'Energy for Life', A Digital Game for Civic Education: Galvanizing Towards Ecological Awareness

Luís Carlos Torrão[2]   Nuno F. Rodrigues[1,2]

[1] Departamento de Informática, Universidade do Minho
[2] DIGARC, Instituto Politécnico do Cávado e do Ave, Portugal

Abstract. 'Energy for Life' is a web based game intended to be played in schools all over the European Continent. Its goals are to achieve the youngsters' attention and interest into the environmental problematic, promoting ecological consciousness and stimulating pro-active behaviors within quotidian life, having the planets sustainability in mind. The foremost feature of this video game is the apprenticeship of domestic energetic economy practices and understanding its favorable consequences over the environment. This paper renders the specification of a serious game that can entertain and enlighten: a closer look to concepts, pedagogy, storytelling and game action will be presented.

1   Introduction

Serious games development has gained strength since their first appearance in the 1980's. Their virtualities in achieving the transmission of knowledge by means of an interactive game were widely demonstrated in different fields like education, engineering, emergency management and defense. Such different applications reflect the variety of implementations of serious digital games. From complex three-dimensional real life simulations to more simplistic quizzes and tests of theoretical knowledge, there are no limitations on what this kind of play can be. The effort of constructing this sort of game is therefore a challenge to ones creativity and dominance of software development techniques.

MOTIVATION. Serious games for civic education intend to serve as a mechanism of transmission of certain values, ideals and practices, mainly in also amusing video games. They are frequently destined to children, since they can be more receptive to learning socially encouraged behaviors by means of entertainment solutions. Ecological awareness is not a simple matter. It involves complex knowledge about the characteristics of nature and of human activities as they produce positive or negative effects on the environment. Nonetheless children in the age of ten to twelve are

nowadays expected to demonstrate at least some ingenuous conceptions of nature protection values. A game that takes that basic concern and tries to make it more conscious and informed is an excellent tool for environmental education circumventing the heaviness of such a complicated subject.

CONTRIBUTIONS. This paper describes the specification of a serious digital game intended to produce in children the awareness of how important it is to preserve the natural environment, stimulating behaviors that produce positive ecological effects on the planet. 'Energy for Life' not only describes the urgency of action to protect nature, but also demonstrates the means by which that purpose can be achieved.

ORGANIZATION. Still in this section we introduce some comprehension of the cultural domain relative to ecology, the main subject subjacent to the game. In subsequent sections the topics approach the games technical specification, discussion about pedagogical/psychological characteristics of preadolescence and adolescence and their connection to the games specification as its target audience, the choice of game type and score system and the document finalizes with a brief conclusion and considerations for future work.

1.1 The Ecological Culture as a Games Background

SCIENCE. Linnaeus' concept of the economy of nature was the starting point for the emergence of a new specialization of Biology. Ecology, the study of the relationships between living creatures and plants to each other and to their environment [1] is nowadays a mainstream subject in Academic and popular culture. Its discoveries have helped us understanding the complexity of life: life cycles, populations and environment are the key concepts to comprehend the evolutive nature that surrounds us, and of which we are a piece. Its knowledge has yielded the tools necessary for predicting the effects of human actions, allowing us the choice of abandoning nefarious unconscious practices. How can a serious game instigate scientific curiosity about Ecology?

CONSERVATIONISM, ENVIRONMENTALISM, ETHICS AND AESTHETICS. The political reflex of Ecology was born with the XX'st century, and became increasingly popular till its majestic blossom in the 70's. Conservationism was its first, superficial [1], expression. The preservation of biodiversity, fisheries, wildlife, water, soil and forestry as unique and indispensable resources for humanity became a human responsibility. Reformist or

deep ecologist, [1], the environmental movement came to unveil a non anthropocentric ideal of nature, where the principles of conservationism are emancipated from man and put on by activism, lobbying and education with the goal of releasing the environment of the human malign domination. The care for nature, the environment, plants, animals, etc, has had considerable expression in fascist regimes as in the most libertarian contexts in the XX'st century. As a philosophy of lights or a romantic appeal, the ecologist culture rises with a new world order conception [1]. What role will a serious game with an ecological background play in the education of the young?

