

Educational Game on Global Environmental Changes: Collaborative Design using a Social Network *

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Abstract—Multidisciplinary teams are essential for the development of good quality and well planned educational material. This project involves a team of four biologists, two computer scientists and six graduate students for the development of an educational game on climate changes and their effects on coastal and marine environments. The development of the work is happening through discussions on a Facebook® group created for such a purpose, using the bases of INTERA process and SCRUM methodology, in a collaborative and interactive design. On a week basis, the tasks pre-determined in the backlog are presented in the group and the results of the work of each member of the team are uploaded there for discussions and suggestions by the other members. The Game Design and Level Design Documents are ready and now the implementation phase is beginning.

Keywords—collaborative design, multidisciplinary team, educational game, climate changes, marine environments

I. INTRODUCTION

The development of educational games must be based on educational theories and on well-based content. This concern is evident, for example, in GOM (game object model) proposed by Amory [1]. In the GOM, an educational game consists of a number of components (objects) each of which is described through abstract (pedagogical and theoretical constructs) and concrete (design elements) interfaces. In this model, educational game designers make use of the abstract interfaces in the conceptualization phase of game design while game developers realize these pedagogical aspects of an educational game by including the concrete interfaces into the game software and gameplay [1].

Thus, the importance of the team in the development of educational games is evident, and each member must be conscious of its role in the process. The INTERA process (*Inteligência, Tecnologias Educacionais e Recursos Acessíveis*), which is used by our research group, aims at furnishing conditions to the control of the steps and the managing of the work of the people involved, besides

encompassing the test and evaluation steps which favor the obtaining of high quality and reusable learning objects. In this process, the role of each member of the team (coordinator; analyst; pedagogical designer; demandant; responsible for content; developing team; web screenwriter; programmer; architect or engineer; testers) is well established.

Another important aspect to be considered in the process of developing an educational game is how the members of the team will interact in order to achieve all the objectives initially proposed and expected. According to Amory [1] dialogue is one of the corner stones of social constructivism and Computer Mediated Communication (CMC) tools (including networks) allow information flow, altruism, reciprocity, collective action, identities, and solidarity. Also, social networks (SNA) allow actors to understand their own relationships with a community in order to develop new insights. Cost-efficient and multimedia-rich interaction opportunities offered by the Internet and the existence of online communities have made virtual co-creation a suitable means of creating value and improving the overall success of new products [2]. Into this context, the purpose of the present study is to report the use of a social network (Facebook®) in the process of the development of an educational game on climate changes and their effects on coastal and marine ecosystems.

II. DESIGN METHODOLOGY

A. A multidisciplinary team

Since the objective of the proposed game is to address the issue of “global climate changes and their effects on coastal and marine ecosystems”, a multidisciplinary team was gathered by the coordinator of the project (Dr. Natalia Ghilardi-Lopes). The team is constituted of:

- a) four biologists, which are responsible for determining the content of the game. One of the biologists is an expert on science teaching and is responsible for the analysis of the educational suitability of the game, two

- are marine ecologists and one is an ecologist with interest on sustainability issues;
- two computer scientists, which are responsible for the leading of the development, implementation and testing of the game;
 - six graduate students. Four are programmers of the game (each one is responsible for 2 levels of the game), one is an illustrator and another is in charge of working with the teachers (production of support material related to the game and its content);
 - one analyst, which is a post graduate student involved in the development of e-learning courses at UFABC.

B. The design of the game – INTERA process and SCRUM methodology

The INTERA process includes the steps of contextualization, requirements definition, architecture definition, development, testing, availability and evaluation. The association of this process with the SCRUM methodology [3], which is an iterative and incremental development process for project managing and software development, is very promising when we consider the establishment of a protocol in which educational game developing can be based on.

TABLE 1. Contextualization artifact of the proposed game.

	Description
Type of learning object (LO)	Software (game)
Pedagogical objectives	Enable students to think about their attitudes and values towards sustainability
Knowledge area	Interdisciplinary (biology, ecology, politics, economy, physics, chemistry)
Main discipline	Ecology
Brief description	The game is about the causes and consequences of climate changes, with emphasis on coastal and marine ecosystems. The three pillars of sustainability (economy, society and environment) will be treated along the game, through the realization of tasks, quizzes and puzzles.
Public	Elementary and high school students
Previous knowledge needed	Basic knowledge on ecology, although all concepts will be explained in the game.
Accessibility degree	The game does not allow the participation of children with visual or hearing impairments
Technological expertise	The students must have a Facebook® account and know basic rules of computer use
Main problem which motivated the creation of the LO	There are few learning objects that deal with the theme of global climate changes. Few people know the coastal and marine ecosystems and also do not know the relation among the climate changes, these ecosystems and our day-to-day activities.
Expected solution	That the game can help students know a little bit more about coastal and marine ecosystems and how global climate changes can influence them. Also, which actions can help minimize the problem

