

RESEARCH GAME: AN INNOVATIVE EDUCATIONAL TOOL FOR TEACHERS AND STUDENTS

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Abstract

This contribution describes 'Research Game', a game produced in a Lifelong Learning Programme-Comenius Project (*The European Scientific Research Game*) which aims at motivating secondary school students through the experience of the excitement of scientific research. The project proposes practical and didactic works which combine theoretical activities with ICT in order to introduce students to the scientific research. Students collaborated internationally across Europe, to build hypotheses, carry out research, test the validity of their hypothesis and finalize a theory based on their findings. On the project platform (www.researchgame.eu/platform) teachers and students registered, created a team, interacted on a forum space, played and learned science in a new innovative way. Here, the students shared their research findings with other groups of all Europe; finally competed online playing a serious game and showing to be able to apply the scientific method.

Keywords

Serious game, e-learning, ecological sciences, scientific method.

1. Introduction

The importance of scientific expertise as main aim in school's education programmes has been underlined in relevant international reports (OECD, 2006) and the teaching strategy adopted is considered one of the most important factors influencing the scientific educational process (Antiseri, 2000). Sandoval (2005) underlines how science educators often underestimate the scientific method concept as a central part of the training activities and highlights how an understanding of the scientific method helps students to better develop scientific knowledge. Students attempting to generate explanations are more systematic in their experiments and more likely to discover the correct functioning of science concepts.

On the other hand, in a Europe that needs to adapt to a rapidly changing business and learning environment, it becomes critical that students understand how science and technology provide the basis for the fundamental advances in education. Moreover, there has recently been an upsurge of interest in using games for learning, emerging from optimism that the motivating

features, evident in entertainment games, could also be deployed to motivate learning.

Here, we propose to use a game-based approach to develop a new pedagogical strategy for helping science educators in the science teaching process within a European LLP-Comenius project, *The European Scientific Research Game*.

2. Background

Games offer methods that are highly consistent with modern theories of effective learning, which propose that learning activities should be active, situated, problem based, interactive, socially mediated; they also offer a range of features that could be usefully deployed in teaching methods and statistics. Kiili (2005) argues that games can offer players support by providing clarity about different stages in solving a problem and provide clear goal, matching challenges to the players' skill level and giving immediate feedback about the correctness of the player's response.

Hwang, Sung, Hung, Huang, and Tsai, (2012) propose a personalized game-based learning

approach based on the sequential/global dimension of the learning style proposed by Felder and Silverman (1988).

Bidarra and Olimpio (2010) present Geodromo, a prototype of an educational multimedia system, part of the Portuguese Ciencia Viva (Live Science) educational program, which is aimed at young people with the goal of bring students closer to an "undercover" reality, as authentic as it gets with digital media representations, and allow them to convey emotions naturally.

Folta (2010) in an effort to get children back outdoors and exploring the natural environment, create a Modular Serious Educational Game (mSEG), Red Wolf Caper, as part of a design-based research study. Red Wolf Caper uses a combination of an augmented reality (AR) game and a serious educational game (SEG) to capture the students' interest in the natural world around them.

The research in education suggests that computer games can serve as powerful learning environments. Eastwood and Sadler (2013) examine three science teachers' implementation and perceptions of a curriculum unit incorporating the game, Mission Biotech (MBt) and a set of supporting curriculum materials. The curriculum unit was designed to provide multiple avenues for teachers to adjust and modify materials and implementation plans based on their unique classroom goals and environments. To understand how individual teachers use, conceptualize and reflect upon the MBt unit and its implementation, three case studies were conducted, including classroom observations and teacher interviews. Findings include many similarities among teachers among which adaptation of activities to classroom norms and practices, high value placed on quality curricular resources and support, advantage of the game to provide experiences that are normally out of reach for students, and concerns about effective use of time. Unique features of different teachers revealed implications for design and professional development for game-based curricula.

The Research Game, taking into account the lesson learned from these other experiences, aims at proposing a new teaching approach and pedagogical strategy using an innovative mix composed by serious games, e-learning platform and teaching materials.