ECO-DEMOCRACY. Luc Ferry [1] advocates a non manichean democratic ecologism he considers necessary for the resolution of the alarming environmental problems in the world. Depolarized, distinct from the deep ecologism and from the cartesian anthropocentrism, emancipated from the custody of religious authorities and disengaged of dogmatic partisan postures, impregnated with a democratic reformist sensibility and conducive to a juridical concept in which nature is not a legal subject *per se* rather than a treasure to be protected by man's laws. Can a serious game be a vehicle for the transmission of democratic values relative to environmental awareness?

2 Game Type, Genre and Story

TYPE AND GENRE DESCRIPTION. 'Energy for Life' is of the Role-Playing Game type, and its genre is Environmental Action. The target platform for the game is the personal computer, with classic minimal requirements, connected to the Internet and using a web browser. The player visualizes the world with a fixed camera that presents one scene of the game each time. Examples of the game scenes are: the living room, kitchen, office, Prime-Minister's cabinet, etc. Rendering of the scenes is presented in a three-dimensional perspective, as shown in Figure 1. In each scene, the player can move freely within the physical space, avoiding collision with objects, that can be tables, chairs, fridges, sofas, etc. Mouse and keyboard interaction are implemented simultaneously in a classic RPG like way.

REFERENCE TO SIMILAR GAMES. Games of the same type of 'Energy for Life' are, for example, 'Indiana Jones and the Fate of Atlantis' and 'The Secret of Monkey Island'.

GAME STORY: PART ONE. This is the story of two young heroes who come from the city of Polimpia: Mika, a boy, and Minna, a girl. They

Fig. 1: 3D Role Playing Game

are two sixteen year old best friends that enjoy the normal life of every adolescent in the 1990's, but something that will change the route of their lives forever is about to happen.

Everything began in the previous night. Mika and Minna had fallen asleep when a horrible nightmare haunted their dreams. A blue spirit, dressed in a long white robe calls them, crying, to see an enormous catastrophe that fell over the planet Earth. Visions of polluted seas, avenues filled with abandoned cars, a gray and heavy sky, no energy! The planet had fallen apart! The spirit of Mother Earth explains that the humanity had been alerted of the consequences its way of life could bring. The low level of oil reserves and their uncontrolled consumption, the immeasurable pollution created by cars, industries and humans in general where intoxicating the air. The planet had become a living hell. Rivers and seas could not uphold any more polluting sewage. The new horizons were colossal laystalls. Without recycling and reuse there was no solution for all the waste generated by man, turning the situation into permanent chaos. Fortunately Mother Earth is not alone in her fight for survival. Alerted by the spirit, Mika and Minna were compelled to offer their help. It is now in their hands the mission of avoiding such a catastrophe. Can they save the world? It is now time to learn how to use fairly and consciously the energy and other resources: this intelligent behavior and the new technologies are the only solution and there is only one chance. It is time to wake up...

GAME STORY: PART TWO. Almost twenty years have passed. Mika and Minna are that kind o people that always follows their dreams, and that

is what they did. Completely immersed in the urge of ecological change, throughout the years they have conducted their lives into contributing to the environmental welfare, as they studied and in their professional choices. They are now acknowledged scholars in Ecology and they have been invited by Polimpia's Prime Minister to be his special advisors, and when he is absent in official affairs they inclusively replace him in the governance labor such is their enormous public respectability. Mother Earth is always on their minds and on their hearts, and they frequently remember the times of their adolescence. There is work to be done: the Prime Minister is on an official visit to a foreign country and the ministers and the secretaries are falling into confusion. Mikka and Minna are there to support them, to make decisions and the government work. Are they going to take this unparalleled chance to make considerable advances in the protection of the environment?

3 Game Structure and Scoring System

'Energy for Life' is based in a concept of realistic sustainability and optimized use of energy. The game pretends to encourage the player to understand that daily tasks, that can not be avoided, can be perfected for lower energetic consumption. In this game, the actor will find two completely different scenarios: in the first one, the player is at home, and in the second level the player will have to expand his domestic knowledges previously acquired to a hole nation. In both levels the player will make decisions that will bring favorable and unfavorable consequences, accordingly to its energetic efficiency characteristics. Good decisions will make the player win the game. The world consists in two different scenarios, a house in Polimpia and the cabinets of the Government of Polimpia. The games structure follows the order presented in Figure 2.