b) Requirements

The objective of this step of INTERA process is to establish and maintain the agreement between the demandants and the other involved about what should the LO do. Also, the objective is to offer the development team a better comprehension of the LO requirements; provide a base to plan the technical content of iterations; provide a base to estimate the LO development cost and time; set the outline of the LO, focusing on the needs and goals to be achieved; provide the link between the technical and pedagogical approach that the LO should have.

We can think about the didactic-pedagogical, functional and non-functional requirements. Didactic-pedagogical requirements represent the concepts and content to be covered and the methodology and pedagogical strategies that the LO should reflect. Functional requirements are related to all the functionalities that the LO must present. Non-functional

a) Contextualization

According to Braga et al. [4], a good quality learning object (LO) must clearly explain its objectives to the user and it is really important that they are pedagogically evaluated before being available to reuse, which are the assumptions of the INTERA methodology. One great concern of INTERA methodology is the pedagogical quality of the LO. Generally, it is observed that LO contents lack desirable characteristics, especially with regard to the reuse and the didactic-pedagogic aspects. Many LO do not make clear to the teacher nor to the student the pedagogic objective to be achieved. This happens because these objects focus only in technical attributes and treat pedagogic attributes as marginal ones. This situation contributes to the low reusability of the object, since it does not aggregate value to the learning process, demotivating its use by teachers and students altogether.

The contextualization step of the INTERA process guides all the persons involved in the development to deeply understand the need for students to use that learning object. In our case, the contextualization of the game can be seen in Table 1.

requirements are related to the quality, usability, access, accessibility, availability, reuse, performance, portability, help and documentation, licensing and authorial rights of the LO.

c) Architecture

After the contextualization and definition of the requirements it is possible to produce a draft or delineation of the LO. Our team has already finished the production the Game Design Document (GDD) and Level Design Document (LDD) for this purpose.

GDD contains the description of the story, characters (Fig. 1) and items of the game. The game takes place at a coastal fictitious city called Apicum. The story revolves around the fact that the city has been showing some strange circumstances. For example, the citizens are suffering with high intensities of raining and high temperatures. According to the main character's teacher, the local coastal ecosystems may

be also suffering with these climatic anomalies and it would be important if the students comb about it. So, the main character of the story will have the task to investigate the causes of these climatic phenomena in the city and in the coral reef near the coast of Apicum as well.

According to Savery and Duffy [5] the use of authentic problem solving activities associated with a wide range of information (data) is essential for learning to occur in problem-based learning environments.



Character	
Features	Description
Name	Bill
Activities	Manager, Surfer, Owner of a diving equipment store
Personality	Calm, speaks using slangs, friendly and outgoing
Appearance	1.80 m tall, strong, slightly overweight with a bulging belly. Long hair only on the sides tied in a ponytail and a bald spot on top of head. Skinned by the sun. Dressed in a Hawaiian shirt, which is blue with white flowers. He wears white shorts and a sandal.

Fig. 1. Example of character description in the GDD.

The game is a typical point and click adventure game, in which the player is the main character in the story and drives it forward by speaking to other characters, finding objects, combining them in creative ways and solving riddles and puzzles. The game progresses through a storyline in which performing some actions unlocks some other potential interactions. [6].

The LDD contains the description of the game levels, the maps, level flows and their “start” and “exit” conditions (examples in Figs. 2 and 3). In order to accomplish his/her tasks, the main character of the game will pass through nine levels, each one with well-defined educational objectives (Table 2). Throughout the levels of the game, the character will gain points of “Environment”, “Society” and “Economy”, the three pillars of sustainability, and the most balanced player in these three dimensions will be the most successful one.

The idea is to create a mechanism in the game in order to monitor the student’s activity, log all the relevant events and generate useful information (reports) which can be used to grade the student’s activity and, consequently, produce data regarding the evaluation of the game and its educational efficiency. According to Mussoi et al. [7], it is possible to identify patterns related to the evaluation of assimilated knowledge through the use of LOs.