3. The Project

The 'European Scientific Research Game' is carried out by a consortium of six partners from Germany, Italy, Portugal, Turkey and United Kingdom, involving expertise in games-based learning, teacher training, pedagogy, educational psychology, teaching and eLearning, institutions with experience in teaching scientific research, project management and a specialism in Ecology.

3.1 Project aims

The project motivates secondary school students by replicating the excitement of scientific research and exposing them to the process of a scientific methodology. An Internet-based educational game has been created in order to develop an understanding of research work and teach best practices (Sangiorgio, Lorenzi, Fiore, Montinaro, Connolly, Josephson, Rodrigues, Quintino, Hoppe, Ulbrich, Klotz, Varcin, and Basset, 2014).

Main objectives of the project are to develop: i) a purpose-built educational research game allowing students to play as real researchers and developing their scientific skills; ii) an innovative e-platform containing scientific materials; iii) research plan templates and guides; iv) workshops and methodology guides for teachers; v) large scale pilot across Europe; vii) a dissemination strategy to inform stakeholders of the final results.

3.2 Project rationale

The project includes three steps: 1. '*constructing*' during which the specification and development of the game have been carried out; 2. '*running*' including the competition in which teams of schools from all over Europe play the game; 3. '*transferring*' in which a set of documents has been prepared in order to replicate the game and allow the understanding of its outcomes. Moreover, during the whole project, management and dissemination activities have been performed and quality control carried out (Fig. 1). '*Constructing*' includes activities finalized to deepening the knowledge on the serious game in order to construct contents for teachers, design and develop the game, define contents for students. During '*Running*' students' and teachers' training has been realized also through mini-pilots and large scale pilot (*i.e.*, the competition).

'Transferring' aims at producing guides and case studies describing the methodology so to get started with the follow up phase of the project.

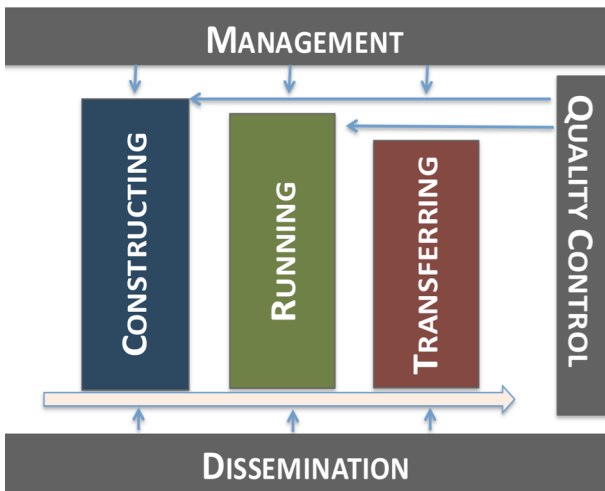


Fig. 1: The rationale of the 'European Scientific Research Game' project

4. The serious game – Research Game

Research game uses a range of 'game based features' to support learning. We proposed a role-playing game (RPG), where players take on the role of researchers and have to perform a study to test specific research questions (Fiore, Montinaro, Sangiorgio, Lorenzi, and Basset, 2014). Players have access to information from various different research resources including: books, notice boards, computers with internet links, video conferencing calls to lecturers and the possibility of consulting advisers. The game also uses 'game features' that have been found to be useful in other learning games, such as a narrative structure, the competition element, the feedback possibility and reflection. Through the game, students can learn more about the scientific method, applied to Ecology, carrying out a study on biodiversity.

4.1 Games phases

The game consists in two phases: 1) 'learning by doing' and 2) competition (Sangiorgio, *et al.*, 2014). The first phase requires students to collaborate internationally across Europe in a research project synthesized by papers, presentations or videos, and share their research findings with other, making comparisons and exchanging information with other teams. During

this phase the researcher-players earn scores in order to participate to the final competition. In the second phase (i.e., the competition) schools teams compete online playing the game and showing their ability to apply the scientific method. Here, the researcher-players have to reach three objectives: *i)* to examine their background on biodiversity; *ii)* to learn more about biodiversity; *iii)* to identify qualitative and quantitative approaches in the scientific method. Players are required to answer questions, solve problems, identify species images and drop the the proper ecosystem type, analyse figures and tables about flora and fauna datasets, read and understand summaries of scientific papers about biodiversity in terrestrial and aquatic ecosystems.