In both levels the player can and in some cases will mandatorily have to make interactions with several NPC's[3] or objects that are fundamental in the game, since they serve the purposes of the game's thematic. Initially the game will work as a tutorial meant to teach the user how to play. At this level the character will be surrounded with NPC's that will incite the player to put some order in the house. This NPC's will assume roles, erratically turning on the television set, the lights,etc. This behaviors can and should be corrected by the character, and that will improve the player's score. 'Energy for Life' has a system of temperature that regulates it inside the house, and more specifically inside each room. This
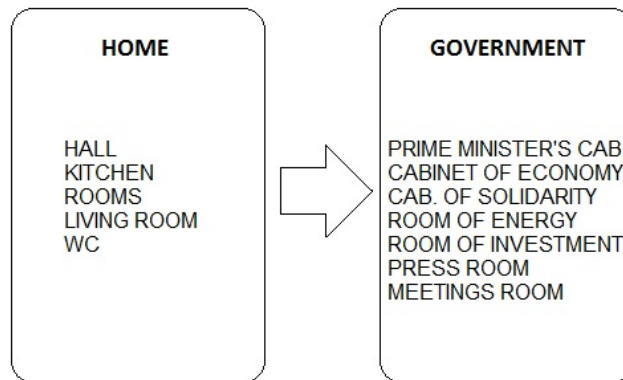
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[3] Non Playing Characters.

Fig. 2: Game Scenarios Flowchart

system influences the player with loss of points of energetic efficiency if the temperature exceeds the limits of the body comfort. During the game the user will be taken to perform some tasks or special actions which, despite being optional, generate bonus points for the player. Such tasks can be, in the home scenario, depositing garbage in the recycling center, daily hygiene, washing and drying the laundry, feeding or keeping the adequate temperature in the house and in the government scenario different decisions on buying and selling energy or helping underdeveloped countries.

3.1 Home Scenario

The home scenario is composed of five divisions and an exterior terrace: one living room, one kitchen, two rooms and one bathroom. There is also a hall that serves as free space between the living room and the kitchen. In the kitchen there is a worktops, fridge, washing machine, drying machine, stove and a small exterior terrace where a hanger and a wall lamp can be found. The houses floor is generally made of clear wood pavement, with exception to the kitchen where square white tiles predominate. The decoration of the house follows the design of a casual and minimal style, with predominance of white.

'Energy for Life's pointing system is based in two main components: energy efficiency points and credits. Energy efficiency points are given while the player uses the objects and when a object is substituted with a more efficient one. This stimulates the learning of consumer efficiency. Credits serve as currency: for 10 EEP the player gets one credit and

the game begins with 50 credits. They are important in the learning of domestic economy. The score system for the home scenario is described in table 1.

