THE SCIENTIFIC RESEARCH GAME: MOODLE AS A GAME BASED
PLATFORM AND A SOCIAL COMMUNITY SYSTEM

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Abstract

‘Research Game – The European scientific research game’ is a Lifelong Learning Programme –
Comenius (Project N°. 527547- LLP-1-2012-1-IT-COMENIUS-CMP) aiming at developing a new
teaching approach and pedagogical strategy to learn a methodology useful in all the subjects of the
scientific research, and also realize and apply creative and innovative thinking. In order to do so the
project chose to use two strategies: learning-by-doing (or situated learning) and game – based
learning, setting up a European wide competition played through a specific serious game. This work
describes the innovative use of information and communication technologies to make the discipline
more appealing and engaging for students of new generations on the topic of biodiversity and ecology.

Keywords: Serious game, e-learning, ecology, social community.

1 INTRODUCTION

In a Europe that needs to adapt to a rapidly changing business and learning environment it is critical
that students understand how science and technology provide the basis for the fundamental advances
in education and in the workplace and how these will affect their future careers. The inductive and
hypothetical-deductive reasoning, that underlies scientific research methodologies, requires logical
reasoning and critical thinking skills, core competences in the development of a more sophisticated
understanding of the world. These higher-level thinking skills provide the fundamental basic abilities
necessary to tackle the ill-defined problems that we face in the 21st century, marking a clear link with
the EU 2020 Strategy "New Skills for New Jobs" and the General Priorities of the Lifelong Learning
Programme, which aims at promoting the acquisition of key competences throughout the education
and training system.

Research methodologies pose significant challenges for many students. The material is challenging
because it is highly abstract and requires the coordination of different but inter-related issues that are
all necessary to develop a coherent and usable skill base in this area. Students have to develop an
understanding of how to formulate hypotheses, identify, define and make operational relevant
variables, select an appropriate design to examine links between variables, collect and analyse data,
identify relevant ethical issues and interpret and discuss the findings.

There has recently been an upsurge of interest in using games for learning. This has emerged from
optimism that the motivating features, that are evident in entertainment games, could also be deployed
to motivate learning. However, games also 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, etc. To be successful the affordances offered by a game have to
match the desired learning outcomes.

According to these theories, we propose to use a games-based approach to teaching scientific
research.

2 BACKGROUND

Games offer a range of features that could be usefully deployed in teaching methods and statistics.
Kiili [1] argued that games can offer players support by providing clarity about different stages in
solving a problem. Games can provide clear goals, match challenges to the players’ skill level and
provide immediate feedback about the correctness of the player’s response. Other ‘game features’
that could be incorporated into the game include the narrative structure of a game, competition, simulation and personalisation. In literature we can find different experiences using serious games in teaching methodologies.

Hwang, G.J. et al. [2] propose a personalized game-based learning approach based on the sequential/global dimension of the learning style proposed by Felder and Silverman. To evaluate the effectiveness of the proposed approach, a role-playing game has been implemented based on the approach; moreover, an experiment has been conducted on an elementary school natural science course. From the experimental results, it is found that the personalized educational computer game not only promotes learning motivation, but also improves the learning achievements of the students.

Bidarra, Jose Martins, Olimpio [3] 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. We found these to be major success factors in the establishment of an effective relationship between the technology and the pedagogy required to study those particular topics.

Folta, Elizabeth Eason [4] 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.

Research in education suggests that computer games can serve as powerful learning environments, however, teachers perceive many obstacles to using games as teaching tools. Jennifer L. Eastwood, Troy D. Sadler [5] examine three science teachers' implementation and perceptions of a curriculum unit incorporating the game, Mission Biotech (MBI) 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 MBI unit and its implementation, three case studies were conducted, including classroom observations and teacher interviews. Findings include many similarities among teachers including 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. For example, the study revealed that teachers need support to integrate and make explicit connections between the game and supporting curriculum materials.

The Research Game, taking in 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 RESEARCH GAME IN A NUTSHELL

‘Research Game – The European scientific research game’ is a Lifelong Learning Programme – Comenius project (N°. 527547-LLP-1-2012-1-IT-COMENIUS-CMP) aiming at developing a new teaching approach and pedagogical strategy to learn a methodology useful in all the subjects of the scientific research, and also realizing and applying creative innovative thinking. In order to do so the project chose to use two strategies: learning-by-doing (or situated learning) and game based learning.

Thanks to the use of new technologies and the game (Game Based Learning), we have been able to make a discipline more appealing and engaging for students of new generations, replicating the excitement of scientific research and exposing the participants to the process of a scientific methodology. To do so, the Project has created an Internet-based educational game to develop an understanding of the research work and teach best the practices, requiring students to collaborate internationally across Europe in building hypotheses, researching and testing the validity of their hypothesis, and proposing a theory based on their findings. Their research findings have been shared with other groups through the project platform.

