TEACHING COMPUTER GRAPHICS IN A LUDIC LEARNING ENVIRONMENT

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Abstract – *Nowadays people's life style is changing fast and increasingly more people are now spending more time on entertaining activities such as computer games. Thus, it is reasonable to consider computer games as a potential complementary learning tool. However, it is widely known that game users do not like educational computer games. They often say that this kind of game does not offer sufficient fun when compared to other type of games. Part of the problem lies on the attractiveness of the plot and on the interface which do not instigate emotions on the end user. In this context, "Ludic Learning" is a project targeted to enable users to learn within a computer game environment. This project used "Edugraph" as its main software platform. The presented paper addresses the preliminary results, particularly the interface aspects of Edugraph within an interactive and ludic environment.*

Index Terms — Ludic Learning Environment, Computer Game Design, Computer Graphics.

INTRODUCTION

Nowadays, computer game industry is worth about US$20 billion worldwide, and it is economically bigger than the movie industry. The high technical quality of many games found in the market explains part of this success. Notwithstanding, it is already common knowledge that computer gamers spend more time playing on a specific game only when it offers challenge and, thus, emotion.

Papert [i], creator of LOGO, puts that many sophisticated games of great acceptance in the market present some concepts of reasonable complexity and that young users develop ways to learn these concepts quickly. Notice that the complexity of the game concepts is similar to the complexity of mathematics any other science taught on high school. The playful effect resulted from the competition embedded environment increase the interest of the student for learning a determined new concept.

These facts lead to the conclusion that it is interesting to consider computer games as a complementary educational tool. On the other hand, it is important to consider that most people do not like educational games because it is often short of challenge and, thus, produce comparatively fewer emotions.

Games usually supply a playful environment endowed with high interaction interface and sophisticated appearance composed by some integrated medias. The study of techniques involved in the development of computer games and the attraction exerted on the users had made feasible and interesting to incorporate playful features to educational software in order to make the process of teaching something exciting.

Ludic Learning is a project supported by CNPq, a Brazilian government agency. Its main target is to study ludic concepts present in computer games stories and interfaces and verify if they can be used to teach some issue. Edugraph is a program to teach computer graphics concepts. It will be implemented using the Ludic Learning environment ideas. This paper addresses the efforts to develop the Edugraph interactive and ludic environment.

COMPUTER GAME

In order to develop an efficient educational game it is important to understand what it is a computer game and which techniques can be used to develop an efficient one. A computer game can be considered as a system formed by three components: "screenplay", "interface" and "engine".

Script or screenplay is the overall description of the entire movement of a film or cartoon. Games have an interactive screenplay, its description and storyboards and technical implementation details constitute the "game bible", the project guide. Movies transmit emotions based in a drama structure. Syd Field, a famous Hollywood screenplay analyst, established drama structure considering that a movie has a linear story divided in three acts: I-presentation, II-conflict and III-solution [ii]. Turning points divide act I from act II and act II from act III. A turning point turns the story direction; it must force the action of characters and/or events that drive the drama forward.

It is difficult to assign a dramatic structure to a game because a game plot is not linear; gamers change the plot direction as they interact with the game [iii], [iv]. A plot level structure can be a solution for this problem. In this case, the gamer knows his final target, but the challenge was divided in small battles and the user must win each one to conquer the condition to go to the last level. It is easier to map the dramatic structure in a plot with subplots (game levels) because each subplot is less complex than the entire plot.

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In the area of games, "engines" are known as computational development platforms. Its use eliminates the work to develop many basic functions from scratch (input handling, collision detection, 3D graphics, etc). Domingues [v] analyzes some of these engines, such as Genesis3D, Crystal Space, Golgotha, etc. Accordingly with his studies, many engines present problems such as program documentation, low efficiency, unplanned architecture, etc. To solve these problems, Domingues proposed a game engine framework. Providentially, many engines have evolved and their features satisfy the minimum requirements to implement a good game. Besides, some general-purpose multimedia authoring programs, as Macromedia Flash and Director, can be used as game engine. Thus, nowadays, developers have a broad set of options to implement a game with low effort.

