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► **To cite this version:**

Nagore Alvarez, Marion Real, Iban Lizarralde, Jérémy Legardeur. Ekit'eko: a serious game to support sustainable aptitudes during the development of eco-innovations. 13th International Scientific Conference "Management of Technology - Step to Sustainable Production", Jun 2014, Primosten-Dalmatia, Croatia. pp. 175-182, ISSN 1848-5022. hal-01004856

HAL Id: hal-01004856

<https://hal.science/hal-01004856>

Submitted on 24 May 2023

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EKIT'EKO: A SERIOUS GAME TO SUPPORT SUSTAINABLE APTITUDES DURING THE DEVELOPMENT OF ECO-INNOVATIONS

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Abstract

Cooperation between stakeholders is becoming a major challenge for the development of eco-innovations. Stakeholders are confronted to acquire new competences when they design projects in a triple bottom line prospective (economic, social and environmental considerations). Besides, other skills related to entrepreneurship, product development and collaboration are likewise key skills for eco-innovation. Educational approaches such as instructional simulations can supplement traditional form of educations. In this paper, we suppose that practicing serious games can be useful educational tools to introduce such thematic and reinforce the empowerment and the learning appetite of future designers. A first version of a serious game stemming from a design thinking approach is presented.

Keywords: Sustainable Innovation, serious game, decision-making

1- INTRODUCTION

Ecological risk prevention and challenges of sustainable development involved important social system changes. In industrial system, company and all their stakeholders require to develop eco-innovative projects which induce to re-think their activities through new offers, new business models or new uses. The training of actual and futures actors is essential to support the development of eco-innovation.

Nowadays, preparing future managers, engineers and designers with real technical knowledge while allowing them to acquire adequate aptitudes and managerial competences, remains a challenge for institutions. Due to the diversity of issues surrounded by eco-innovation, engineering institutes must teach an ever greater number of disciplines to their students. Actually, several types of educational methods (classical amphitheatre theoretical courses, practical work, student projects and internships) co-exist in both virtual and physical learning environment with initial or continuing training students. Teachers need to adapt the form and the content of courses according to the type of skills they want to transmit. Practitioners and academics highly recognize the strong importance of experiencing in context when teaching not only technical but especially behavior and meta-cognitive skills [1]. Thus, more and more immersive environments are proposed to student to enhance their learning experiences. Internships and student projects are the first answers delivered by the academic institutions to encourage their future engineers to act as actors in real situations.

Instructional simulations are other options consisting in a simulation of some type of reality (system or environment) but which also includes instructional elements that help students to explore, navigate or obtain more information about that system or environment that cannot generally be acquired from mere experimentation. Such environment prepares students as if they were practicing in real context. It is accordingly very difficult to reproduce such a training environment when striving for a pedagogical goal with short-term constraints.

The gamification of learning defined as “the use of game principles in learning environment” is pervading graduate education adding playfulness to classical courses. This approach is aimed at

reinforcing student engagement. It concerns as well board games than video games. Gamification is often considered as a behaviorist approach limited to add competition between students with scoring & rewarding systems. Nickolson [2] highlight that meaningful gamification focuses on introducing elements of play instead of elements of scoring. Besides, it is necessary to separate result of the game with the way students are evaluated so as to maximize the learning experience and avoid useless conflictual tensions. The potential of combining game elements and instructional simulations into serious games offers some possibilities to encourage the immersion in context, the empowerment and the learning appetite of students.

In this paper , we propose a serious game dedicated to be used in educational institutes or companies as a pedagogical tool introducing a training module of eco-innovation.

Before presenting the description of the actual version of “Ekit’eko” game, we first explain our serious game design methodology, revisit the different pedagogical objectives supported by eco-innovation training and propose a short state-of-art of existing games in those domains.

2- SERIOUS GAME DESIGN METHODOLOGY

The French institute of education defines 8 principles to consider when designing serious game [3] : (1) encourage motivation and get students to engage in the situation, (2) identify the knowledge that students will have to handle, (3) give students a freedom governed by rules, (4) introduce instructional elements that allow students to have feedbacks on the strategies they adopt, (5) allow error, don’t dramatize the failure, (6) enhance the interaction between players, (7) take into account the emotional aspects and (8) integrate playfulness phase in the learning situation.

