AN INTERNATIONAL ONLINE COMPETITION TO STIMULATE STUDENT'S INTEREST ON ECOLOGICAL ISSUES

Franca Sangiorgio*, Vojsava Gjoni*, Nicola Fiore*, Donato Tarantino*, Alberto Basset*

*University of Salento – Lecce, Italy.

Abstract

A serious game on ecological matter and Earth sciences is one of the products of ENVRIplus project. ENVRIplus is a cluster of Research Infrastructures (RIs) for Environmental and Earth System sciences aiming at improving Earth observation monitoring systems and strategies. Here we present the ongoing activities of the *training action*, which has a serious game and a competition as main final products. The serious game, named *Research Game*, is direct to students of intermediate and high schools. Students, acting as researchers, have to apply the scientific experimental method in a practical work about topics of Ecology and Earth Sciences, and finally will play the serious game during a final European competition.

Keywords

Educational game, ICT, Earth sciences, Ecology, experimental method, environmental education.

1. Introduction

Today science and technology provide the basis for the fundamental advances in education; the evolution of our societies has witnessed changes both in the way students learn and teachers establish their teaching environment. From the traditional system of education where teaching and learning occur at the same time and at the same place, an increasing number of educational institutions are adopting a 'distance education' in which learner and tutor are separated by distance and some times by time (Petrova, 2001). In this new educational environment, Information and Communications Technology (ICT) represent one of the main tools to teach and learn (Karamat & Petrova, 2009). In this new learning system, a proper communication medium is required in order to facilitate the needs of educational distance system (Thomas , Carswell, Emms, Petre, Poniatowska, & Price, 1996).

Moreover, in Europe, the Member States agree on the promotion of creativity and innovation, considering the use of ICT in education as an important element to ensure the effectiveness of European education systems and the competitiveness of the European economy (EACEA-Eurydice, 2011).

On the other hand, all over the world, we are witnesses of significant changes in the structural and functional characteristics of the ecosystems so much to increase the attention of politicians and administrators on ecological and environmental issues. Air pollution, climate change, deforestation, species extinction, soil degradation, overpopulation are some of the world's biggest environmental problems (Strassburg, Rodrigues, Gusti, Balmford, Fritz, Obersteiner, Turner, & Brooks, 2012; Diffenbaugh, & Field, 2013). In this framework it is very important to stimulate the interest of young people about Natural Sciences and ecosystems that provide our societies with goods and services of high economic values (Daily, 1997; Costanza D'Arge, De Groot, Farber, Grasso, Hannon, Limburg, Naeem, O'Neill, Paruel, Raskin, Sutton, & Van den Belt, 1997; Folkersen, 2018).

There is evidence that students learn better if they are actively engaged in their learning, rather than being passive recipients of information provided by a teacher. This concept comes out from the Kolb's learnign theory (Kolb & Fry, 1975) and refers to learning styles model (Kolb, 1984, 2015).

Here, we propose a combination of scientific research and serious game applied to ecological topic and Earth Science, direct to students and

teachers, in order to arouse their attention on environmental issues and to improve their skills in the use of technologies for learning.

2. Background

Video games in general aim to have fun and entertain, while serious games aim at learning (Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012). Most students know and use games from very young just to fun; games are seductive, deploying rich visual and spatial aesthetics that draw players into fantasy worlds that seem very real in their own terms, exciting awe and pleasure (Bokyeong, Hyungsung, & Youngkyun, 2009).

Serious games were developed for purposes of training in business, government, healthcare as well as in education (Sawyer & Smith, 2008).

In the last years, gaming is becoming a new form of interactive content, with high value of exploration for learning purposes (Bouras, Igglesis, Kapoulas, Misedakis, Dziabenko, & Koubek, 2004), and an increasing number of serious games have been produced on different topics in many field such as education, communication, politics, etc. (Djaouti, Alvarez, & Jessel, 2012).

Moreover, from same years, games are commonly used to promote student's learning because they capture student's interest and bring up their motivation (Bergin & Reilly, 2005).

As reported by Corti (2006), serious games allow learners to know and experience situations that are impossible to live in the real world. Serious games are designed to promote active participation and interaction as the center of the experience, instead of pure entertainment (Bergin & Reilly, 2005), thus adequate serious games can attract and motivate students to learn more.

Games and competitions have been already used to promote the desire to improve ourselves (Adams, 1998; Becker, 2001).