‘Research Game – The European scientific research game’ addressed key priorities of the Scientific Research and Lifelong Learning, in particular:
• Helping young people in acquiring the basic life-skills and competences necessary for their personal development, and future employment opportunities;
• Improving the quality and the volume of partnerships among schools of different Member States;
• Supporting the development of innovative ICT-based contents, services, pedagogies and practices for lifelong learning;
• Improving students’ basic skills in mathematics and science, ICT and transversal key competencies in a field that crosses multiple subjects areas;
• Developing new approaches to teaching and learning, through the use of international digital games;
• Fostering the European dimension in teaching and learning;
• Taking a holistic view of students’ learning by using a cross-curricular methodology and competencies;
• Promoting the use of foreign languages.

To achieve the original purpose a consortium has been formed by University of Salento [IT], University of West Scotland [UK], University of Aveiro [PT], European Ecological Federation, BSW [DE] and KAR-DER [TR].

The project activities can be presented as follows:
1. A preliminary investigation of the relevant topics resulted in a repository of academic and best practice literature;
2. The creation of a set of guides for teachers and students on the subject of study, the scientific method applied to biodiversity, the project as such and the technologies used;
3. The development of an Internet-based ‘Research game’, where students act as real researchers;
4. The organization of a small scale pilot to test the game, technology and materials, which involved six schools from three different countries;
5. The development of a platform which served as game and communication space;
6. The organization of a large scale pilot involving at least 30 schools of 6 countries in a European wide competition on the scientific method applied to biodiversity;
7. The organization of public conference, to award the schools participating to the project and present its results to the wide public;
8. The production of guides and workshops for teachers based on the experience gathered during the pilot phase;
9. The elaboration of a methodology, case studies and use-case scenarios to allow the replication of the game and enhance the understanding of its outcomes;
10. The activity of dissemination, during the whole length of the project, to recruit participants and promote its achievements.

Although the project is still on-going, its core activity, the large scale pilot and the European wide competition, has just been concluded, so we are able to present its first results. The public conference mentioned in point 9 took place on May 22nd, 2014, the production of the guides is expected for this summer and workshops will be organised next September, with the beginning of the 2014/2015 school year. The dissemination activity, started with the project itself, is reaching its peak and will continue until the end of our activities.

4 THE GAME PLATFORM

4.1 Requirements elicitation

The project proposes practical and didactic works which combine theoretical activities with ICT in order to introduce students to the scientific research. The proposed innovative game will use a range of “game based features” to support learning. The point of RESEARCH GAME is learning a methodology; the project uses experimental research planning as the process through which this can
be learnt and taught. Research planning means producing a scientific idea and testing it with experimental activities. The research plan is the vehicle for learning the methodology. The important thing here is the ‘methodology’ and the research work process, not the end results or the individual skills required.

RESEARCH GAME focuses on the scientific methodology (i.e., the learning goals), specifically it is oriented on scientific/ecological content contextualized to the country of each partner. The game in centred on developing a research plan on ecological contents (i.e., biodiversity), and verifying the acquired competences.

The game itself consists of different steps to acquire the research methodology and of a competition among teams.

4.1.1 Stakeholders
We identified the following stakeholders directly related to the game:

- Mentor: normally an educator (teacher, teacher trainer, etc.) interested in adopting the Research Game method.
- Student: the target of the Research Game project. The main goal of the student is to learn through playing.

4.1.2 Game Rules
The Game is composed by two phases: the first one is the “Research Project” the second one is the “Competition”.

The Game is played by teams, composed by 4-8 students plus a mentor; each school may have more than one team. Students in the team are organized in a sort of organization chart (reflecting roles, among which: who studies in detail the topic, who carries out practical activities, who posts assignments, etc.). 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. The request has to be then evaluated by the Scientific Committee’s and after its approval the team can start the game. This moderation a posteriori procedure is needed to ensure that all teams referred to real schools and teachers, and protect underage children from potential scams. The game includes tasks that also should be carried out by the mentor (providing feedback, etc.).

Phase I of the Game demanded teams to carry out a research project applying the scientific method to biodiversity. The final product all teams had to produce is a research report in English, either in the form of a written document, or as a poster or as a video, following the guidelines given by the Scientific Committee, and then share it with the other teams.

For some of the played steps, the team can earn a ‘badge’ and that reflects their progress through the game. During this first phase, students can exchange information with other teams.