A multi skill team was established in order to develop the game. This team includes a psychologist, a product development expert, an eco-innovation expert and a designer. The design process of Etik’eko consists in three stages: the first stage concerns the identification of the pedagogical aims of the game. The second stage can be seen as the classical inspiration and ideation phases of design thinking: an overview of existing games and recent tendencies were elaborated followed by creative sessions aimed at defining the main principles and the environment of the game. The last stage concerns the development and tests of the game in an agile philosophy based on the power of short cycles of improvement. For each iteration, three questions are checked: how the **pedagogical** objectives of the game are integrated into the game? What about its **playfulness**? Is there any **ergonomic** problems?

3- COMPETENCES TO MANAGE ECO-INNOVATION

The eco-innovation training is addressed to future managers and design engineers.

Four different modules were elaborated to develop managerial eco-innovation skills to those students: sustainability, entrepreneurship, collaboration and product service system development.

Sustainability

Eco-innovation is looking for designing viable solutions in the triple bottom line perspectives. It implies a capacity to consider economic, social and environmental consequences when assessing situations and creating alternatives. The module introduces several methods which exist to stimulate and evaluate each part of sustainability: eco-ideation, eco-design and life-cycle analysis introduce the complex notions of impact transfer and rebound effect as key reflexes to adopt for analyzing environmental impacts during all life of products. Cost and value analysis are aimed at balancing economic incomes and costs while marketing and more recently CSR-ISO 26 000 approaches are focused on social aspects looking for optimizing the well-being of all stakeholders, particularly the clients.

Collaboration

Two different scopes have been considered related to collaboration. On one hand, the collaboration is dealing with relationships between members of the same company. These members of a new product development team might have to respect constraints related to its function and responsibility scope. Collaboration in this case aims to obtain the global optimum seek for the developing system beyond the local optimums related to each function.

On the other hand, eco-innovation lead to reconsider the question of the collaboration among stakeholders networks with multidisciplinary teams capable of efficient collaboration. The collaboration practices among project stakeholders are an essential catalyst for creative sharing of skills. By its socio-technical characteristic, the collaboration is a relatively complex phenomenon to study and to formalize in the organization. The interaction between the individuals themselves, as well as the interaction with the surrounding systems (offers, context, etc.), creates major concern in the academic and industrial world. The module shows the complexity of collaboration in the industrial context through its numerous “parameters” to consider (personal development, individual and group psychology, enterprise culture, power game, general working habits, etc.).

Entrepreneurship & innovation

Managers of eco-innovative projects require having the entrepreneur streak. The module “entrepreneurship and innovation” is aiming at giving students methods to improve their know-how to be open, creative and opportunist while being objectives and in-law. It is composed of an introduction to creativity, partnership exploration and business plan methods. More formal administrative rules (intellectual property, type of incubation structures) are also presented. Future entrepreneurs need to be aware that their behaviour and each choice they made are influencing the pathway of their projects and how they are perceived by its environment. Recent works on sustainable business model [4] is also introducing new ways of considering triple bottom line perspectives as central values of the project. Entrepreneurs need to promote their projects to their in-construction ecosystem encouraging new dynamic thanks to such values.

Product-Service System development

Whatever the eco-innovation is dealing with product, services or product-service system, students need to be familiar with the different steps of development process of project they are going to manage. The module is presenting several processes according to the domain and the type of systems. Different links between eco-design rules and economy of the functionality and PSS development will be proposed.

The aim of Etik’eko game is to introduce briefly all aspects of the management of eco-innovation so as to improve the empowerment of students and their capacity to understand the coherence between each course.

4- OVERVIEW OF EXISTING GAMES

Different types of games were listed, categorized and analyzed through the prism of three axes: pedagogy, playfulness and ergonomics. (*See table 1*)

From a sustainability point of view, several games are available for different age categories. Some serious games focus on a particular aspect of the environmental category (awareness to the energy problem or to the waste management issues), others aim to find the balance between social, economic and environmental factors in the frame of a new city construction or new business development. Shades of environmental impacts are rarely presented and therefore the impact transfer occurrences are not included in the mechanisms of the analyzed games.

From an entrepreneurship point of view, the implication of the educational system on promoting entrepreneurship values has been a mayor center of interest in universities[5][6][7]. The development of serious games related to this field has focused mainly on role games bringing the student to follow a new company creation process. Combining with eco-innovation process, such approach demands a triple bottom line focus as the main principle for the serious games that promote entrepreneurship and sustainability. From a new product development point of view, there are several serious games that have been developed focusing on engineering aspects or more production management oriented.

We have selected to detail the Delta Design Game [14], which merges the new product development and collaboration aspects.