Burguillo (2010) reported a deep description, highlighting advantages and disadvantages, of Game-based Learning (GBL), Collaborative-based Learning (CBL), Problem-based Learning (PBL) and Project-based Learning (PjBL).

Tournaments and other learning techniques could be a useful support to Competition-based Learning (CnBL – learning is achieved through a competition and is independent of the final results [score] of the competition) because could bring up student's motivation and performance (Burguillo, 2010).

Within ENVRIplus project we have combined a scientific research (*i.e.*, an experimental work) with a serious game that will be played during a final competition in which students have to earn score and try to be winners. Both the experimental work and the game concern topics on Ecology and Earth Sciences.

3. Rationale

The game is developed as product of the *training action*, carried out within the project '*ENVRIplus: Supporting environmental research with integrated solutions*'. ENVRIplus is a Horizon 2020 project bringing together Environmental and Earth System Research Infrastructures, projects and networks with technical specialist partners to create a more coherent, interdisciplinary and interoperable cluster of Environmental Research Infrastructures across Europe.

The project includes twentysix Environmental Research Infrastructures from four enviromnetal domains in order to provide key tools and instruments for the researchers to address specific challenges within their own scientific fields (table 1).

The *training action* of ENVRIplus consists in one of the themes of the project and ensures the cross-fertilisation and knowledge transfer of new technologies, best practices, approaches and policies of the Research Infrastructures. The main objective of this action is to organize and develop concrete training programs.

We are developing a final version of the game, organising the final competition, producing training and supporting material for students and teachers of middle and high schools to introduce them, in an attractive way, into issues about environmental research and the role of the project's research infrastructures within the research. The educational material is referred to documents and guides useful to get a background on the subject of the game and to deep the undestanding of the methodology for the scientific research.

Tab. 1: Domains of the Research Infrastructures involved in ENVRIplus

Aquatic domain
Ecosystem/Biosphere
Enviromental domain
Solid Earth domain

4. Game concept

The game (*i.e.*, the *Research game*) is developed to test the skills of the students in the field of the scientific method and on the research based on Ecology and Earth sciences; it is for students (ages 10 and up) coming from schools through all Europe.

The game will allow students to study and apply the method of scientific research in an entertaining way through the use of a serious game focused on environmental topics, such as biodiversity and ecosystems, hydrogeological risks, marine sciences and ICT such us computing environment. Each step of the game has a fixed structure in order to facilitate the playing: *i)* GAME RULE (at the top), including the description of the the rules for the game; *ii)* QUESTION (on the left side) including the objectives of each step and the question that students are going to answer; *iii)* specific requests for each step of the game (in the central section); moreover, the passed time and the earned score are reported (fig. 1).

A demo of the game is already completed and student/players can select the topic of major interest among: Biodiversity and ecosystems, Hydrogeological risks, Marine sciences, Computing environment (fig. 2 a-b).

For each topic, players are asked to reach several objectives proceeding step by step: answering questions, dragging species images and drop in the proper ecosystem type, matching items with the corresponding ranks and more. Some examples of the game's steps are reported in the figure 3a-b.

The game is designed to include a practical experimental work and the real online game. It is based on a moodle platform, where teachers and students can find game guides and other supporting material on game topics (www.scientificgame.envri.eu).

Teachers and students, participating to the game and organised in teams, have to complete two steps in order to try to become final winner: *i)* step 1 – carry out a research experimental work (deadline April 6th, 2018), and *ii)* step 2 – participate to the online competition playing the serious game (April, 2018).

During the experimental work, all students and teachers (as mentors) carry out all activities required to learn and apply the scientific method. They have to make a research planning that's mean producing a scientific idea and testing it with experimental activities; so the research plan is the vehicle for learning the methodology. The main important thing here is the 'methodology' and the research work process, not the final results or the individual skills required.

At the end of this step, teams add to the platform, on the team wiki area, the products (as video, poster, report etc.) of their own research in order to earn score and to participate to the competition with the highest starting score possible. More information about the organization and presentation of the research project are available on the project's website. The products of each team will be evaluated by a scientific committee of the own country, which reserves the right to attribute special prizes taking into account the results produced by the teams.

During the online competition, teams have to play the serious game in which players are required to answer questions, solve problems, drag and drop correct images and concepts, analyse figures and tables, read and understand summaries of scientific papers, identify the correct hyphoteses to work about Ecology and Earth sciences. The competition fulfills aspects of the proposal and serves to consolidate the basics of the scientific method referring to each topic selected.