Besides usual ergonomic parameters, game interfaces have being implemented considering artistic and emotional appeals. Different types of games require different interfaces, for example, a shooter (Doom) may require a 3D scenario with a perspective and first person view, adventure and strategic games (Outlive) may require a 3D scenario with an axonometric and third person view.

In first person view, the screen works as the user eyes, thus, the user cannot see himself in the scenario. In the third person view, the user sees his agent (avatar) in the scenario. Perspective projection allows depth perception, thus, it is appropriated for rooms navigation. Axonometric projection does not allow depth perception, thus, it is appropriated for games which scenarios use maps or planar terrains.

Battaiola [vi] analyses other game interface aspects, such as dimension (2D, $2^{1/2}$D and 3D), graphics (sprites, polygons), user orientation in a game world navigation, etc. These aspects have been considered in the Edugraph interface definition.

COGNITIVE ASPECTS IN LEARNING MULTIMEDIA SYSTEMS

Educational games can use several integrated medias, such as texts, animations, video, audio, etc. The act of using some integrated medias helps the effect of multimodal presentation and divided attention.

The use of visual symbols along with verbal explanations revealed to be more effective than visual presentations (graphics more text) or verbal explanations separately. This effect is justified in terms of a human memory model. The memory is capable to process more information if it is presented in two different ways (visual and auditory). This is one of the keys for the learning with multimedia [vii], [viii].

The multimedia presentations transmit a set of information that varies in terms of importance for the learning process [ix]. A set of cognitive rules that can involve forms, sizes and colors should be considered to classify the information in a scale of assimilation priority [x].

Mayer and Moreno [xi] had examined the integration of sound, text and animation in a multimedia program of learning in computer. They have concluded that animation with sound in association with image (visual and auditory media) had been more effective that animation with text only (visual media). Lowe [xii] presents four important points to be considered in the transpose of an education environment based on static pictures for another based on animation: animation have a bigger content of information; during the animation, the observer has little time to observe and to process information; complex animations require more attention to integrate different information transmitted through many changes in different parts of the screen; the observer needs to store information of previous and subsequent pictures in a limited work memory, during a substantial amount of time, what makes his/her attention to be divided between different forms of transmission.

Previous knowledge of a determined content affects critically the ability to process it. Ollernshaw et al. [xiii] reported that a learning system based on multimedia with information presented in texts or diagrams would not bring any benefit for the participants with good "priori" knowledge on the subject, but with excellent benefits for students without knowledge. In this case, games with progression levels can be used to present information for students with different knowledge degrees.

Games place users into a virtual environment. Pantelidis [xiv] enumerates the following reasons for the use of a virtual 3D environment in the education: a) promotes motivation, b) allows multiple views of objects inside the environment, c) allows the apprentices apply their own rhythm of learning and d) encourages active participation.

A 3D environment construction may benefit from previous game expertise [xv]. Games interfaces may present the environment in first or third person view. In a third person view, the relation between user, character and world allows more chances of interaction, due to the user capability to see its character in the scene. This type of interface magnifies the user interaction level, facilitates the navigation, allows comparisons of 2D with 3D graphics and propitiates practice in 3D navigation. Thus, educational software with a third person view interface improves student skills to understand and navigate virtual worlds.

The game must offer an intuitive navigation and interaction interface because the majority of the users do not read manuals before start to use a program. Also, the interface must encourage discovering and exploration.

The user must have control on the scene, with total understanding on the place to which he/she is going and why. Indicative guides are often used to lead the user through the environment to specific places. When reaching the correct places, the user can be rewarded of some form, for example, increasing his/her points. Adopted this strategy, the positive progress of the user will have always to be rewarded and he/she will gradually learn to get the correct action.

EDUGRAPH PURPOSE

Edugraph is a program planned to teach some computer graphics concepts. The focused area of teaching is computer graphics because: a) many popular programs offer interfaces with graphical features, b) generally software users learn these concepts only to utilize the software functions, and c) many professionals and students apply these concepts in their work and studies; engineers and design students use CAD programs to develop a product model, arts students use 2D and 3D editor programs to produce complex graphics, computer science students implement software using graphical interfaces, etc.