4.2 Games platform

We conceived the platform to satisfy the requirements and build the access point to all the resources related to the game; the architecture of the game is shown in figure 2.

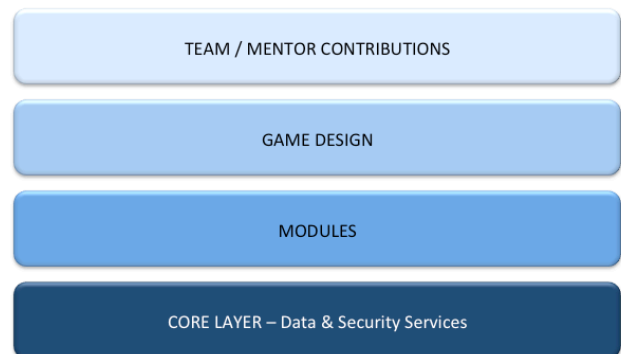


Fig. 2: Open Research Game Management System

The game can be accessed only from the platform (www.researchgame.eu/platform), which has also to host all documents and information about it. The platform shall provide guide for teachers and students and guidelines for the competition between teams in which the winning team(s) will ultimately be awarded.

The platform includes: *i)* registration functions; *ii)* direct access to all resources and games; *iii)* good practices from previous players. The platform is divided in an open area and reserved one dedicated to registered users. In the open area interested students, teachers or parents can find information about the system and the scientific content in six languages (Fig. 3).