The teacher (mentor) and one student, representing the winning team (first position), will be invited to a conclusive awarding ceremony.

5. Platform

We conceived the platform to satisfy the requirements and build the access point to all the resources related to the game.

The platform shall provide guide for teachers and students and guidelines for the competition between teams in which the winning team will ultimately be awarded. It includes: *i)* registration functions, *ii)* direct access to all resources and

games, *iii)* good work/practices from previous players.

The platform is divided into an open area and reserved one dedicated to the registered users. In the open area students, teachers and other interested people can find information about the system and the scientific content. The platform is very simple and intuitive to use, so to be suitable also for educators with low technology capability. A login is required to participate to the game.

Mentors shall create their own teams and registered students (as team) and mentors can access to the phase 1.

The teams will enter the second phase (i.e., competition) with a starting score in order to play the final competition in a fixed time during the same day. Through an automatic classification generated by the platform, which has the task of adding the score of the first phase with that achieved in this second phase, the platform itself decrees the winner in real time.

6. Perspectives

We think that the understanding of the scientific method and the improvement of own skills in the use of ICT at school could help young people to better develop scientific knowledge.

Here, the proposed game could represent a very interesting experience both in using informal educative approaches and teaching the scientific method also through a practical experience.

Thanks to the use of new technologies and games, we could be 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 engaging the foundations of the 'deductive thinking' and 'logical reasoning', necessary not only for science, but also for the future life of young students.

We have invited schools to participate to the competition and we are finalizing the game that will be played during the final competition in May 2018.
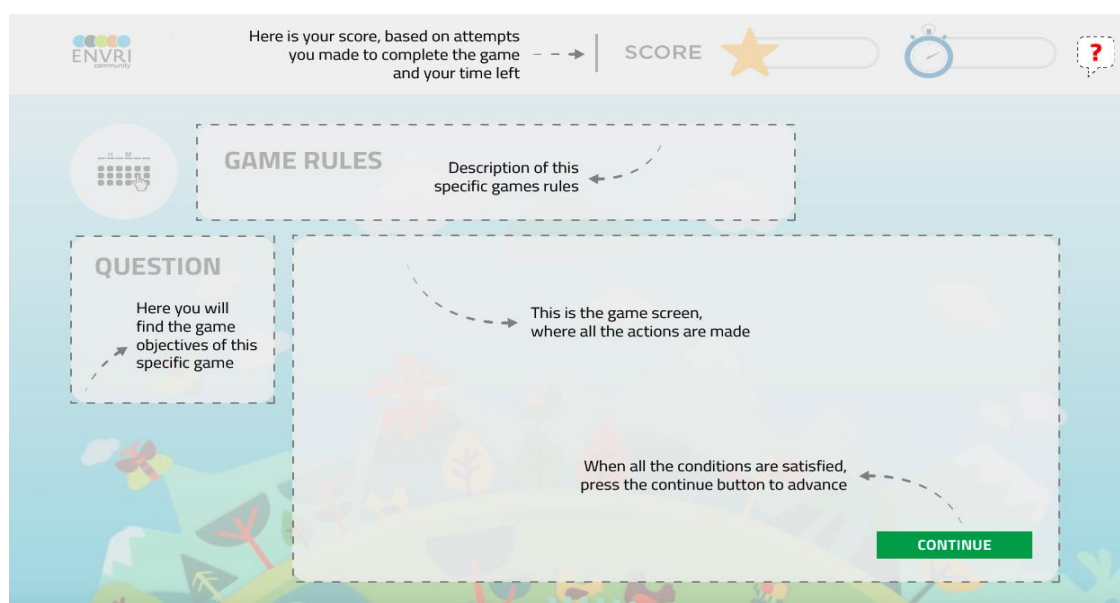
7. Acknowledgements

Fig. 1: Scheme of the general structure of the game.

