eCity - Virtual City Environment for Engineering Problem Based Learning

Progress Report

Public Part
Project information

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Executive Summary

Secondary education students still face a lot of difficulties when learning Mathematics and Sciences and as a consequence they don’t want to follow a technical academic path like Engineering. But this is not due to lesser skills of these students but mostly due to wrong educational strategies that fail to capture their interest and to motivate them.

Problem-based learning (PBL) is an active, learner-centred educational pedagogy in which students develop their abilities by going through a problem solving process, usually based on real-life situations. Engineering is one of the areas where PBL reportedly benefits students with considerable improvements in critical, lateral and creative thinking, problem solving skills, group collaboration and communication skills. In a convergent path, games and simulations can be instantiated for learning as they involve mental and physical stimulation and develop practical skills – they force the player to decide, to choose, to define priorities, to solve problems, etc.

The main objective of the eCITY project is to design, develop and validate an online, collaborative, city-development game simulation platform which integrates and exploits PBL challenges to be used to scaffold learning in engineering schools and, at the same time, to foster the interest in Math, Sciences and Engineering in secondary school students. The older students will tutor the younger ones in the problem solving process.
The idea of the project came from the partner’s experience as engineering/technical education entities that are quite familiar with the needs of their students. It also derives from the research experience of the partners in fields related with Learning Technologies and, in particular, with the use of games and simulations for learning.

Currently, a set of 10 problems was designed covering electrical, civil, mechanical and chemical engineering (and others). The game platform is under development and two of these problems have already been integrated. A set of pedagogical guidelines for the use of these problems in curricular activities are also being created to support teachers. In the second year, the platform and the problems will be finalized and piloting will address about 1,000 individuals from the different countries involved.
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1. **Project Objectives**

The eCity project rationale is based on the observed need to motivate students to follow technical and scientific careers. The project's proposal is to address this need by proposing a pedagogical methodology that requires a more active and immersive participation of the student in the learning process. With an increased motivation the level of knowledge acquisition will be higher and at the same time students will develop other personal skills and competences.

Fundamentally, the project proposes to combine problem based learning (PBL) and games. PBL is a learner-centred pedagogy in which students are assessed on their ability to go through a problem solving process, usually based on real-life situations. In a convergent path, games and simulations can be instantiated for learning as they involve mental and physical stimulation and develop practical skills – they force the player to decide, to choose, to define priorities, to solve problems, etc. Games can also be social environments, sometimes involving large distributed communities. They imply self-learning abilities (players are often required to seek out information to master the game itself), allow transfer of learning from other realities and are inherently experiential with the engagement of multiple senses. Therefore, gaming and simulation environments are excellent learning tools because, through Virtual Environments, they can replicate real contexts or even provide training situations that occur in very specific circumstances while retaining the players' motivation to learn. Mixing PBL, games, simulations and virtual environments provides a Virtual Learning Environment (VLE) where digital natives feel comfortable because they are immersed in technology, they can communicate and they are active.
Engineering is one of the areas where PBL is a valid learning alternative/complement to the traditional methods. An engineer is a professional practitioner, concerned with applying scientific knowledge and ingenuity to develop solutions for technical problems. The work of engineers forms the link between scientific discoveries and their subsequent applications to human needs through new technological solutions. The responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. Engineers must weigh different design choices on their merits and choose the solution that best matches the requirements.

Therefore, the main objective of the eCity project is to design, develop and validate a PBL-oriented, online, collaborative VLE platform, based on a city-development simulation engine that stimulates the integration and continuous exploitation of Problem Based Learning. The platform will be used collaboratively by students from secondary and vocational schools and higher education engineering schools.
2. **Project Approach**

The project approach relies on a planned integration of the PBL-oriented approach and the game platform in a clear pedagogical methodology. This is to ensure that the upmost relevance is given to the process of learning.

eCity’s will provide a stimulating context due to the nature and complexity of the problems that will be available in the virtual city but also due to the collaborative solving approach. The challenges and problems are based on real life situations and the learners’ solutions exploited in the resolution or improvement of those situations can then be based on their experience from the real world. Problems can be configurable and customized by teachers for specific issues or even to represent real local situations.

Problems or challenges can be designed as homework, teamwork, curricular activities, extra-curricular competitions, big or small projects, etc. PBL can be incorporated within existing structures with little disruption as it can be implemented in a variety of forms. Therefore it is not necessary to change the curricular organization as problems can be formatted to different time and work schemes. Nevertheless, to support teachers, guidelines on how to use these problems in a pedagogical way will be provided to the teachers.