Table 1: Scoring System: Home Scenario

Item	Temperature	Type	State	EE points	EE Costs
TV			On	-	10/30"
TV			On[4]	-	-
TV			Standby	10/30"	-
TV			Off	20/30"	-
Lamp		Any	Off [5]	10/30"	-
Lamp		Incandescent	On	10/30"	5/30"
Lamp		Halogen	On	15/30"	4/30"
Lamp		Fluorescent	On	20/30"	3/30"
Lamp		CFL	On	30/30"	1/30"
Lamp		Incandescent	Preinstalled	-	-
Lamp		Halogen	Installation	-	10
Lamp		Fluorescent	Installation	-	20
Lamp		CFL	Installation	-	30
Window		Normal	Preinstalled	-	-
Window		Caulked	Installation	40(Bonus)	100
Window		Thermic	Installation	120(Bonus)	200
Window/Shutter	Red	Day(Summer)	Open/Open	-5/30"	-
Window/Shutter	Orange	Day(Summer)	Closed/Open	-3/30"	-
Window/Shutter	Yellow	Day(Summer)	Open/Closed	-1/30"	-
Window/Shutter	Green	Day(Summer)	Closed/Closed	-	-
Window/Shutter	Green	Night(Summer)	Open/Open	-	-
Window/Shutter	Orange	Night(Summer)	Closed/Open	-3/30"	-
Window/Shutter	Yellow	Night(Summer)	Open/Closed	-1/30"	-
Window/Shutter	Red	Night(Summer)	Closed/Closed	-5/30"	-
Window/Shutter	Violet	Day(Winter)	Open/Open	-5/30"	-
Window/Shutter	Green	Day(Winter)	Closed/Open	-	-
Window/Shutter	Blue	Day(Winter)	Open/Closed	-5/30"	-
Window/Shutter	White	Day(Winter)	Closed/Closed	-3/30"	-
Window/Shutter	Violet	Night(Winter)	Open/Open	-5/30"	-
Window/Shutter	White	Night(Winter)	Closed/Open	-1/30"	-
Window/Shutter	Blue	Night(Winter)	Open/Closed	-3/30"	-
Window/Shutter	Green	Night(Winter)	Closed/Closed	-	-
Air Conditioning			Installation	300(Bonus)	200
Air Conditioning			On	10/30"	5/30"
Central Heating			Installation	600(Bonus)	500
Central Heating			On	-	2/30"
Stove		Class B	Preinstalled	-	-
Stove		Class A	Installation	-	400
Stove		Class B	On	20/use	10/use
Stove		Class A	On	50/use	4/use
Refrigerator		Class B	Preinstalled	-	-
Refrigerator		Class A	Installation	650(Bonus)	500
Refrigerator		Class B	On	8/30"	3/30"
Refrigerator		Class A	On	10/30"	1/30"
Washing Mach.		Class B	Preinstalled	-	-
Washing Mach.		Class B	On	10/use	10/use
Washing Mach.		Class A	Installation	550(Bonus)	450
Washing Mach.		Class A	On	20/use	5/use
Drying Mach.		Class B	Preinstalled	-	-
Drying Mach.		Class B	On	10/use	10/use
Drying Mach.		Class A	Installation	250(Bonus)	450
Drying Mach.		Class A	On	20/use	5/use
Hanger				10/use	
Bath				5/use	10/use
Shower				20/use	2/use

[4] While watching informative videos on environmental issues.

[5] With someone in division.

3.2 Government Scenario

The Government headquarters are installed in a summer palace of neo-classic style, with many luminous and wide checkered windows that go from the floor to the ceiling and surrounded by verdurous gardens. In the interior the sober decoration essentially consists of multiple shelves made of noble woods, in the walls, where there are no windows or doors, filled with countless books and interrupted with some classic paintings of democratic symbology, dark green carpet floor and high and long satiny portiere in an ensemble that transmits the antiquity and dignity that are expected in a space of this nature. The palace entrance flows into the space of the Prime-Ministers Secretary. From here, the rulers can move to the press room, where a lectern, chairs and a table with a computer destined to follow the latest news can be found, the meetings room, whith a big table and chairs, or the ministerial area itself. The Prime-Ministers cabinet (a character that never appears, since he is out of the country in an official visit, leaving Mika and Minna has special advisors with executive powers) has a main table, sofas and a small lateral table with a computer. The solidarity and economy cabinets, as well as the energy and investment rooms all share the same configuration, with tables, sofas, other accessories and a computer. In the energy room there are also several screens that monitor different aspects of the national energetic management. The two heroes can freely access all the divisions during their stay at the palace.

For this scenario there are green energy, red energy, budget and satisfaction points. They start at 6000 BP, 0 GEP, 0 REP and 0 SP. 250 budget points are given every thirty seconds. The management of renewable/ non renewable energy, people satisfaction and budget are the key for victory. Points are given as shown in table 2. Fore the game final score, this points are exchanged on credits and one credit worths 100 BP, GEP, REP or SP.

3.3 Temperature and Time

The game has an internal house temperature system that allows the player to control it. Initially he sees an horizontal bar with seven levels of color/temperature: violet (very cold), blue (cold), white (some cold), green (biological comfort), yellow (some heat), orange (hot), and red (very hot). At the same time the exterior temperature will change without the

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[6] Random value between 0 and 1.

Table 2: Scoring System: Government Scenario

Power Plant	Cost/BP	Red Energy/30"	Green Energy/30"	Satisfaction/30"
Gas Thermoelectric	200	20	-	20
Coal Thermoelectric	300	20	-	20
Oil Thermoelectric	300	20	-	20
Biomass	200	5	15	20
Wind	200	-	$10*RV^6$	20*RV
Solar	200	-	10*RV	20*RV
Hydrous	400	-	26*RV	10*RV
Nuclear	600	40	-	10*RV
Wave	300	-	10*RV	20*RV

players intervention and he will have to use the windows and heating and air conditioning systems to minimize the effects of exterior cold and heat inside the house. Each time the player makes changes like, for example, caulking the windows, the levels of temperature reduce in number to just five: orange, yellow, green, white and blue. By making them thermic the levels reduce to just yellow green and white. This way there is a progressively less arduous way to regulate the temperature in the house.