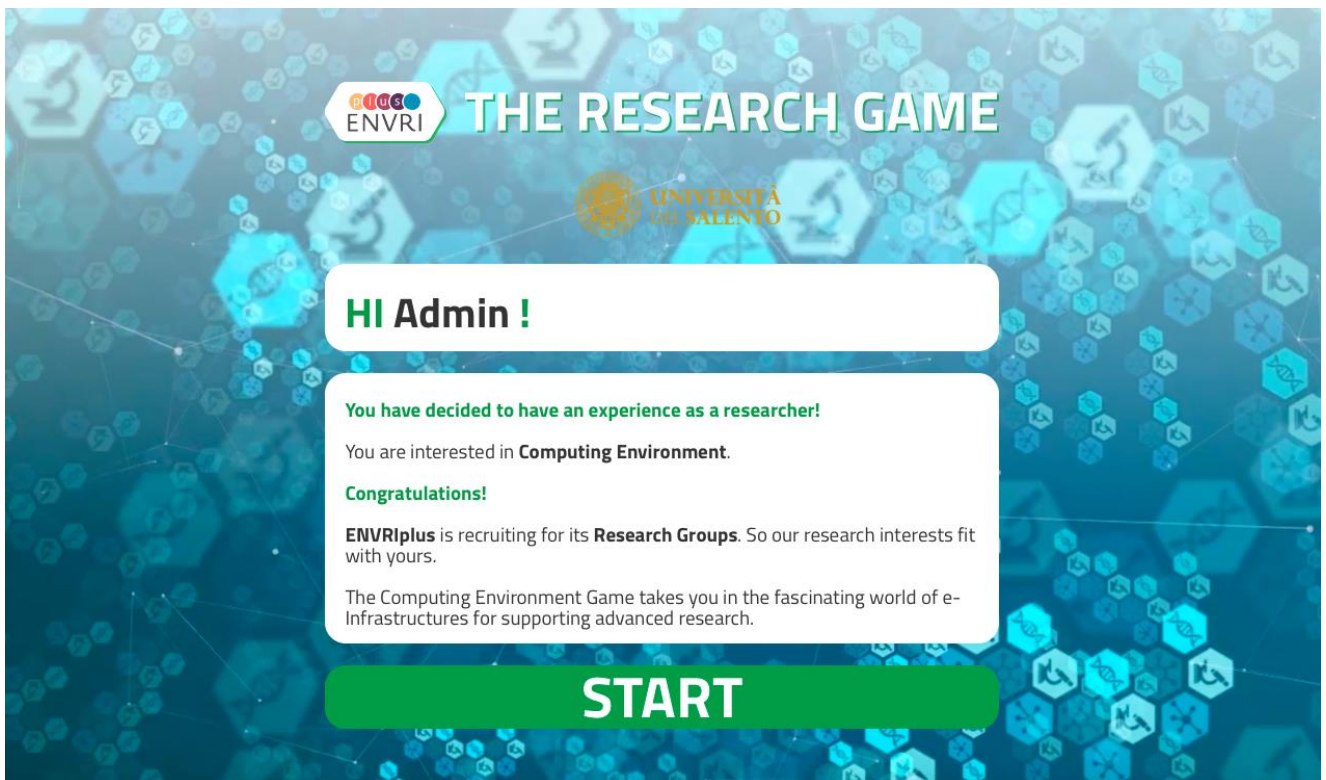**Fig. 2a:** Screenshot of the first slide of the game for the topic on Biodiversity and Ecosystems.