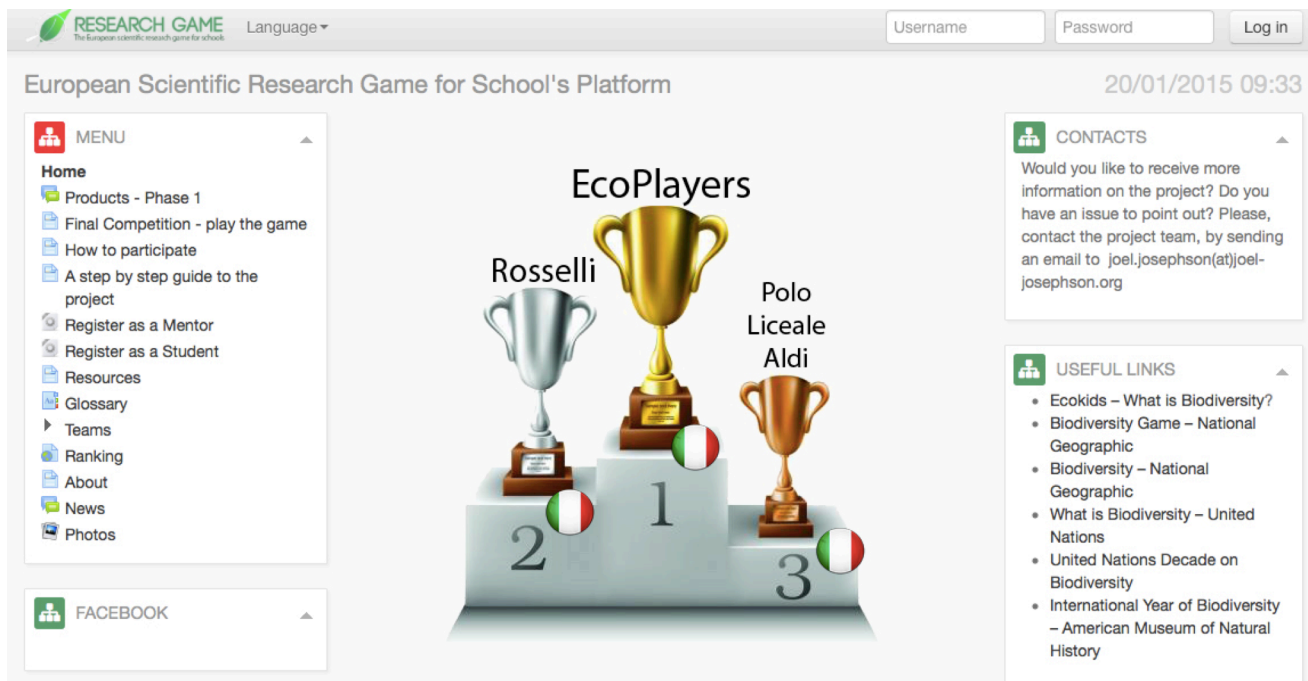


Fig. 3: The Research Game Platform Home

It was needed the platform to be very simple and intuitive to use, so to be suitable also for educators with low technology capability. The platform shall run on low-spec PC, typical of what would be found in schools and conform to Web accessibility standards/guidelines. A login is required to participate to the game. Once logged on, the options are dependent upon the role (students, mentor etc.) of the user. Mentors create their own teams, register students (as team) and enter game phase I. At the end of the phase I all teams publish the products (i.e., papers and videos) of own ‘research project’ on a dedicated space known as the ‘team wiki area’. Score and preferential votes are earned as new badges from the team. In this way, the teams enter the phase II (i.e., competition) with a starting score. We identified the following stakeholders directly related to the game: *i)* mentor -normally an educator (teacher, teacher trainer, etc.)-interested in adopting the Research Game method and *ii)* student: the target. The mentor is a teacher and provides his/her data and the school’s ones, and contextually put the request to create his/her team by giving its name. Students in the team are organized in a sort of organization chart (reflecting roles as who studies in detail the topic, who carries out practice, who carries out practical activities, who posts assignments, etc). Figure 4 shows the page for the registration of the mentor.

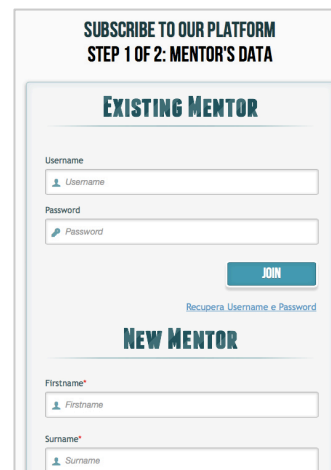


Fig. 4: The Research Game Platform Page for the registration of the mentor

4.3 Platform development

The Research Game platform has been developed customizing the Moodle Platform (<http://moodle.com>). Moodle (acronym for Modular Object-Oriented Dynamic Learning Environment) is a free software e-learning platform, also known as a Learning Management System, or Virtual Learning Environment (VLE). As of June 2013 it had a user base of 83,008 registered and verified sites, serving 70,696,570 users in 7.5+ million courses with 1.2+ million teachers. A mapping from the Research Game

concepts (Player, Mentor, Team, etc.) and the Moodle concepts has been developed together with the interface. Usually Moodle is used as an e-learning platform, where teachers and students can create different online courses in the traditional e-learning way, connecting to the system only to follow a class or download materials. In this case we decided to make an innovative use of Moodle, rethinking it as a game based platform system. The classical Moodle structure has been replaced by a team structure, where each teacher (mentor according to the Research Game terminology) can create his/her own team. Moodle's interaction with the game has been enhanced in a way to permit an immediate recognition of participants' commitment in the project and their achievements. The second aspect redesigns Moodle as a Social Community System, able to connect Phase I and Phase II of the project, and to create a link between the offline and online activities of the participants, providing a place to show their progresses in the creation of the research project, publishing and sharing the results of their researches, evaluating them through a facebook-like system (Fig. 5). Furthermore, Moodle has acted also as link among the different online activities, as participants used the platform as a way to compare and contrast their approaches to the project, interact on the topic of ecology and biodiversity sharing relevant information and materials, and, in few words, creating a thematic expert community working through the online interaction and used by all those teachers and students interested in sciences and biodiversity involved in our project (Fiore *et al.*, 2014).