The total time of the game is of eight days, four for each level. A day corresponds to ten minutes in real time. The first levels begins on Wednesday and lasts till Sunday. The second level starts on Monday and ends on Thursday.

4 Discussion

4.1 The Outset of Adolescence

IDENTITY. For Erikson [2], abilities, interests, needs and desires are the elements that the adolescent must connect in its self-awareness in order to build a frame of identity in the wall of role confusion. This is adolescence's main task, solved when a profession is chosen, inherent values are adopted and sexual identity becomes satisfactory. It is the time for searching a personal and ideological compromise that brings confidence. Adherence to life objectives, consciously defined, is expected. Accordingly to its process of construction, very influenced by family and personality, identity can be cataloged into four stages: accomplished, granted, moratorium and diffuse. The first is a result of a individual transcendence of crisis into compromise, the second derives of acritical acceptance, the third is the absense of compromise in crisis and the last is the lack of crisis itself, and

consequent lack of compromise. 'Energy for Life' proposes a set of values that can be digested by the player. The introduction of concepts like environmental awareness can trigger the interest of teens and influence their identity process and the assumption of conducts in an expansion of information.

MORALITY. Morality is cataloged by Kohlberg [2] into three stages, two of them occurring in preadolescent and adolescent age ranges. In conventional morality, the pattern of authority figures is internalized and there is a moral objective of being 'good', please the others and keep social order. In post-conventional morality the moral patterns established collide with self-conscious morality, generating critical morality. In terms of ecological morality, it is expected that preadolescent defend either anthropocentric or in some cases biocentric principles of nature protection. One that sees the effects of nature welfare in human welfare, and the other that protects the nature for itself. This serious game is meant to awake and accelerate the emergence of ecological morality, transmitting a sense of urgency of environmental protection behaviors and pointing out to the imminent catastrophic consequences of their absence.

PARENTS. In the beginning of adolescence it is natural some increase of a conflict with parents, that usually stabilizes and ends at the end of this phase. Margaret Mead [2] unveils that teenage rebellion is not representative in a culture that allows gradual transition to adult life, though. By the other hand Hall and Freud believed that the generational gap and urge for independence always turned out to produce some kind of conflict. Parents with democratic authority stress values, rules and standards but are available to hear, explain and negotiate. Parenthood of warmth and acceptance is considered to be the best practice. Mikkas parents and Minnas grandmother share a role of concerned adults that need to be reminded by the player of all the actions that can be taken at home to preserve the environment. Galvanization of this type of behaviors at home is the objective behind this: children can educate their parents too and the player should feel motivated to it by playing this serious game.

BROTHERS AND SISTERS. At this stage, adolescents spend less time with their brothers, but still show affection and admire them, despite of an increasing distance. Larger age gaps between brothers seem to generate a more affective relation, and the younger try to identify with the older, showing respect for than person that has the power and status of being the 'older brother'. Mikka and Minnas younger brothers and cousins are

the avatars of the expression of the players authority as an apologist of environmental and ecological values. This game allows the player to take that role and possibly enjoy and assimilate it.

Friends. Friends generate the space for experimentation, and a place to reach autonomy and independence from parents. Their relations are different from the familiar ones, since they urge from equality, and that is why they are less conflictive too. In adolescence, friendships are very important and intimate, there is a sentiment of loyalty and friends influence each other in the way they think and act. Mikka and Minnas friendship should make the player recognize itself in the game and accentuate the sharing of ecological values in friendship.

4.2 Choice of Game Type

A game like 'Energy for Life', that intents to produce change in mentality and behavior in teens should be an object of recognition. That is why storytelling and the representation of real life are so important and was the main reason for choosing the Role-Playing type conception. The Role-Playing-Game is like a living movie where the protagonist is the player and in this manner there can be a simulation of conduct that should produce questioning about real life behavior.