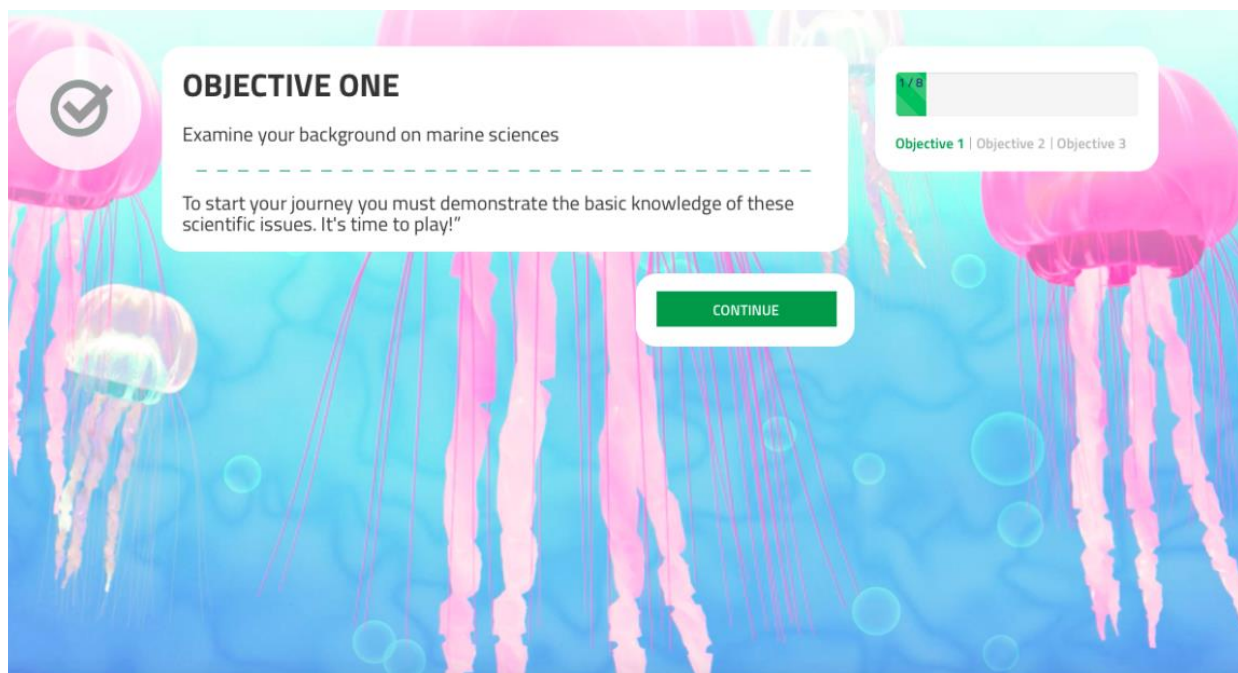**Fig. 2b:** Screenshot of the first slide of the game for the topic on Computing Environment.

Fig. 3a: Screenshot of the first game's objective in which player is asked to examine his/her background on Marine sciences.
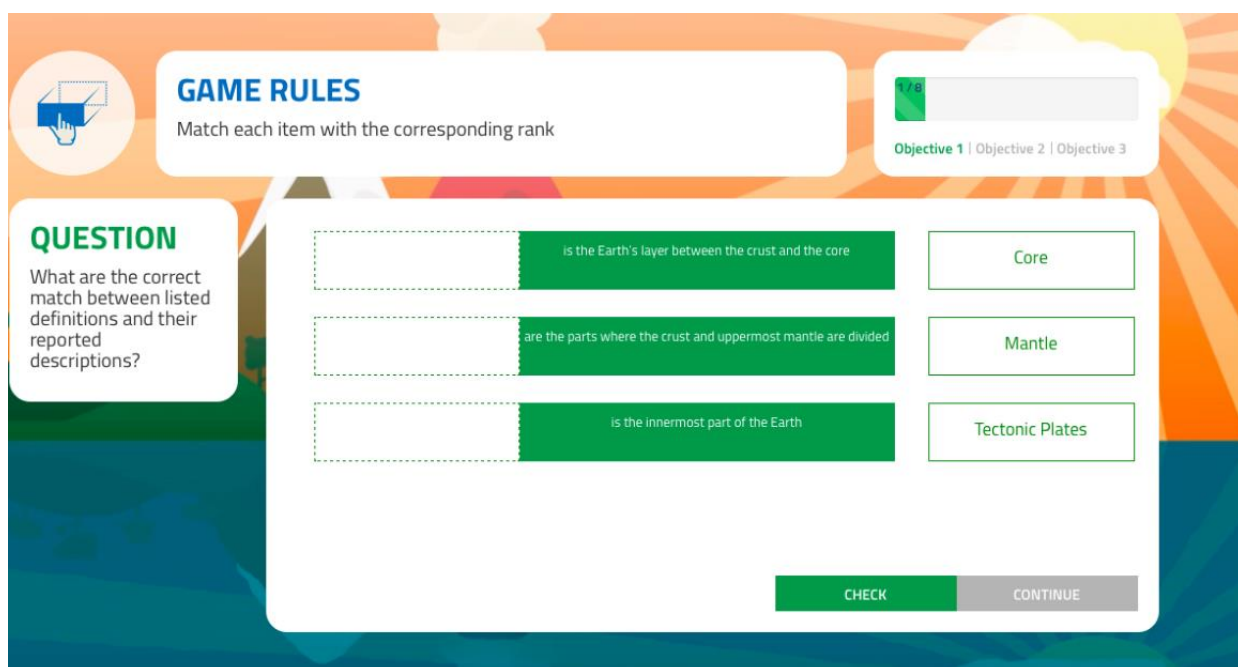

Fig. 3b: Screenshot of one of the game's objectives in which player is asked to match items with the corresponding ranks (here for the topic on Hydrogeological risks).

