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# *Be Civic*: An Immersive Serious Game

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## Abstract

Nowadays, serious games are one of the biggest existing industries and it is still growing steadily in many sectors. Particularly, the use of virtual worlds and serious games in education is growing.

This paper introduces the development of a serious game in an immersive learning environment for teaching Civics. The work's idea is to develop a game to motivate, educate and train learners on civic rules by placing users in different civic roles and giving them agency to address real-world problems and issues. In order to improve the user's experience, the game was developed to work in a cave-like immersive environment by using a conversational character for a new kind of Human-Computer Interface.

The game includes static and dynamic 3D environments, allowing players to share the experience of navigation in the scene among the users, even geographically distributed. In order to evaluate the game's performance, a between groups experiment with thirty participants was designed.

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## 1. Introduction

It is not a secret: humans love playing games. Humans have figured out a way to create games with every emerging technology in history. In fact, games have often contributed to the expansion and deployment of many of those technologies. Today, there are millions of games with different rules and goals; they are played in many different circumstances by people of different cultures and various ages [1].

Computer games, an ascending industry compared with sports franchises and board game empires, have established a following that extends beyond hard-core computer types [2].

As a natural outgrowth of the rapid expansion of the games industry, game developers, educators, marketing firms, and domain experts are excitedly envisioning serious applications for computer game technologies. These applications (serious games) represent opportunities for game developers to apply their talents to areas outside of the entertainment industry [3].

A common working definition of a serious game, as presented by [4] , for instance, is a game that does not have entertainment as the primary purpose.

Nowadays, the role of serious games is rapidly expanding in daily activities and entertainment. One of these areas is education [5].

Educational games "attempt to teach the user using the game as a vehicle", and subgenres of educational games include games for specific areas of academic instruction, such as geometry or biology (Video Game Genres).

Many existing learning games utilize more or less story structures, virtual worlds, and various characters as a part of a topic. Computer game genres, such as adventure games and role-playing games, have received a lot of attention in the field of serious games by researchers and game developers. Thus, the employment of virtual reality is a natural idea for show elements from the real world and accomplish a realistic learning [6, 7].

Additionally, the power of "immersive experiences" is more engaging and motivating than standard approaches for training and education, and the

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evidence of this efficacy is growing in literature. The notion of "immersion" itself is becoming considered as a central design tool as we move towards considering learning not only as knowledge construction but also as socialization [8]. Immersion is critical to a good game design because it engages and motivates, and often includes components of interactivity, narrativity, "flow" and fidelity.

One of the most important reasons for immersive environments use, as Cave-Like Environment, is that user interaction with a virtual world through their senses is more suitable using environments like the one suggested at present work.

Of course, the processes of learning and persuasion in a topic must be the most natural possible, they have to be transparent and unconscious to user. In this context, the virtual reality helps a lot to deceive to user but it needs several means for make easy user interaction and increment the credibility. The cognitive processes that take place throughout the game should be intuitive processes.

For this purpose to include some form of natural user interface is an attractive solution to this interaction issue.

Conversational Characters are a new kind of Human-Computer Interface that are embodied and have conversational skills. Conversational Characters promise to increase the quality of communication between humans and computers, as they are designed to communicate and interact in a human-like manner. To hold a conversation, they must exploit a part gamut of natural language research, from speech recognition and keywords detection to synthetic voice generation and speech synthesis [9, 10].

This work presents an immersive serious game, *Be Civic*, for the specific area *civic rules*. The work uses a cave-like environment, virtual reality and conversational character. The idea is to develop a game for motivate, educate and train on civic rules.

The paper is organized as follows: section 2 describes major components and concepts about the developed game and section 3 presents an evaluation and discussion around users' interviews based on their learning. Finally, Conclusions' section outlines the results of the work.

## 2. *Be Civic* Concepts

The behavior and attitude people have in the streets correspond to implicit and explicit rules that regulate and determine a model of relationship and social coexistence. If the behaviors' rules are known and respected then the coexistence model is civilised, else the model is based in the "law of jungle", where it reigns the strongest and most skillful one [11].

When an accident happens it is normally referred as "bad lucky" or "blamming the other", but most of the time this is not true because so many accidents can be prevented if we are civilised [12].

*Be Civic* is a 3D serious game dedicated to reinvigorating civic learning through interactive and engaging learning resources. The idea is to prepare the next generation of students to become knowledgeable and engaged citizens giving them agency to address real-world problems and issues.

Direct purposeful experiences provide the best basis for understanding. As Confucius stated ("*I see and I forget. I hear and I remember. I do and I understand*"), actively participating in an action, making concepts intuitive, encouraging motivation through engaging experiences, and the thoughts inside one's head all contribute to understanding.

More over, adding other indirect experiences within a direct purposeful game can further enhance understanding leading to a progression of learning experience more efficient than what can be achieved by traditional ways.

In order to assure that user feels like he is in the real world *Be Civic* considered a virtual world into an immersive environment allowing user's sensitive interaction with the virtual world, and conversational character which interacts with user through natural ways.

All the components and learning modules are described on following subsections.

