mission, a sense of affiliation, healthy competition, rewards, and social recognition by peers among other mechanisms. Furthermore, HERA aims to empower educators to integrate the proposed active, game-based learn interventions into classrooms through good practice guidelines thus enriching existing practices and promoting career satisfaction.

The rest of this work-in-progress paper is organized as follows. Next section introduces the partners of the project. Then, section III shows the intended educational and game scenario intended to support students learning following an active, gamified and experimental approach. In section IV, some initial challenges to be developed in the educational and game scenario are described. Section V provides an overview of the expected project outcomes.

II. CONSORTIUM

The HERA consortium includes 4 European HE institutions and 1 Small Medium Enterprise (SME) specialized in educational technologies, serious games and

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gamification. The project partners are located in the north (Denmark), east (Estonia), south (Greece), and west (Portugal and Spain) of Europe. This wide geographical distribution of partners ensures that input on the design, implementation, and evaluation of project activities and outcomes will be generated in diverse educational, cultural, and economic environments ensuring that results are relevant at a European level.

Consortium partners have complementary expertise and different profiles:

- Tallinn University (TLU) has a strong experience in game design as well as the design of graphical user interfaces. The organization has a strong media department, which will contribute to the design of the graphical assets of the proposed software tools. The organization focuses on game design and offers specific curricula on this discipline.
- University of Thessaly (UTH) has a strong expertise on the design and development of software applications, including web services, social platforms, simulations, and games, for educational purposes. UTH will act as the technical lead of the project, in relation to game design, coordinating activities related to educational application development.
- Virtual Campus (VC) is a SME from Portugal with a strong experience in the design and implementation of educational software systems and applications. This partner will also bring an important industry perspective into the project.
- University of Vigo (UVigo) from Spain has a strong profile on the design of learning interventions that combine emerging pedagogical design and ICT. The partner further has strong experience in areas such as problem-based learning, active learning and emerging approaches such as agile production design. This will be exploited towards the design of the HERA learning intervention for engineering and economics.
- Finally, Aalborg Universitet (AAU) from Denmark has strong experience in the area of active learning, namely problem-based learning and on designing learning offerings for economics education. This will be exploited for building activities that combine engineering and economics knowledge. In addition, the organization has a strong profile on methodological design. This experience will be exploited in learning requirements analysis, the design of the active, game-based learning framework, and the design of learning scenarios to be integrated into the software tools.

III. Existing Erasmus+ Projects with Serious Games Platforms

Games have for some time been considered to increase learning effectiveness and engagement and to create motivation, and interest in learning [6][7]. Several Erasmus Plus projects have taken the approach to work through serious games as well. These are a few examples:

- The GAME project that focuses on creating serious games that can educate about anti-doping within different sports (http://projectgame.phed.auth.gr).
- The ISG for Competence project focuses on developing serious games for social and cognitive competences for children and youth (http://www.isg4competence.com).
- The Increa project, social inclusion of migrants through creative industries, targets needs of migrants and integration into new societies (http://increa.erasmusplus.website).
- The ID games project uses games to assist people with intellectual disability to enhance their inclusion (http://www.erasmusplus.edu.gr/en/portfolio-items/id-games).

Fundamentally, these projects use games to emphasize and support skills development both with respect to real curriculum competences but also with respect to social and integrative skills – soft skills.

The HERA project addresses students from higher educations focusing on competences in engineering and economy. However, in a global, international world as we have today, it is necessary to develop more soft skills which are related to problem solving when working with real problems. The need for the soft skills within software engineering for example can be seen in the Software Engineering Body of Knowledge (SWEBOK) [8]. Additionally, many universities are ranked also with respect to students acquiring soft skills. However, some higher educations do see the fun and playfulness to be a contrast to the traditional content and the way it is being taught. Using games it is not a common thing within higher education institutions [9]. In that way, HERA addresses the needs for soft competences while learning.

IV. The HERA Educational Game Platform

In order to support the development of competences such as soft skills, critical thinking skills, and problem-solving skills required to solve 21st century challenges, HERA proposes the design and development of a digital learning game in the form of a platform. A main goal of this platform is to expose students to complex challenges the solution to which requires integration of knowledge from diverse fields in a manner that simulates how engineering and economics professionals work and collaborate in the real world.

