Virtual Cities as a Collaborative Educational Environment

Daniel Nehme Müller, Otto Lopes Braitback de Oliveira,
Joelma Adriana Abrão Remião, Paloma Dias Silveira,
Márcio André Rodrigues Martins, and Margarete Axt

Laboratório de Estudos em Linguagem, Interação e Cognição (LELIC), Faculdade de Educação (FACED), Programa de Pós-Graduação em Educação (PPGEDU), Universidade Federal do Rio Grande do Sul (UFRGS), Av. Paulo Gama, 110, Porto Alegre, Brasil
`danielnm@inf.ufrgs.br, ottolb@gmail.com, jremiao@brturbo.com.br,`
`paloma.dias@gmail.com, mmartins2006@gmail.com, maaxt@ufrgs.br`

Abstract. The CIVITAS (Virtual Cities with Technologies for Learning and Simulating) project presents a research, teaching and extension approach directed to the construction of cities imagined by students in the first years of elementary school, with an emphasis to the fourth grade. The teacher ventures on a deviation from the official curriculum proposed to reflect upon the invention of cities along with the children. Within this context, the game Città is introduced as an environment that allows the creation of digital real/virtual/imagined cities, and enables different forms of interaction among the students through networked computers. The cooperative situations, made possible by the access to the game, are tools for teachers and students to think about the information that operate as general rules and words of order with the invention of the city/knowledge.

Keywords: Educational simulation environment, Computer-Supported Collaborative Learning, Educational games.

1 Introduction

In the first years of elementary school in Brazil, the exploration of the city, its structure and dynamics, is often accomplished through a curricular activity based on building city models. This takes place in a short period of time, usually one or two days, and has the sole purpose of representing urban spaces such as buildings, roads, and public squares.

Within the context of the CIVITAS project and its proposal for a continuing development education for working teachers, the city's model is built as an *axis* of the pedagogical practice. This way, it operates not only as a temporary activity, but also as a mechanism for study throughout the school year as well, or while there is reason for its existence.

The city in which the child resides and lives is studied and represented as a municipality in the conventional curriculum; it participates as a memory, as strength of an entire past lived by the child. In our studies, this memory, this entire past, this

city in its group of material, living and human relations constitutes the virtual of the cities created by the children [1].

The use of diversified materials such as cardboard, wood, clay, and paint (Figure 1), for the child to build collaboratively, based on imagination and conversation with fellow classmates, can be considered another curricular activity with a planned beginning and end. But the use of these materials, most of them recyclable, is far from being an activity with an established purpose, because the emphasis is given to the building process, the imagination. Furthermore, there is content that can be related to the city through its history, economy, geography, geometry, basic sanitation, health system, transport, social and political relations, among other things.

In discussion about new research and teaching methodologies for the classroom, the LELIC (Laboratory for Studies in Language, Interaction and Cognition, of the Faculty of Education of the Federal University of Rio Grande do Sul) team proposed a city editing software (the game Città) with which the children could, collectively, build virtual cities with other materials and technologies (like word processors and presentation tools) in the classroom. The opportunity to increase group work with the online interaction between classes, and the possibility to create simulations of other natures (natural or with human intervention events), formed the motivating nucleus in favor of making *virtual cities* in the most varied ways, including digital technology.
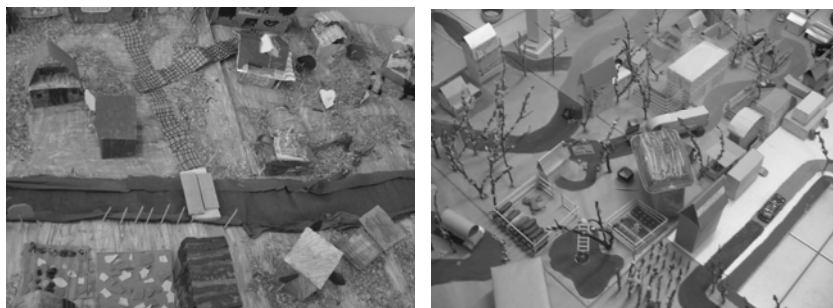

Fig. 1. Pict0075res of models built by students in the CIVITAS project

This was the beginning of a partnership between municipal governments, teachers and university, where all counterparts were involved in the creation of pedagogical practices regarding the virtual cities. The LELIC team and teachers worked together, in study and development groups, discussing traditional pedagogical practices and alternatives, considering the challenging world of teaching-learning relations contained in virtual cities as a central axis of this process.

Città, the educational game presented here, is a part of the CIVITAS project and it seeks to establish an environment that not only reproduces, but intensifies as well, the inventive possibilities of other city models. This article will present the CIVITAS project, where the game Città originated, a view on the technology of educational games, a description of the game and its components, future perspectives and some conclusions.