4.3 Score System

Implementation The scoring system as been constructed in order to guarantee consistency in the game. As it is here exposed, it has been established that the game should have an average maximum score of 5000 points, obtained by reaching the maximum score of 2500 in the home scenario and 2500 in the government scenario. The average minimum score is established as 50 credits, but if it gets negative in a certain level, it should reduce the score of the other level and in the final count, if still negative, should be of 0 credits.

Home Scenario: Average Minimum Score.

$$Score = Initial + \frac{ContinuousPoints + DiscretePoints + Bonus + Install.}{10} =$$
$$= Initial + \frac{(Gain - Loss)*Turns + (Gain - Loss)*Usage + Bonus + Install.}{10} =$$
$$= 50 + \frac{[(10*5+50+8)-(10*3+3*5*5+3)]*80+(108-108)*Usage+0+0}{10} = 50$$

Home Scenario: Average Maximum Score.

$$Score = Initial + \frac{ContinuousPoints+DiscretePoints+Bonus+Installations}{10} =$$
$$= Initial + \frac{(Gain-Loss)*Turns+(Gain-Loss)*Usage+Bonus+Install.}{10} =$$
$$= 50 + \frac{[(20*3+30*5+10)-16]*80+[(50+10+20*3)-16]*80+2510-2650}{10} = 2500$$

An average maximum value of 2500 credits of final score for the home scenario has been obtained.

Government Scenario: Maximum Score.

$$Max.Score = \frac{BP+GEP+REP+SP}{100} = 2500 credits$$

It has been decided that the government scenario should have an average maximum score of 2500 credits also:

$$AveragePowerPlantOutcome = \frac{\frac{\sum Outcomes*Turns}{5}}{100} =$$
$$= \frac{\frac{(30*4+36)*80}{5}}{100} \approx 25 credits$$

$$Max.NumberofPowerPlants = \frac{2500}{25} = 100$$

So it results that, for an average maximum score, the maximum number of power plants possible in the game is of 100.

$$AverageBP/PowerPlant = \frac{200*3+400+300}{5} = 260BP$$
$$AverageBP/100PowerPlants = 260*100 = 26000BP$$
$$InitialBP = 6000$$
$$GivenBP = 250*Turns$$

The budget points should be of initial 6000 plus 250 every 30 seconds.

Government Scenario: Average Minimum Score.

$$Min.Score = \frac{BP+GEP+REP+SP}{100} = \frac{(6000+250*80)+0+0+0}{100} = 260 credits$$

Validation Hypothetically, there may be three players that have different perceptions on energetic efficiency practices. Player 1 is comfortable with traditional domestic electronics and sources of energy and is a spender. Player 2 likes the latest trends on house equipments, is not a spender, but thinks nuclear power is the most futuristic and powerful solution. Player 3 is very aware of the negative effects of unselected domestic electronics and the lack of energy economy and of the importance of renewable energy sources. Considering that they have played the game enough times, in this hypothetical play they make all their decisions as they start the game, maximizing the scores achieved in a periodical manner, and in the second level they all implement 40 power plants of their preferred type. These scores are reflected in the following table:

Table 3: Validation

Player	Home Scenario Score	Government Scenario Score	Final Score
1	50	140	190
2	2500	-940	1560
3	2500	1252	3752

Player 3 is the winner of the game with a total score of 3752 credits, as it would be expected of a game that has been constructed in order to promote the appliance of energetic efficiency and environmental awareness concepts.

5 Conclusion and Future Work

The main technical aspect in the conception of the game is its NPC's, objects and pointing system, built to engage the player into understanding the real concepts behind energy efficiency. The words of order of 'Energy for Life' are 'consumption efficiency' and 'green energy', and they are the foremost apprenticeships this serious game provides by taking a simple game structure to exhibit multiple ways of reducing and improving energy consumption. It is expected that children will acquire some concepts of domestic governance and some political environmental message too. Ecological awareness and practice are also important learnings this game proposes, and those where the objectives of our project. Meant to be played in schools all over European Continent by students, we take the risk of assuming that it will produce some cultural effect in these adoles-

cents, modestly contributing for the construction of a common ecological sense.

In future, we expect to conduct evaluation experiments, by means of questionnaires, to validate the pedagogical effects of the game on the adolescents that have played it in European schools. That evaluation can also be very useful for future serious game development.

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