The traditional boarding in the teaching of computer graphics adopts usually the following presentation steps: hardware and graphical software, input and output primitives, bi-dimensional and three-dimensional transformations, projections classification, rendering techniques, etc. However, without knowing, many computer users employ, routinely, some graphical concepts. For example, when drawing a house through a set of lines, the user of a simple graphical program, as the PowerPoint from Microsoft, uses the command *group* to group the lines and define only one object. This operation diminishes the effort of object manipulation and makes some operations possible, such as selection, scaling, rotation, etc, of all the object primitives.

The fact that users utilize graphic commands to produce graphics and images doesn't mean that they have a precise idea of the commands function. Normally, users learn how to operate a command, but they don't learn the conceptual function of the command. In this case, concepts are presented in a restricted and specific way. This learning process doesn't help the learning of similar concepts present in other application programs and, consequently, doesn't allow that users become independent of software interfaces. This problem can be solved by an educational program that teaches computer graphics concepts in a pedagogical, intuitive and ludic way.

Usually, concepts of computer graphics are presented through generalizations, or either, first they learn afins transformations (rotation, scaling and translation) in the 2D space and later these operations are generalized for the 3D space. Generalization can be used in the exposition of other concepts, as solid modeling. Thus, the Boolean union operation used to join two 3D objects can be taught from the conception of gluing 2D forms with diverse formats to generate one final form.

Another interesting point is that teaching can acquire a playful character easily, for example, the student can learn solid modeling assembling a simple or sophisticated object in a 3D environment. This environment can count on sonorous and visual resources that strengthen the concepts. The tasks can be designed to be developed in a cooperative way, involving many students. Summarizing, educational software of computer graphics concepts must consider the following possibilities:

- to correlate concepts acquired empirically in the real world with those learned formally – for instance, it is possible to learn the concept of rotation and translation transformation using these transformation to drive a car in a virtual world;
- to explore the playful potential involved in this type of teaching;
- to extend the boarded concepts in the 2D space to the 3D;
- to exposure the concepts through an amount of integrated medias in accordance with cognitive criteria;
- to define and implement an interface that attract people and encourages experimentation;

EDUGRAPH ENVIRONMENT

The development of Edugraph environment involves the following quarrels: what to teach, b) who to teach and c) how to teach. It is considered that Edugraph will teach computer graphics concepts and its public has a minimum knowledge of the computer graphics area, but that already has knowledge of computer usage. This defines a public whose minimum age limit points to pre-adolescents with some notion of computer use based on different activities, such as computer games. Based on a) and b), it was stipulated that the educational methodology would use the potentiality of a computational system, through the use of a learning environment that incorporates many medias, interactivity and ludic features.

Edugraph has a 3D virtual environment with a third person view. The environment was defined in a way that motivates exploration and allows a five levels game.

The introduction phase shows Edu (Educational), the main character, walking. At some moment, walls will appear and close him. The camera will move around him and it will show a portal in the front wall and three rotating spheres in the ceiling. A three buttons control appears when the camera returns the focus to Edu. He faces the control and starts to press the buttons to figure out their functions (figure 1). The buttons control spheres movement (rotation and translation). It is necessary to understand how to use the afins transformation in order to move the spheres and incase them in the portal rabbets; the rabbets have sphere shape. After Edu moves the spheres and incase them in the rabbets, the portal will open and Edu will be dematerialized. He will be materialized in a cube (figure 2). In the beginning, Edu's body had five colors; in the cube, the body loses all colors. Edu must solve five problems (five game levels) to recover his body's color.

The cube works as a new portal. Locks are located in the four walls and in the ceiling. Using different mechanisms, Edu will open these locks and he will be moved to other worlds. The first three worlds have 2D scenarios (figure 3); the last two worlds have 3D scenarios.

At the end of the game, it is expected that Edu has learned afins transformations and solid modeling Boolean operations.