REFERENCES

Adams, J. (1998). Chance-it: an object-oriented capstone project for CS-1. In *Proceedings 29th ACM Special Interest Group on Computer Science Education (SIGCSE) Technical Symp*. *Computer Science Education* (pp. 10-14). New York, NY, USA: ACM

Becker, K. (2001). Teaching with games: the minesweeper and asteroids experience. *Journal of Computing in Small Colleges*, 17(2), 23-33.

Bergin, S., & Reilly, R. (2005). The influence of motivation and comfort-level on learning to program. In *Proceedings of the 17th workshop on psychology of programming - PPIG'05* (pp. 293-304).

Bokyeong, K., Hyungsung, P., & Youngkyun, B. (2009). Not just fun, but serious strategies: Using meta-cognitive strategies in game-based learning. *Computers & Education,* 52, 800-810.

Bouras, V., Igglesis, V., Kapoulas, I., Misedakis, O., Dziabenko, A., & Koubek, M. (2004). Game-based learning using web technologies. *Journal of Intelligent Games and Simulation*, 3(2), 67-84.

Burguillo, J.C. (2010). Using game theory and Competition-based Learning to stimulate student motivation and performance. *Computers & Education,* 55, 566-575.

Connolly, T.M., Boyle, E.A., MacArthur, E., Hainey, T., & Boyle, J.M. (2012). A systematic literature review of empirical evidence on computer games and serious games. *Computers & Education,* 59, 661-686.

Costanza, R., D'Arge, R., De Groot, R.S., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruel, J., Raskin, R.G., Sutton, P., & Van den Belt, M. (1997). The value of the world's ecosystem service and natural capital. *Nature* 387, 253-260.

Corti, K. (2006). *Games-based Learning; a serious business application*. PIXELearning Limited. [www.pixelearning.com/docs/games_basedlearning_pixelearning.pdf]

Daily, G.C. Ed. (1997). *Nature's Services. Societal Dependence on Natural Ecosystems.* Island Press Washington DC

Diffenbaugh, N.S., & Field, C.B. (2013). Changes in Ecologically Critical Terrestrial Climate Conditions. *Science*, 341, 486-492.

Djaouti, D., Alvarez, J., & Jessel, J.P. (2011). Classifying Serious Games: the G/P/S model. *Handbook of research on improving learning and motivation through educational games: Multidisciplinary approaches*, 2, 118-136.

Education, Audiovisual and Culture Executive Agency (EACEA)-Eurydice (2011). Key Data on Learning and Innovation through ICT at School in Europe 2011, *Education, Audiovisual and Culture Executive Agency P9 Eurydice*, Brussels.

Folkersen, M.V. (2018). Ecosystem valuation: Changing discourse in a time of climate change. *Ecosystem Services*, 29, 1-12.

Karamat, P., & Petrova, K. (2009). Collaborative Trends in Higher Education. *Systematics, Cybernetics and Informatics,* 7(2), 57-62.

Kolb, D.A., & Fry, R.E. (1975). Toward an applied theory of experiential learning. In C. Cooper Ed., *Theories of group processes* (pp. 33-57). NY: John Wiley & Sons.

Kolb, D.A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs. NJ: Prentice-Hall.

Kolb, D.A. (2015). *Experiential learning. Experience as the source of learning and development.* Neidlinger A., & Glasser L.J. Eds. New Jersey: Pearson Education Inc.

Petrova, K., (2001). Teaching Differently: A Hybrid Delivery Model, *Proceedings of the GBATA International Conference* (pp. 717-727). Istanbul, Turkey.

Sawyer, B., & Smith, F. (2008). Keynote address. In The second European conference on games-based learning (pp. 16-17). Barcelona Spain: Universitat Oberta de Catalunya

Strassburg, B.B.N., Rodrigues, A.S.L., Gusti, M., Balmford, A., Fritz, S., Obersteiner, M., Turner, R.K., & Brooks, T.M. (2012). Impacts of incentives to reduce emissions from deforestation on global species extinctions. *Nature Climate Change,* 2, 350-355.

Thomas, P., Carswell, L., Emms, J., Petre, M., Poniatowska, B., & Price, B. (1996). Distance Education over the Internet. In *Proceedings of the First Conference of the Special Interest Group in Computer Science Education and Computer Uses in Education* (pp. 147-149). New York, NY, USA: ACM