2   The CIVITAS Project

CIVITAS was born from the collaboration and partnership of LELIC-FACED-UFRGS, involving researchers, post-graduate students, undergraduate scholarship students and municipalities from the countryside of the state of Rio Grande do Sul through their schools, teachers, students and managers.

CIVITAS is intended as a project featuring classroom experiments, actively involving teachers and students in the first years of Elementary School. The project expects to open alternative spaces for doing-thinking-making *Virtual Cities* from the varied use of multiple technologies available in the classroom, including digital technologies.

From the beginning, the development team and teachers have worked together, discussing the methodological feasibility of the project in the classroom, including the beginning of the modeling process of the simulation editor Città before classroom use of the prototype was possible. The meetings with the teachers became systematic and evolved into a work and study group, configuring a continuing development education at the workplace. The group started being more concerned with contemporary teaching practices and how these practices can be changed. This was to prepare for the coming of the simulator in the classroom, as well as other technologies such as digital cameras and camcorders, in a way to avoid this equipment and software from becoming just one more technology without any qualified implication on the educational practice. However, this transformation process is not just a simple substitution of one pedagogical approach for another. There are activities and discussions about the coexistence of several practices in the same classroom, as well as the coexistence of several technologies, from the blackboard and chalk to computers and virtual simulation environments.

The project has the important goal of combining classroom curricular activity, content, and different methodologies with the exploration of possibilities in the construction of a virtual city, benefiting both the learning process and knowledge. Throughout this work, the teachers considered it important that they engage in a more systematic and deep discussion about the educational challenges emerging from the insertion of a new technology in the classroom. The description of practices, the identification of common problems, the need of theoretical reading to support the discussions about possible solutions, all this, step by step, led to the breaking up with routine practices and the creation of new lines of action. Just like they did in the study group, teachers began experimenting discussions with the children on how to study the city, how to organize in order to retrieve interesting data, what are interesting data, what was "necessary" to learn about the city they lived in.

The search for information and other elements to support the constructions at the varied levels of the children's interests (the urban infra-structure, the organizational structure, strictly speaking, and its relations with environments such as the natural-social, urban-rural, historical-cultural and so on) started being applied in several modalities. The children participated actively, along with the teachers, in the definition of different search possibilities – visitation, field research, interviews with family members, neighborhood residents and people of the city's public life, research in documents, videos, movies, music, virtual libraries, websites and interactions through virtual learning environments (VLE). The results were recorded according to

the children's creativity (especially in written observations), in physical or digital support, in pictures and collections of materials, or in an exhibition of objects and relics.

Still without the use of the simulation editor Città, the children's productions, based on the results of their records and research, in this stage, were expressed: (i) through countless and varied ways of artistic productions[1]; (ii) with descriptions and narratives created over a determined plane of reference, in technical-scientific reports standards, like seminars and results discussion; (iii) or still, in an imminent plan of thought, exercising conceptual construction, unfolding in several and multiple manners of existence bounded by an ethics and aesthetics of respect regarding differences and life [2] [3].

Furthermore, the schools' computer labs connected to the internet have allowed the children and teachers access to the network. The VLEs have been used with several possibilities and purposes of discussion and research. Since 2004, the project proposed the insertion of technological islands (a set of three computers and a printer) connected to the internet in the classrooms: this device positively confronted the teaching practices with the demand for diversity, difference and multiplicity in the classroom.

3   From the Models to the Simulation Editor Città: Learning and Teaching Perspectives

The CIVITAS Project, while inserted into the classroom context, operates as an articulator of the goals, thematic blocks and contents found in the school curriculum, which is organized according to the National Curricular Parameters (NCPs) for elementary school. Therefore, the project is not a strange element in the teaching activity, but it joins the daily life of the school and questions how the curriculum contents are treated and developed, suggesting an intense degree of reflection on the possibilities of creating alternative spaces for the construction of the City.

In this perspective, the purpose is not to talk about the introduction of a project in schools as a model to determine the *best* curriculum or the *best* way of working in the application of this curriculum. What the project proposes is exactly the opposite: not to be regarded as a guideline to be followed, but to refrain the impulse of following an homogeneous ideal, where everyone must learn everything at the same time, and consider the challenge of opening up to instabilities; seeking, in the multiplicity of points of views, for a creative and ingenious insertion of the students in the learning process, finding new (other) ways of seeing, thinking and acting.