In order to perform a systematic analysis and an adequate evaluation of LOs, some criteria and aspects must be identified, such as the epistemological conception in which the LO is based on, the objectives which are described in its metadata, the quality of the addressed content, the ease of use by the student (and teacher), the interactivity and the used language.

Finally, the illustration of scenarios (Fig. 4) began after the conclusion of LDD by the team.

TABLE 2. Levels of the educational game on climate changes and their effects on marine and coastal ecosystems, with the objectives proposed for each one.

Level	Objective(s)
Introduction	Help the people who suffered with an extreme storm Talk with marine ecologists
School	Learn about marine ecosystems and climate changes
Character’s home	Make his/her home more sustainable
Coral reef	Visit a coral reef, take environmental measures in order to understand why the corals are bleached
Store	Buy diving equipment
Library	Learn about the subjects dealt within the game
University	Talk to a marine researcher and get help to understand the problem with the coral reef
Laboratory	Learn about environmental factor’s measurement equipment
City Hall	Choose for a candidate taking into account the dimensions of sustainability



Fig. 2. Examples of maps designed for the game levels

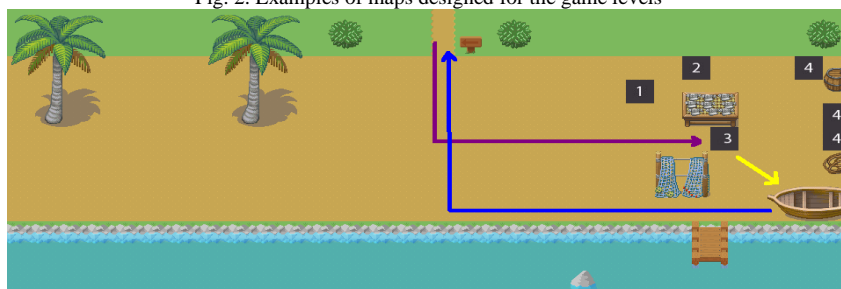


Fig. 3. Level flow designed for the “Coral Reef” level (the character is at the beach trying to reach the coral reef).

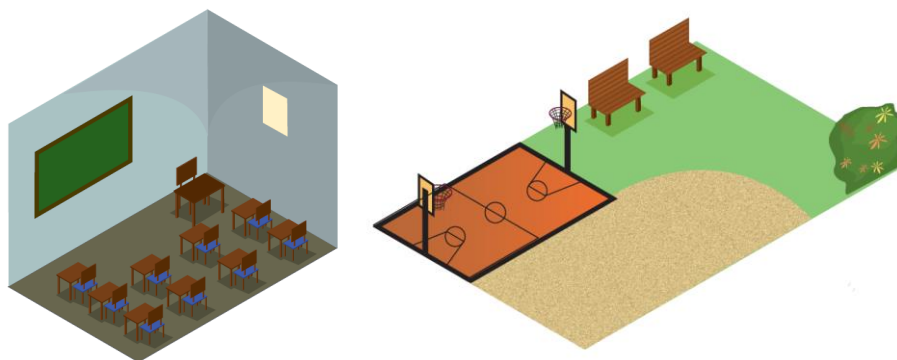


Fig. 4. Illustrations created for the “School” level.

C. The interaction of the team through a social network

Since the beginning of the project, the team decided to work in the most interactive [8] and collaborative [9] way as possible.

Thus, in December 2012 a Facebook® group was created so that all member of the team could interact. All documents produced (the script of the game, GDD and LDD) were posted within the group and everyone was able to access and comment them.

On a week basis, the programmers performed activities in order to learn how to use the software chosen for the development of the game (GameMaker Studio). Also, they learnt how to export the prototypes they were creating to Facebook®, because the idea is to let the game available in this social network so that everyone who owns an account can easily play the game, avoiding the problem that lots of teachers face when they try to use LOs in the classroom (for example, installing them in the computers). The results of their activities could be commented and discussed by any of the 14 members of the group.

Also, the members shared news and articles related to educational games, in order to allow the discussion of new possibilities to our own game.

Since the creation of the group more than 120 posts, 30 files and 225 commentaries were published by its members.

III. CONCLUSION

The production of good virtual educational material depends on the interaction and collaboration of multidisciplinary teams. The development of a game on global climate changes and their effects on coastal and marine

ecosystems is being performed by a group of 13 people who interact through a social network. So far, we have already developed the contextualization and requirements artifacts, the GDD and LDD and we think that Facebook®, allied to a good LO development processes (here we use INTERA) and methodologies (here we use SCRUM) can be a powerful tool for the integration of development teams.

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