From the student point of view, the platform will show the typical landscape of a virtual city game, like SimCity, where it is possible to perform different actions to develop a city in an appropriate and suitable way, cf. Figure 1 [10]. This city landscape, intended to be engaging, will involve several different scenarios, each one proposing a specific challenge related to a non-trivial problem inspired by 21st century needs. Some examples of possible scenarios include the management of water provision and disposal needs taking care of the environment maintenance and issues such as possible flooding; the deployment of Christmas lights in a way that promotes tourism and citizens well-being while it is environmentally friendly; the development of leisure infrastructures considering the interests of stakeholders, etc.

To solve these challenges players will have to take decisions related to the design of the city, the selection of the elements to be included, the use of the budget, the satisfaction of the citizens, etc. In addition, each scenario and challenge could be approached from different points of views, represented by different stakeholders that have specific goals, which to some extent could be opposite, and also managing different information and resources. The idea is that these different views and conditions will be performed by different roles. Such roles will be played by different students that in

this way will be forced to interact with others players during the development of the game.

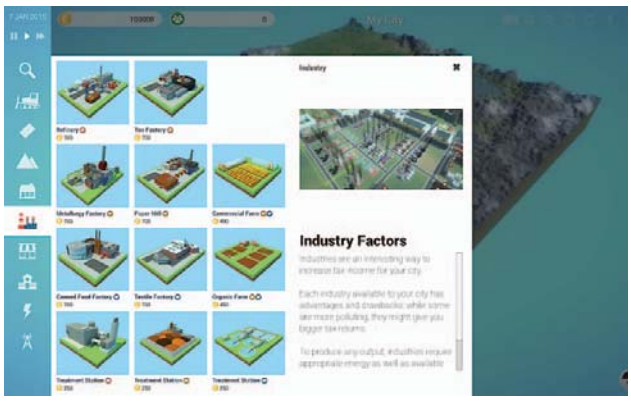

Fig. 1. Screenshot of the E-city virtual city serious game [10]

Gamification mechanisms will promote the long-term engagement of students learning. They may include:

- Rewards for engagement, collaboration, and feedback generation
- Clear, relevant, and inspiring missions
- A sense of affiliation, belonging, and inclusiveness
- Leaderboards
- Social recognition

In addition to the city-based game landscape the HERA platform will also involves the provision of tools to support students communicating and collaborating. More specifically, a kind of virtual post-it facility will be included to allow participants sharing ideas or proposals among them. This will be similar to the DesignIT virtual post-it tool, cf. Figure 2. In this way, players could maintain discussions about the strategies and interests involved in the city development. As it has been indicated, different roles will be provided with different goals, information and resources, therefore it will be important that they could communicate their point of view and knowledge to the others, search for help when necessary of share information when needed.

Furthermore, a tool to support the management of projects based on the use of tickets in a way similar to Trello or Jira, will also be included. This provides a simple and common planning facility that will allow participants to coordinate and manage the development of activities in a shared way.

To complete the platform, the dynamics of the game will be supported by the involvement of a limited management, conditioning the actions that can be performed, a rewarding system resembling a kind of tax system, and the variations in the number of inhabitants and visitors. In addition, a peer-based assessment system will be included to promote the involvement of the students.

The platform will be deployed as a complementary learning tool that enriches engineering and economics education practices. It is not meant to replace existing curricula, but rather to be deployed alongside existing approaches in the context of wider, blended learning. The activities to which the students will be exposed to will require a combination of engineering and economics knowledge in order to address non-trivial challenges the solution to which requires innovative mindsets.

Students will be challenged to think as professionals. In the real world, the solution to a given problem does not only exploit knowledge from one thematic area. Typically, it involves the combination of knowledge in a field of expertise, and often the combination of multidisciplinary knowledge. In addition, professionals need to consider practical issues related to limited resources as well as societal perceptions on what is a good solution. As an example, economically it may be preferable for a factory to allow some danger of waste, having a plan for cleaning the environment in case of an accident. However, societally this solution is often not accepted. The proposed learning game will simulate exactly this nature of real-world problems, preparing HE students to effectively act as professionals in the real world by considering technical feasibility, resource availability, and societal acceptance.