From the model to the simulation editor Città there is a set of actions that permits us to invest in the CIVITAS project as a space for thinking about the development of the teacher allied to new technologies, without disregarding the treatment given to the technologies that are already a part of the educational environment. Thus, the game Città does not arrive in the school as an accessory, or a technical device to improve planning, but to rather to allow ways of simulation that were not considered before,

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[1] Deleuze and Guattari (1997) suggest three modes of thought – that of art, philosophy and science – which are respectively built on planes of aesthetic composition, planes of knowledge reference and planes of immanence of thought.

and offering new possibilities to create the virtual City. The planning and the way of teaching, in addition to the flexibility in its use in the classroom, features another understanding of how knowledge occurs from the perspective of how students learn, as well as in how teachers invest in their own development.

From the point of view of the student's involvement, it is observed that the knowledge occupies a place of pleasure, which is more than the simple acquisition of certain content. To create the City in the model the student needs, besides skills and cognitive and motor abilities, to know how to work in a team, in order to allow projects emerging in the group to come up and know how to deal with inevitable conflicts. The student also needs to know how to listen, analyze, discuss, stand-up for his/her point of view, find solutions, imagine, create, write, research, seek for information or alternatives. In Città, the interactions are broadened, new challenges are contextualized and other research issues are triggered from the needs that arise in its use in the classroom, joining students, teachers and researchers efforts.

4   Digital Educational Games

Città can be classified as a *civilization game*, where the game allows conquering of space and construction of the necessary infrastructure for the population's survival [4]. However, differently from commercial games, the goal of Città is not the conquering of other nations, but the construction of a city, similar to Simcity (by Electronic Arts), Caesar or Pharaoh (both by Impressions Games). Nevertheless, Città differs a lot from these because it is free software, less complex, collaborative and can be adjusted to specific curricular and educational needs. In other words Città is a collective game, but without a competitive purpose, based on a constructive logic of cooperation and collaboration.

Digital games are precious instruments for education, because they are attractive to children and teenagers. According to Mysirlaki and Paraskeva [5] many basic principles of social cognitive theory can be found in digital games, because they influence behavioral models, repetitive behaviors and construction of the imaginary, among other factors [5]. After examination of several commercial games, Mysirlaki and Paraskeva recommended the creation of networked educational simulation games, which coincides exactly the purpose of Città.

Along this line, Stone and Gutiérrez used games to guide the learning process and explained how the computer can intercede in the solution of problems in a teaching environment [6]. In their work tyhey try to generate, through an educational game, a continuing redefinition of the object being studied by the student, where the teacher acts as a collaborator in a process of discovery mediated by the computer instead of performing an analysis or previous orientation of knowledge. It is possible to say that the game Città is in alignment with this kind of practice because it intends to be a mediator in the process of discovery, especially in creation and shared knowledge construction.

The computer as a teaching tool of the 21st century is defended by Spires, Lee and Lester [7] who say that the new ways of work, communication and knowledge organization involve the computer as a means of communication between people. They also report that network games stimulate reasoning and the elaboration of

strategies, besides the organization of virtual social interaction between the players. In this sense, Città being a multiplayer game provides an environment for social interaction in the virtual space, demanding the elaboration of rules to guide the players involved in the construction of the city.

According to Rieber [8] the act of *playing* is associated with several interactive activities and has an important role in mental and social development. In the digital educational game, when the *playing* appears involved with the micro-worlds and simulations environments, this role can be reinforced by the interaction with other people.

Therefore, multiplayer digital games allow the participation of more than one player at the same time and enable the occurrence of direct or indirect interactions among players, generally in the form of competition, cooperation or collaboration [9]. Digital multiplayer educational games present the same features of educational systems that can be used to promote computer-supported collaborative learning (CSCL).

The CIVITAS project focuses on collaborative educational games and is based on the CSCL definitions proposed by Dillenbourg [10], who defines a collaborative learning activity as one with the purpose of sharing an understanding or solving a problem. In this case, understanding refers to the actions and strategies developed by the players, and the problem refers to collectively winning or bypassing the challenges and obstacles presented by the educational game. For instance, when one of the CIVITAS teachers suggests a task to be done with Città, he/she imposes resource limitations or conflicting tasks that need to be solved by the players. Arising from the interaction among students as Città users, we have a favorable context for socialization, cooperation and learning processes when the students work to solve problems and overcome limitations imposed by the simulator program.

5   The Città Game

As mentioned in the previous section, Città is a collaborative educational game aimed at a collective construction involving cooperative and negotiating actions. To enable the simulation of cities with this collaborative format, Città was developed in Java language, specially for children's tridimensional (3D) modeling of cities under guidance from their teachers. To speed up the application development an OpenGL Graphic Engine API, developed by Jouvieje and available in its website [11], is being used. It offers many graphic resources compatible with JOGL, LWJGL, and GL4JAVA, and is distributed under a GNU license. The multiplayer resources are developed with the Java's RMI (Remote Method Invocation) command. The game's architecture was conceived under the MVC (Model-View-Controller) project standard, which solves the dependency problems between data and application interface through the separation of the development in data model, business logic, and user interface. Moreover, Città is a multiplayer game and should provide resources to enable real time construction by various authors on the city's elements, in a way that simulates the interaction in an actual physical model of cardboard or clay.