Table 1 : Non exhaustive list of educational games reaching one or several of Ekit'eko pedagogical objectives

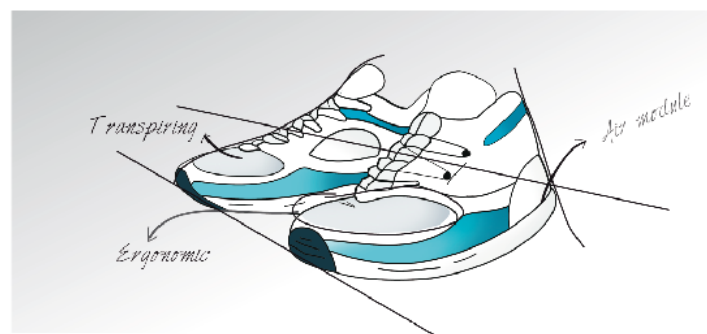
Game	Objectives	Pedagogical relation	Instructional elements	Playfulness	Ergonomic	Type of support
[8]Climate defense	Climate Defense is a tower-defense game that explores the issue of climate change. The climate is in peril and it's your job to use strategy and tactics to defend it!	Sustainability	Vocabulary of international climate change organizations Scoring with cost, temperature and Co2 emissions	Realistic scenario Boardgame with point systems Two modes (virtual or real situations)	Coherent symbolic and graphics Interactive	Virtual
[9] Change artisans	The objective of this game is to grow a business in the context of sustainable development. We must therefore make the right choices to find the balance between social, economic and environmental factors	Sustainability and innovation	Customization according student profiles / scoring in TBL as a gauge	Boardgame with thimble / Bonus-malus cards / Point systems/Competition	Graphical choices coherent/repetitive music/hard to win	Virtual
[10] EDF Park	Build a park playing on a mix of energy sources to supply the energy needs of its attractions to build.	Sustainability	Disguised in the support / scoring	Time pressure /Scoring system/ Construction of city/immersive/Competition	Help menu/clear support	Virtual
[11] Climcity	Reduce greenhouse gas emissions and develop renewable energy in a fairly rural town.	Sustainability	Scoring feedbacks and mini-course during the game	Ambitious and visible objectives/ Scoring/Sims inspiration	Difficult to explore the map Feedbacks in each action	Virtual
[12] Collapsus	The game propels protagonists among a team of 10 people who seem to be caught in a conspiracy of energy and must find new ways to feed the world in clean energy	Sustainability	Documentary parts based on sourcing facts.	Transmedia. Original missions and esthetic framework/Cooperation	Interactive experience. Adapted feedback.	Virtual
[13] Innov'nation	As a new manager in the company X, the objective is to structure the innovative process to find relevant sectors to develop and proposing them to the direction	Entrepreneurship and collaboration	Wiki / Feedbacks/ scoring on three variables (resources/Money/Time) /collaboration with experts and teams	Virtual work environment/Individual game	Avatar indicates the pathway. Adaptable according to previous choices.Not enough freedom	Virtual
[14] Delta Design	The team must design a house by assembling equilateral triangles in either red (heating triangle) or blue (cooling triangle) formations.	Collaboration and product development	Simulation Feedbacks on post-session	Cooperation intra group and competition intergroup Complex solving problem Lack of enthusiasm	Well-detailed instructions Hard to control Support could be improved with adapted 2D-3D softwares	Physic
[15] Wallbreaker	Several teams must manage the merger of two SSII sizes and very different cultures. Participants determine the actions to accompany 10 employees with different profiles	Collaboration	Simulation Robust arguments on decisions Based on management theory Corrective actions	Cooperation Big Board and objectives	Visualization of each group progress Clear &coherent graphical choice	Physic
[16] B to Green	B to green consists in developing eco-innovative strategy in a economic context for 5 years. Responsible of concurrent companies, participants develop new products and need to have the highest number of marketplaces	Innovation & eco-innovation	Debriefing + adapted pedagogic sessions	Board game with cards representing competitive advantages.Three-steps process for each year	Well-defined and illustrated rules Tutorial video	Physic
[17]Kosmodisea	It is a virtual journey in planning and implementing a teamwork project and has the objective of promoting collaboration and the use of Information and Communication Technologies.	Entrepreneurship	Defined agenda with objectives and dead-lines/ collaboration with experts and teams / scoring/ feedbacks after every delivery	Rewarding system with points/competition	Graphical choices coherent/ Interactive experience/ Clear support (all the information is well distributed and completed)	Virtual
[18] PEGASE	The aim of this platform tool is to help change management support during the implementation of a PLM system in an industrial company	Entrepreneurship and Product development	Customized scenarios with indicators/ Interaction with colleagues and training presentations/ informative archives available	Construction / Sims inspiration/ Interaction with other players/ Real product data collection	Interactive experience/ Scenario adapted to the real situation of the user	Virtual
[19]Solidarisk	Each team (for 2 to 4 people) plays the role of members club Cigales which will decide whether to support the corporate projects submitted.	Entrepreneurship	Collaboration with experts and teams/ feedbacks/ documentary parts	Ambitious and visible objectives/ rewarding system with points/ competition	Interactive experience. Adapted feedbacks.	Virtual