Fig. 5: The Research Game Facebook Page

4.4 Competition

The competition (*i.e.*, Phase II) has been deployed from February to May 2014. Phase I has ended on 5 April 2014 when the teams have posted the final products on the platform's wiki space. A Scientific Committee evaluated the reports by giving them up to 30 points: 20 points were given assessing the use of the research method and the coherence of the subject of study with biodiversity, 5 were given to the communication/presentation impact and 5 to the likes each team gave to other reports. To allow a fair evaluation and permit to all teams to read and understand each other products, we demanded that the products were presented in English so to encourage the use of a foreign language to communicate, as described in the objectives of the project. At the end of the phase I, we counted forty-nine teams who submitted the report. Teams have chosen to use different forms for their reports (Table 1), and although only one report was required, thirteen teams decided to submit two or three, showing that project managed to achieve that surplus of motivation, which was amongst its aims. Totally 30 teams (Junior category) and 19 teams (Senior category) registered on the platform. The evaluation at the end of phase I has shown that all products sent were of high quality, all of them reached either the silver or the golden badges, respectively corresponding to 11-20/30 and 21-30/30 points, so that the bronze one, 1-10/30 points, remained unused. On the front of self evaluation, alias teams granting likes to other teams, we had a very varied response, the average of likes per team is of 6, but this is the result of the combination of some teams which got until 52 likes and others which decided to give none. All students products are available on the platform here¹ (access is restricted to registered users).

Tab. 1: Final Products submitted by teams

Category	Junior 30 teams	Senior 19 teams
Written report	15	9
Presentation	12	6
Poster	4	6
Video	8	7

¹<http://193.204.79.61/game/mod/forum/discuss.php?d=11>

This phase proved to be particularly interesting as teams autonomously started using the platform blog as a “work in progress” space, to share ideas about the research projects, the topics chosen, putting questions to each other, publishing photos on biodiversity and anticipating their findings. The online competition took place on 29 April 2014 at 10:00 a.m. C.E.T. and involved, as Phase I, eight countries. The competition was run through a serious game, developed by the project consortium, and available on the platform in English, French, Italian, German, Portuguese and Turkish. The game was made to test the abilities of students in applying the scientific method and recognize different approaches and methods of investigation, and the knowledge acquired in the field of biodiversity. To make the game more complex it was decided to give a huge relevance to the time taken in finishing it, so after 10 minutes a multiplier was added to deduct points from the final score (Fig. 6).

The access to the competition page was restricted to the mentors of the qualified teams, so once they had arrived on the game the platform was automatically able to recall the associated team. At the end of the game the final score was registered on the data base, and the platform showed the general ranking splitting participants in the two categories (Junior and Senior) showing teams’ results in phase I and phase II and the total.

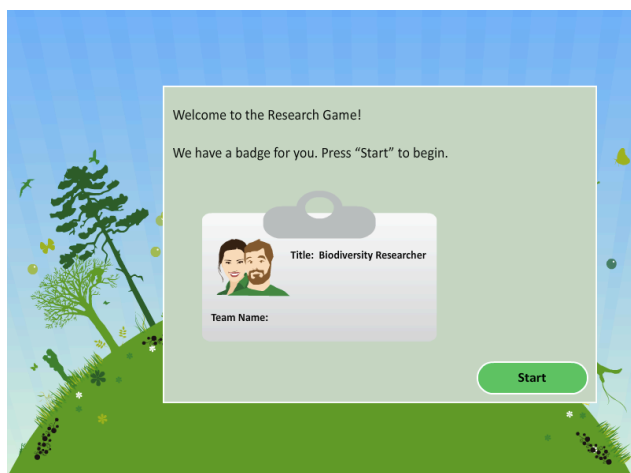


Fig. 6: Home page of the ‘Research Game’