The eCity approach is also innovative because of the combination of secondary and higher education students and the collaborative approach that allows students from different countries to work together in a problem. It is a quite ambitious objective but one that renders the project even more rewarding.
The complexity of the project’s goal requires that strong and careful analysis, design, development, implementation and evaluation steps are in place. The project follows a development methodology based on educational content and application development. It starts with an analysis stage, then a design stage, development, implementation and evaluation. In parallel there will be project management and quality assurance tasks. Dissemination sets the process of publicizing project results and predefines the exploitation stage.

The first year of the project was mainly dedicated to the analysis and design stages. Development has started with an initial prototype of the game platform incorporating two of the problems. The second year will be dedicated to the completion of the development and to the piloting of the game platform.

All these stages are done with a close involvement of end-users. With this approach it will be possible to create interesting problems or challenges for the students. A multiple case study approach will allow validation of results through the comparative analysis of several learning implementations in different countries.

The project work plan closely follows this approach and the development work packages (WP) are the following:

- **WP3 – Specification and Design:** This WP will handle the specification and design of the pedagogical model. It will be implemented through collaborative work with the teams formed for each specific task (involving brainstorming, activities of exploration / discussion group, etc) using electronic mail and discussion forums (Documents specifying that evolve from the different contributions)

- **WP4 – Development:** This WP integrates the tasks related to the production of the environment, contents and experiments.
• WP5 - Implementation and Test: This WP corresponds to the implementation of the experiments phase.

The major milestones are connected with the development WPs:
Milestone 1 – Specification of the PBL Environment and Experiments (end of WP3)
Milestone 2 – Full prototype of the environment (end of WP4)
Milestone 3 – Fully working environment (end of WP5)

As a support for the project, four other work packages provide important auxiliary activities:

• WP1 – Project Management: This WP integrates project planning and monitoring. It is lead by the coordinator with the help of the Steering Committee that includes a representative of each partner.
• WP2 – Quality Assurance and Monitoring: This WP is dedicated to the process of quality assurance of the approach and results of the project. It is accomplished through a continuous process of monitoring, internal and external evaluation.
• WP6 – Dissemination: This WP aims to spread out information on the project and its results, in particular for the main target audience (students and teachers).
• WP7 – Exploitation: This WP consists of the determination of processes of multiplication and generalization of the results achieved in the project, either by widening the geographic scope of project, expanding to other knowledge areas and its possible commercial exploration.
3. Project Outcomes & Results

The main objective of the eCity project is to design, develop and validate a PBL-oriented, online, collaborative VLE platform, based on a city-development simulation engine that stimulates the integration and continuous exploitation of Problem Based Learning. The platform will be used collaboratively by students from secondary and vocational schools and higher education engineering schools.

As concrete results, the project expected results are:

- A free, online, collaborative simulation platform based on the engine of a city-development simulator. This PBL environment is designed to allow an easy transfer of learning from and to other realities due to the enjoyable, dynamic play that replicates real contexts and provides practical training for very specific situations.
- A set of 8 ready-available problems, platform setups and pedagogical guides for use. These problems will reflect real cities’ situations.
- A validated pedagogical methodology to integrate the eCity platform that can be replicated in different engineering schools. In fact this methodology is composed by two different complementary approaches:
  - On one side, it will be the engineering students themselves that will develop new challenges and problems. This way they will be directly applying the concepts learned at higher education
  - On the other side, they will be solving the set of project-developed challenges plus the new ones with the support of secondary/vocational students. By doing this they will scaffold
their engineering learning but will develop other skills like leadership, group work and collaboration.

- A motivational methodology, to be used in secondary and vocational schools to integrate the eCity platform as a complementary activity for students to develop their interest and motivation towards engineering

The problems currently in development include:

- To accurately dimension the power elements required to serve an existing city
- To find the better location for a windmill power generation cell
- To distribute mobile phone antennas so that the city has full coverage
- To find the better ways to use buses to reduce the amount of traffic in a city
- To prepare a city for an effective data-distribution system
- To prepare solutions to reduce created by industries and the heavy use of fertilizers in farms
- To design and locate a city which is resistant to flooding
- To design and locate a city which is resistant to earthquakes