The results have been evaluated from the Scientific Committee and scores based on a specific matrix, and focused on the process followed, rather than on accuracy of results. Students were also asked to evaluate each other’s products, by granting at least three likes per team. This approach is chosen to use a language, facebook’s one, very familiar to the new generations.

The best team (with the highest score) of each school will access to the Phase II: “The Competition”. During this second phase, the team has to cover a set course with questions, multimedia interactive exercises, statistical tools. Technical Requirements

The game is accessible and usable by all users (students, mentors) with a normal web browser with a standard internet connection and includes user track systems.

We planned the game to be independent from Facebook, as often blocked by many school networks.

4.2 Requirements analysis & design
We conceived the platform to satisfy the requirements and build the access point to all the resources related to the game. The game can be accessed only from the 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 needs to include:
1. Registration functions
   - students register individually
   - mentor registers and creates the team
   - teams can welcome new members even if the game has started
2. Direct access to all resources and games
3. Good work/practices from previous players.

The platform requires to be 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; learning goals and the games available in all the six project languages.

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 will be dependent upon the role (students, mentor etc.) of the user.

Mentors shall create their own teams (each team will have a name and a list of students). Registered students (as team) and mentors can access Phase I. For some of the played steps, a team can earn a ‘badge’ that is displayed on their profile and reflects their progress through the game. During this first phase, students (indicating the name of their own team) can exchange information with the others on the ‘team forum’. At the end of the first phase all teams have to publish the products (i.e., papers and videos) of our ‘research project’ on a dedicated space known as the ‘team wiki area’.

Score and preferential votes are earned as new badges from the team.

The achievements in the games will be related to the team profile so that badges can be collected, scores can be displayed and the progress with regard to the learning goals can be tracked.

The teams may enter the second phase (i.e., competition) with a starting score. Each team has to play the competition in a fixed time (3 hours) during the same day.

The architecture of the game is shown in figure 1.

![Figure 1. Open Research Game Management System.](image)

### 4.3 Implementation

The Research Game platform has been implemented 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 of students. 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 one and phase two 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. 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 (in particular didactic pictures), 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.

Figure 2 shown the interface for the user.

Figure 2. The Research Game Platform Home.

5 THE LARGE SCALE PILOT

The large scale pilot 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. The Scientific Committee evaluated than 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 Phase I, we could count 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.

<table>
<thead>
<tr>
<th>Category</th>
<th>Written Report</th>
<th>Presentation</th>
<th>Poster</th>
<th>Video</th>
</tr>
</thead>
<tbody>
<tr>
<td>Junior: 30 teams</td>
<td>15</td>
<td>12</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td>Senior: 19 teams</td>
<td>9</td>
<td>6</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

The evaluation 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.

This phase proven 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.

Because of the rules\textsuperscript{1} of the project, the teams, which actively took part to the second part of the project, were 26 over the initial 49 participating to Phase I.

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. 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.

5.1 Statistics

The Scientific research Game platform registered 437 students and 77 mentors, from 8 countries; 35 schools 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 here\textsuperscript{1}). During the first phase of the project, teams posted 67 files on the platform to support their research projects, as 13 teams presented more than one attachment each. 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.

The game (Phase II) was completed in an average time of 23’25”, if we split this data in junior and senior we can see that the younger students took in average 2 minutes and half more than the elder participants (22’18” of the Seniors vs. 24’56” of the Juniors). Senior teams performed better also if we look at the average score, 51.025/70, while Juniors showed an average of 46.596 points.

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. In particular 144 posts testify this exchange on the blog of the platform.

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 (9 February to 9 May 2014), we count 4623 sessions, 9.41 pages per session for an average duration of 11’19”, 941 sessions last between 181 and 600 seconds, confirming a high engagement rate. We registered a total 43509 page-views, with two clear peaks corresponding to the project’s milestone: April 5 (the deadline to deliver the research project for phase I) with 2157 page views, and April 29 (the day of the online competition) with 1352.

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%). Although most users accessed the platform through a pc/laptop, 14.52% of users used a mobile device.

\textsuperscript{1} http://193.204.79.61/game/pluginfile.php/255/mod_page/content/13/Game_Rules_EN.pdf
6 CONCLUSION

Research Game proved to be a very successful experience in using informal educative approaches and teaching the scientific method. Besides the statistics on the pilot, first feedbacks, collected from schools through questionnaires distributed during the awarding ceremony and spontaneous comments, show a wide group of students and teachers from many different countries enthusiastic about the game and 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.

The project team is now working on the next step, the preparation of workshops and webinar for teachers, and the future replicability of the European competition. A prestigious group of institutions has claimed its availability for next year, and we are currently investigating how to adapt the game and organise another competition, while teachers training materials will be ready in a few months and available to final users in the course of next autumn.

REFERENCES