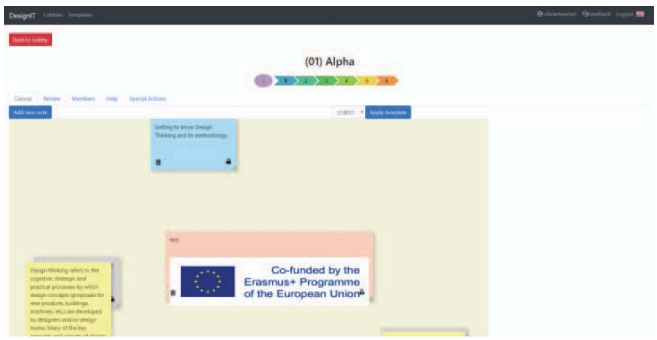

Fig. 2. Screenshot of the DesignIT virtual post-it tool [11]

V. GAME CHALLENGES

At least 3 challenges will be implemented. The exact nature and content of the scenarios will be decided early in the implementation period of the project. They will be selected in a manner that makes them applicable at a European level taking existing educational practices and student/educator needs. Examples of scenarios that may be implemented include designing green energy coverage for a town with a limited budget, implementing internet access for all, implementing environmental upgrades to public buildings, providing public transport to reduce pollution, and many others. The scenarios, in addition to building base field knowledge will help develop transversal skills:

- Following a systemic design process
- Collaboration in teams, fostering industry demanded complex communication skills
- Development of problem-solving skills
- Facilitation of brainstorming and sharing of key ideas
- Evaluation of information stemming from different sources
- Effectively formatting a problem and solution objectives
- Critical and innovative thinking
- Working with limited resources
- Designing for end users

VI. EXPECTED RESULTS

The following results are expected upon completion of the project:

- A needs analysis for HE for multidisciplinary engineering and economics offerings for building effective young scientists for the 21st century. The analysis will start with a documentation of the current status quo in HE in countries in which HERA has project partners in terms of promoting the development of desirable problem-solving capacity and other soft skills required by young scientists in their professional activities. It will continue with a mapping of all stakeholder groups in engineering and economics HE that stand to gain directly or indirectly from HERA activities and outputs, such as students, educators, university leaders, educational authorities, the industry, and more. It will continue with an analysis of skill development needs of direct stakeholder groups of HERA, namely students and educators. The analysis will be based both on literature review and a questionnaire-based study.
- Analysis of problem-solving skills that young professional need to possess to solve challenging real-world problems. These may include formal field knowledge, soft skills such as high-level thinking, capacity to analyze the factors that contribute to an unwanted situation, designing alternative interventions towards solving a problem, evaluating alternative potential solutions implementing and assessing the effectiveness of a solution. As an example, economically it may be preferable for a factory to allow some danger of waste, having a plan for cleaning the environment in case of an accident. However, societally this solution is often not accepted.
- An active, game-based methodological learning framework tailored to the needs of engineering and economics HE. The framework will promote the problem-solving capacity of students that are necessary for them to effectively as 21st century innovators in the face of rapid technological business process evolution, and pressing societal problems the solution to which requires the integration of diverse knowledge, collaboration among scientists and with diverse know-how, analytical thinking, evaluation of information, innovative and entrepreneurial thinking, and more.
- A digital learning service in the form of a learning game that will challenge students to apply problem-based learning approaches to address complex issues inspired by the real world the solution to which requires integration of knowledge from diverse fields. The platform will be a complementary learning tool that enriches HE practices. Learning activities will require a combination of engineering and economics knowledge in order to address non-trivial challenges the solution to which requires innovative mindsets. Students will be challenged to think as professionals. In the real world, the solution to a given problem does not only exploit knowledge from a single thematic area. Typically, it involves the combination of knowledge in a field of expertise, and often the combination of multidisciplinary knowledge. In addition, professionals need to consider practical issues related to limited resources as well as societal perceptions on what is a good solution. The proposed learning game will simulate this nature of real-world problems, preparing HE students to effectively act as professionals in the real world by considering technical feasibility, resource availability, and societal acceptance. The game will integrate scenarios inspired by real world 21st century challenges, such as mitigating climate change, designing smart city networks, designing energy networks based on renewable resources, managing natural resources, and more.
- Reference material in the form of a user guide on the functionality of the proposed active, gamified platform for problem-solving skill development.
- Instructor support content that enables the smoother integration of the proposed learning intervention into HE classrooms. The content will be in the form of documented end-to-end suggested classroom activities built around the proposed platform. In addition, videos will demonstrate the functionality of the digital learning game and its content.
- Good practice guidelines on how to best apply in real educational contexts the HERA proposed learning intervention. The guidelines will be informed through a validation process that will take place in all countries in which the HERA consortium has project partners. The results of the validation activities will be documented in this output, which will conclude with the introduction of good practice guidelines for adoption of HERA results
- Dissemination content and activities for widely project results at the national and European level, such as publications, internet presence, social media posts, traditional media articles, and more
- Uptake activities in the form of multiplier events that promote the deployment of project results beyond the consortium and

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