Fig. 1 eCity website (http://ecity-project.eu)
4. Partnership

For this project it was important to gather engineering institutions, secondary and vocational schools, research organizations and entities where engineers have relevant roles. Therefore, the consortium was setup respecting the following criteria:

- The inclusion of partners from higher education (engineering) secondary and vocational education;
- Research organizations with expertise in Learning Technologies and/or Engineering Education;
- The definition of a nucleus of partners that worked together before, to guarantee the stability of processes, communication and the attainment of results;
- An adequate number of initial partners that creates a strong kernel for the development and application of the project results and provides the basis for growth;
- A good coverage of European countries and cultures, for increased diversity of views and different approaches to the subject;

Four partners are Higher Education Institutions with involvement in research and educational application of VLEs and innovative pedagogical methodologies in different levels (basic, secondary and higher education) but particularly in the scope of engineering schools. All partners have been using e-learning steadily in the past few years so technology enhanced learning has become common in their teaching processes. Each of the Universities participates in the project through their Engineering Faculty, Education
Development Departments and/or Research Groups in Learning Technologies.

ISEP has lead projects on Serious Games for different education levels and has extended experience in Learning Technologies for Higher Education. The same is true for UTH, UVAL and UVIGO. IKAROS is a vocational school that prepares students for technical professional paths. AKAL is a secondary school preparing students for the University. The project consortium also includes a private company, Virtual Campus Lda, which works in the Learning Technologies area and has experience in European projects.

An important aspect is the access to the target groups. Although the institutions involved already provide that direct access, all the partners are involved in networks which can increase the number of possible target users.
5. Plans for the Future

The project has two direct target groups:

1. The first target group are the students from secondary and vocational schools (initial levels) that need to be motivated to follow an engineering or technical academic career
2. The second target group are students from Higher Education in Engineering careers

The indirect but closely related target groups are:

1. Teacher/trainers from secondary and vocational schools (initial levels) which will support their students and benefit from the eCity platform as a complement to their teaching
2. Teachers from Higher Education in Engineering faculties that will be able to tutor their students and complement their teaching with the City platform

In the project scope it is expected to reach about 1,000 individuals from the different countries involved. They began to be involved in the research stage – students and teachers from Higher Education contributed to the problem definition, teachers from Secondary education contributed to the pedagogical definition of the PBL strategy and students from Secondary Education contributed with their game-oriented expectations. So far, in all the participating countries, about 350 end-users were directly contacted in the research stage. The final impact will be possible because most of the partners are organizations with direct access to the target groups and they can use the eCity platform with their own students. They also have a very strong relationship with other European Education networks so the consortium will be able to exploit these links.

A high number (more than 50) of dissemination activities already took place, some with smaller, direct impact and other with larger impact oriented to the public media or social media. The project has been disseminated to over
500,000 persons of the general public and 25,000 of the direct target group. Conferences and other dissemination events have also been used as visibility and exploitation opportunities but also for technical and scientific validation of the project.

European Education, Engineering, Training, Game Development, Computer Science networks, conferences and other dissemination events will be major opportunities for exploitation. Dissemination and exploitation will also be oriented towards a different target group – educational managers in schools and universities. The replication of the project activities in medium/large scale requires that this is approved at a higher level and not be dependent on the will and interest of a few teachers and students. Therefore it will be necessary to reach this target group through direct contacts.

In total, it is expected that in three years about 5,000 individuals will be using the project results.
6. Contribution to EU policies

The eCity project contributes to EU policies as it addresses a common European challenge: the lack of engineers and technical staff. In order to address that issue, the project is developing strategies to:

- Integrate new and innovative learning methods in Higher and Secondary Education ensuring better prepared, active, autonomous, self-relying and innovating students;
- Motivate younger students, from secondary and vocational schools, to follow an engineering or technical academic degree;
- Foster best-practice and expertise exchange on how to develop and adopt new and innovative ways of using ICT in education;

![eCity presentation to secondary education teachers in Volos, Greece](image_url)
The eCity project transcends national identity and introduces a transnational scope to the community because collaboration between students is extended through virtual environments. Getting the target groups to virtually meet their peers in other countries will reinforce the European spirit, strengthening the economic and social cohesion of the Community. It can also be an opportunity to develop new forms of cooperation and to intensify physical mobility of students and teachers.

The methodology, game platform and problems can be reused in several linguistic and cultural environments. Therefore, the success of the project can lead to quick replication and a strong European impact in addressing the identified challenges.