4.5 Statistics

The Research Game platform registered 437 students and 77 mentors, from 8 countries; 75 teams registered, of those 49 took part in the phase I and 26 in phase II (the reduction is due to the rules of the project available here²). During the first phase, teams posted 67 files on the platform to support their research projects. Each team gave in average 6,02 likes to the projects presented by other teams, so the double required by the rules in the chapter on interaction. The average score earned during this phase is 21,48/30 and the younger students took in average 2 minutes and half more than the elder participants. The game was completed in an average time of 23’25”. Generally speaking we can claim that the interaction went beyond our expectations, as teams started to use the blog of the platform as a tool to share findings and compare results, ask questions and opinions to the other participants. If we take into account the platform statistics, elaborate through Google analytics, we notice that for the whole period during which the platform has been opened to the public either to register, or to carry out the activities demanded by the project we count 4623 sessions. 1670 users connected over the period of interest, those came from Italy (43.48%), Portugal (20.10%), Turkey (18.60%), Germany (6.47%), Romania (3.46%), Spain (1.19%), Macedonia FYROM (1.17%) and the United States (1%) (Fig. 7).

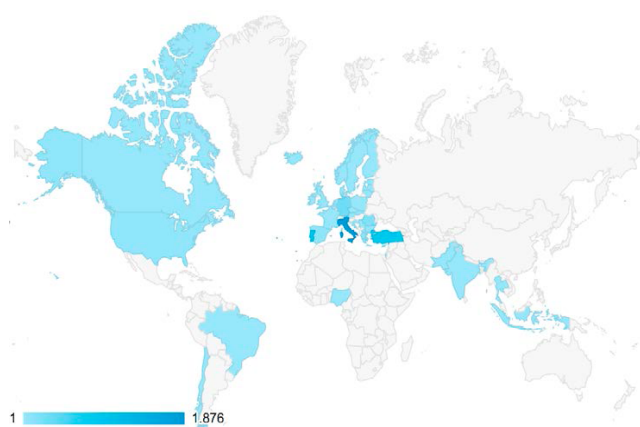


Fig. 7: Map showing the areas around the world connected to the Research Game platform

²http://193.204.79.61/game/pluginfile.php/255/mod_page/content/13/Game_Rules_EN.pdf

5. Discussion and perspectives

In our opinion, Research Game succeeded in spreading the scientific knowledge and expertise as OECD (2006) advises for a proper citizen education. Research Game also offers to teachers and students an opportunity to deepen scientific issues related to biodiversity. The biodiversity concept is very important both from an ecological and educational point of view. From several years, human societies have been trying to protect all different types of biodiversity characterizing our biosphere. On international scale, scientists, politicians and managers have been making several attempts to define and produce reference documents in order to preserve biodiversity such as the Habitat Directive (1992) and the Convention on Biological Diversity (1992). Biodiversity is one of the main aspects of Ecology; the concept is therefore of great importance also from an educational point of view. Applying the 'Research Game' to Ecology allows to raise awareness on the importance of diversity, support improvements in pedagogical approaches, and achieve good protection of the environment, sustainable economic development and create better job opportunities.

Research Game proved to be a very successful experience in using informal educative approaches and teaching the scientific method. The feedback from students and teachers showed a wide enthusiasm about the game and a willing to see a 2015 edition. This marks the good performances of the game and the pedagogical approach, and welcomes the innovative use of Moodle made during the project, establishing a new exploitable option for this kind of platforms.

Currently, the materials developed for the European Scientific Research Project are available on the platform on the resources³ page and can be used in all project's languages by teachers for class or field/laboratory research activities related to the scientific method and biodiversity. Both the minipilot training game and the pilot final game can be directly played on the platform or downloaded, becoming a tool for interactive learning sessions, which can be used in the framework of curricular activity and independently from the competition dimension. Research Game also proved to be a valid source of inspiration for schools' own projects; in two cases

our approach and tools have been used for e-Twinning and other Comenius project activities.

³ <http://193.204.79.61/game/mod/page/view.php?id=62>

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