Audio and video media will be incorporated in the Edugraph environment, but it will be avoided the use of text messages; Edugraph interface must allow an intuitive interaction. The interface development will consider all the cognitive concepts that refer to the use of multiple modalities for the learning process.

FIGURE. 1
INTRODUCTION PHASE – EDU FACES PORTAL AND CONTROL

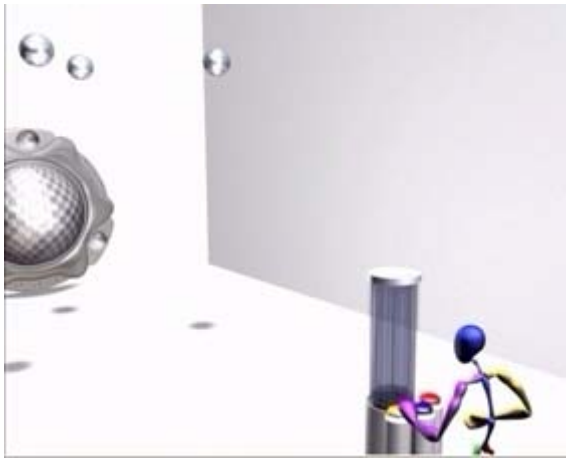
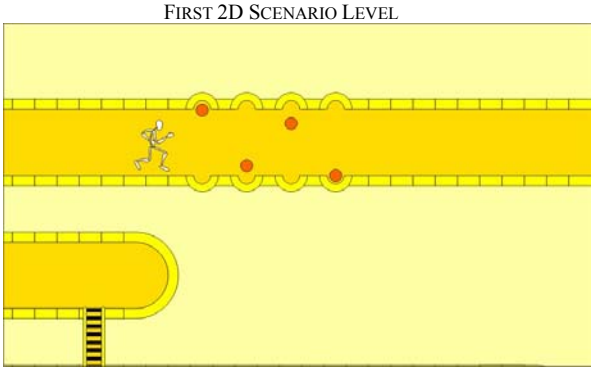


FIGURE. 2
CUBE PHASE – EDU LOSES COLORS AND FACES A NEW CHALENGE

FIGURE. 3
FIRST 2D SCENARIO LEVEL



Besides complementing the exposition of concepts, the audio will be used in association with texts or graphics to notify the accomplishment of correct operation. Audio is an important element in a game to make the environment immersion more realistic. Usually, games use three types of audio: digital, interactive and 3D. 3D audio will be used in simple form in the 3D environments to simulate collision sound or to strengthen the depth perception. Interactive audio will be used in a future multi-user version [xvi].

The use of video in games has increased significantly [xvii]. When it is well used, the video can magnify the pleasure and the understanding of a game plot, strengthen a narrative, introduce a character, etc. It's not recommended long videos because this decrease user pleasure of interaction. In an educational software context, video can be used basically to introduce concepts.

Edugraph environment will use only virtual characters to keep a game aspect, but it is planned to present videos, where the avatar is merged with real scenarios. In this case, the avatar will be rendered in blue or green background. Through the chrome-key technique, the background will be replaced by the real scenario.

Edugraph environment will not present specific evaluation tests. Generally, gamers discriminate educational games. The tests will be incorporated in the game sequence.

EDUGRAPH IMPLEMENTATION

The Edugraph implementation is based on the Macromedia Director package. This package exports to the Web a 3D environment with integrated medias and multi-user features, what opens perspectives for cooperative work.

The video that introduces the plot was already developed. The first 2D environment is in implementation task. It is planned to have the full system finished in July, 2004.

CONCLUSIONS

Until the moment it was not detected any educational software with Edugraph features, so it is a pioneer in the area. The disadvantage of this fact is the inexistence of matching parameters to evaluate its functionality.

It is planned to elaborate a detailed evaluation process based on the performance of its users. The industry of games has used some methods to evaluate this type of software [xviii]. However, in the case of educational software, certainly the correct is to appeal to the evaluation methods recommended by psychologists and pedagogues. Thus, the evaluation of the Edugraph will be made with the assistance of these professionals.

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