In the Delta Design Game, the team must design a house by assembling equilateral triangles in either red (heating triangle) or blue (cooling triangle) formations. The design team is composed of a project manager, a structural analysis specialist, a heat engineer, and an architect. Each member of the team receives two documents. The first part presents the team composition and target. This directive also specifies the global task to be undertaken by detailing the design requirements of a house. This first part is the same for all participants. The second part of the document, different for each stakeholder, outlines the essential requirements for the correct execution of the role assigned to the player. Therefore, the team task is to design a house that takes into account and integrates all of the stakeholder's rules that are sometimes vague or precise and subjective or formal. The main interest of Delta Design game remains the analysis of the collaboration "highlights". An external viewer or a set of viewer-player can do this analysis for each stakeholder. Analyzing the corpus, the pictures and videos of a session with Delta Design allow us several opportunities for insight and observation of individuals in a collaborative situation. We will not develop the pedagogical interest of this approach as the reader may consult the paper [20]. Thereby, through reflective analysis [21], he can better understand and analyze his own behavior during a collective action. However, we have identified some limits of the Delta Design game. First of all, the future design product engineers occasionally have a lack of enthusiasm or concern for the experiment. This is related to the fact that the final objective of the experiment is the design of a house assimilated to the formation of architecture and with characteristics not focused on the mechanical product technology. The representation of the object to be designed (under the triangle assembly) seems to be too abstract to solicit more interaction between the players. Moreover, the 2-D format differs from the 3-D formats (CAD) traditionally used in product design. The game format imposes its utilization at the present moment and does not allow for a test in a distributed environment. Taking these limits into consideration, **we designed a different game, including more playfulness and focused upon a more familiar system of product/service.**

5- PROPOSITION OF THE SERIOUS GAME: EKIT'EKO

Ekit'eko is a simulation-strategic game where participants are asked to develop a new innovative product in the most sustainable way. The chosen product is a sportive sneaker. This market has a high eco-innovative potential and people get easily connected with it.

As in any serious game, the session consists in three parts: the introduction phase, the game session and post-game session.



"You are a group of friends that intends to start a business together. You have just obtained the autorisations required so you are going to create an enterprise that will be introduced into the sportive sneakers market.

However, for the beginning, you will subcontract the rest of the staff which is, in your opinion, the best solution as your initial budget is not too wide.

Therefore, now's the moment to define the objective that the business will follow."

Figure 1: Screenshot of the mission presentation interface

The introduction phase

It consists in the establishment of groups and the presentation of materials. The game is designed to be played in groups of around three-five people. So participants will be asked to make groups before the game starts. They will be given all the explanations and rules of the usability of each material so that the participants will get connected with the game's process.

The game starts with the introduction of the overall context. The mission is introduced to the groups (See Figure 1). Then, participants are proposed to play a role, defined at the presentation of the mission, which is going to determine the way of thinking they will have to defend. Three personas are created: an ecological products design engineer, a business administrator and a marketing director.

Proceeding of a game session

After the introduction of the context, teams will have to make a series of decision concerning the development of their products. The game begins with the choice of a strategic orientation of the company. Each group will have to adopt a strategy that will condition their decisions during the session. Every step to the final result is actually a question that all the groups will have to answer by choosing one of the 3 optional proposed answers. (see Figure 2a)