Each group of children can build its tridimensional virtual city in Città, from the topographic mapping through the *Mappa* component, to the layout of rivers and

streets and the localization of constructions, as well as color customization through the *Edittore* component. The game still includes the intelligent assistant *Maga Vitta* to offer alerts about ecological events in the city.

Initially the game offers only a plain terrain over which the terrain's topography modeling will be applied. With the Mappa component the student can create hills, mountains and many other sorts of elevations where the city will be built. The user chooses the sector (tile) to alter, and selects its total elevation or one of the four sides to proceed with the inclination. Over the relief generated, the student can create roads and rivers. It is possible to select the kind of path, or to create lakes, rivers, etc. An example of the effect created with the terrain inclination can be seen in Figure 2.
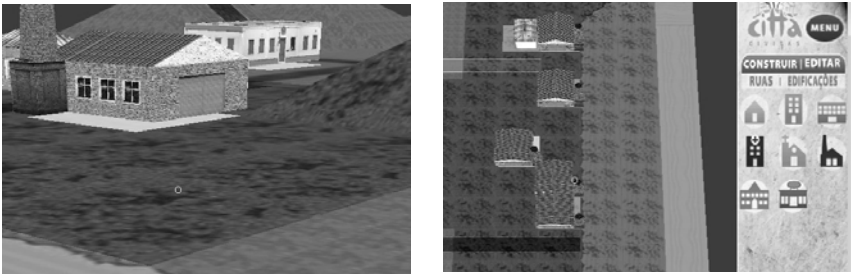

Fig. 2. Images of the pollution effect (dark area in the terrain)

The coherent organization of constructions is the first goal of Città. The users can freely create the structures they judge necessary, and place them over the terrain. The constructions available are house, building, church, city hall, factory, market, school and farm (for the rural zone).

To start creating, all the student needs to do is click on the button *construir* (*build*), then on the button corresponding to the image of the structure desired and place it on the terrain. After being created, each structure occupies a space in tiles, according to its size, and has a set of properties.

Just like in a physical model, the constructions can be painted in different colors. On selecting a structure, the Edittore component allows the possibility of changing its color, as well as write the history related to its creation. These resources can be accessed within the set of properties of each structure. To enable the color customization and maintain the texture, the *multi-texture* technique [12] was used, making it possible to use several textures on the 3D object at the same time.

The Maga Vitta assistant is an intelligent agent designed to be the ecological regulator in Città [13]. During the game, according to the user's actions, some factors such as signs of pollution around certain constructions can occur. For example, around a factory, the terrain will become more polluted over time, as shown in the dark area in Figure 2.

The actions of the Maga Vitta agent develop around four axes: *nature*, *water*, *energy* and *population*. In the *nature* axis, which is still under development, the air, water and land pollution aspects should be evaluated. In the other axes, the evaluation will be on the water contamination, waste and supply, the illumination and use of electric devices, and the monitoring of the population size and its relation to the

infra-structure. The agent interacts with the user through alerts, with the intention of promoting discussion about critical situations that can be hazardous to the city population.

6   Conclusions

Ever since its beginning in 2003 the CIVITAS project has been engaging in an increasingly deeper way the teaching-learning processes involved with interactions in the construction of city models – the virtual cities. In this sense the digital collaborative educational game Città is used as a virtual model, and creates a new challenging environment for both educators and students.

Città is based on civilization games, but its goal is to be a environment for simultaneous collaboration among several players. Therefore the city can be constantly built and modified, demanding from the teacher an elaboration of challenges for the students and promotion of the construction of knowledge and mutual managing of the city's priorities as a whole, aiming at its long term survival.

It is also important to mention that Città is an educational game, developed not *for* the teachers but *with* them, and based on their needs and reality. Unlike commercial games Città is not intended to be a product for mass use, but rather a means for innovation of teaching methodologies and pedagogical practices in early elementary grades.

The project is evaluated weekly by the teachers involved, along with the University team, in meetings at the schools. The project results, as a whole, are presented once a year by the teachers participating in the project, in an event of shared evaluation with the University team and guests. This year the children suggested a "kids seminar" to present their experiences to parents and interested public, which shows how they are building their place as student-researchers.

Città is not finished yet; it is still under development, and it may never be completed because it is a game under constant construction and reconstruction. Besides following the natural technological evolution, it will also attend to the needs – in constant growth – of students and teachers in a globalized world.

Acknowledgements

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