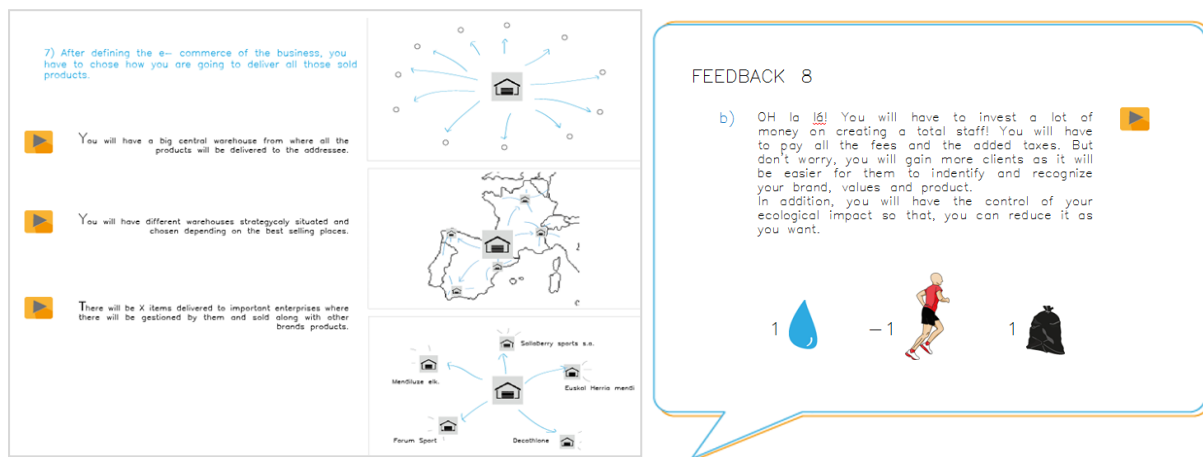


Figure 2: Screenshot of examples of (a) questions and (b) feedbacks

Each of the answers supposes a different impact in the final (and provisional) results, so, all groups will have to study and identify which is, for them, the best option and if it is deemed to be satisfactory in all TBL aspects. These variables are one by one: the economical, the social and the environmental (which is made up of the water pollution, the oil repercussion and the environmental global impact). So that, if a team wants to take care of the environment, they will choose the most ecological option, or on the contrary, if they want to gain a lot of money, they will decide to make a bigger action even if it doesn't care about the environment at all. During the game, the variables will show up the state of each group related to the chosen objectives and the impact they are doing on the different aspects. So, depending on the decisions and answers they will choose, impacts will vary positively or negatively. Every time a decision is made there will be given real time feedbacks that will allow participants to understand the possible consequence of their impacts on the three sustainable variables. (see Figure 2b) Thus, these variables will be key elements to show the progress of each team in real time.

Post-game session

Finally, after answering all the questions, each team will reach to different final results and they will receive a personalized final conclusion of their progress during the game. They could realize if they reach a balanced state between their triple bottom line impacts. At the end of the game, a feedback discussion is initiated with all teams. They compare their results and are asked to talk about the 4 axis of the pedagogical objectives. Finally, teacher introduces the 4 modules. Participants are supposed to have a more important learning appetite and find more coherence in the organization of the course.

Embodiment of the game

The environment of the game is important to facilitate the immersion of participants. The metaphor of a trail was used to design all supports. The progress of the innovation is compared to the pathway of a mountain composed by several steps. The evolution of economic, social and environmental variables is respectively visible through the quantity of liquids available in an energy drink, the number of runners and the number of trashes present in the mountain. (See Figure 3) Both board and video game supports are being developed so as to adapt it according to user preferences. Other ways of interactions are actually considered so as to improve the playfulness of the game: the use of corrective actions to recover points in one of the three variables, the presence of a panel sharing the progress of each team strengthening inter-group competitions and time course.



Figure 3: Board of Ekit'Eko in an ongoing game

6- CONCLUSION

The goal of our game is to deal with the socio-technical practices [21] underlying the development of eco-innovations. We think that our contribution can be useful in particular in the case of the training of complex skills such as the collaboration faced to sustainable development challenges. It was first developed as an introduction tool for institutional courses on eco-innovation. Etik'Eko could also be used from the early stage of eco-innovation development as a stimulus preparing entrepreneurs and designers to change their classical way of making decision toward sustainability.

Several iterations will help us to finalize our rules and supports so as to optimize the three objectives of our serious game (pedagogy, playfulness, ergonomic). We are currently building system dynamic models in order to have personalized feedbacks. Therefore, adapted corrective actions could be proposed for each group. Furthermore, we are planning to organize a test in order to compare how students perceived the four pedagogical modules in both traditional and based on Etik'Eko game sessions.

After first internal tests, we would like to propose an experience between several institutions (engineering schools, universities, companies) in order to test this game in a distributed way (between several teams, at distance (at different locations)).

The game will be presented in the form of free tests to the participants of the MOTSP conference.

We would like to acknowledge APESA, the INTERREG project RESOT in the framework of POCTEFA and all IKASI team members which participate to focus groups and experimentations.

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