### 2.1. General Aspects

When game starts, the user views the virtual world without seeing himself. The game does not give instructions on what to do, you must learn by yourself which is the correct behavior in the navigation of the stage. The play ends when the user has learned enough to be considered civilised. Based in bibliography, we defined some general aspects about *Be civic* [13–16]:

- *Scenary*. The game was situated at the central square of a city, the user can navigate for the square and streets around of it. The scenary constructed include a physical system for testing the user's actions (See fig 1).
- *User's Rol*. The game is a role-playing game, the user can be a pedestrian or can be a driver. Every user's action is checked in real time, when the gamers fails then a conversational character says then about which are the correct action. With each correct action the score is increased and with each failure it is decreased.
- *Visualization*. The camera is a first-person camera, then the user can't see himself. The game graphics trys to be realistic.

- *Goal*. The ultimate goal of the gaming experience is to provide a positive association between pedestrian and driver rules as part of the suit of educational experiences.
- *Topic*. In the game the user must accomplish traffic rules or rules civic-mindedness, depending of the user rol.
- *Timing*. The game timing is decided by the user. If the user want, he can walk for hours or just only be still.
- *Multiplayer*. The multiplayer mode is available by internet network, each user can play from a place geographically different.
- *Platforms*. The game is working for Microsoft Windows and Ubuntu.

**Figure 1.** *Be Civic* Scenary

## 2.2. Learning

In his book, the game designer Jane McGonigal advances the notion that game elements could be used to engage and motivate more "real world" activities, such as education.

The reality learning is in general very unsatisfying for many persons, however, people are finding increasingly ease in learning games environments [17].

The *Be Civic* game consists in learning from experiences, then the game does not give the rules from the beginning. The learning process is a *problem-based learning*, that involves understanding problems or finding solutions to them. Its approach to learning starts with exploring learners' problems and identifying problems that need to be solved [18].

The user should learn what is the appropriate behavior and what it is not. Of course during the exploration the player can use the method of trial and error. The game guides the user in the right direction correcting his errors.

## 2.3. A Computing Platform for Immersive Visualization

The game was developed to work on a computing platform for immersive collaborative 3D virtual world visualization (See fig 2). It allows the use of geographically distributed VR media, called a multi-VRmedia. Remote players can navigate and interact through a 3D scenary in a multi-VRmedia. During the navigation, the players can exchange information in order to cooperatively solve the observed problems [19].

**Figure 2.** Immersive environment

A computing platform includes a hardware architecture and a software framework (including application frameworks), where the combination allows software, particularly application software, to run. Typical platforms include a computer's architecture, operating system, programming languages and related user interface (run-time system libraries or graphical user interface). Figure 3 shows an overview of the work. A system to visualize scenarios in a multi-virtual reality media environment has been defined. Such system will provide the necessary structure for attributes definition, rendering and collaborative multi-visualizations, as well as the needed interactive resources.

The distributed multiple-display virtual reality hardware components used in this work are a Desktop Driving Set, Head Mounted Displays (HMDs), Data Gloves, Motion Trackers and a CAVE-like virtual environment.

## 2.4. Conversational Character Interaction

In recent years major efforts have been made to promote the use of virtual assistants by several applications; conversational characters are computer-generated images with life-like facial features and body movements, capable of performing a collaborating role as instructors [20].

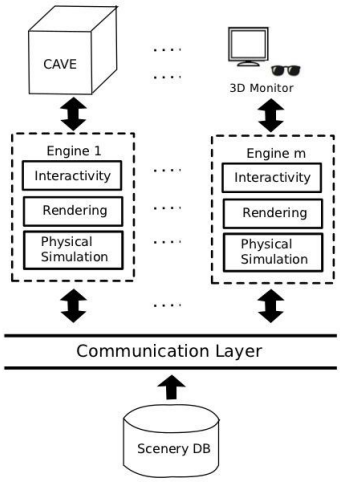



**Figure 3.** Computing Platform

The game includes a conversational character gifted with human figure animation and verbal communication skills, like natural language processing and speech recognition and synthesis.

The conversational character comes into play in two situations:

- When a player comes up to the conversational character and asks it a question, the system driving the character analyzes the user's question and selects the appropriate response from the collection.
- When the player makes a mistake, the conversational character warns about the incorrect behavior and offers advice on what it is the correct behavior.

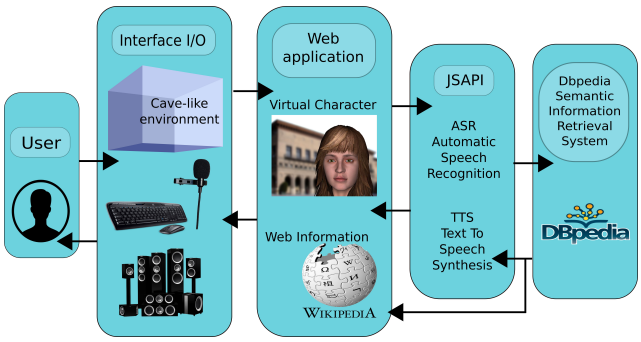



**Figure 4.** Conversational Character Interaction

At interaction, a human user interacts with the character, which transforms the user's speech to a textual representation by using speech recognition.

Then, a dialogue manager breaks up this textual representation into a structure of denotations' terms getting a semantic representation.

Based on these inputs and internal state, the character will create a communicative intent. This intent is further fleshed through natural language generation. Speech is generated on the fly (text-to-speech).

The game uses a client/server architecture where the server deals with the character engine and the client deals with the game application. While into the game, user's requests are send to the server through a communication layer. The server actives the character animation and reacts following the character engine rules. Such architecture makes the system flexible, distributable and usable via a network.

Figure 4 shows an overview of this proposal based on [21–23] previous works.

## 3. Evaluation and Discussion

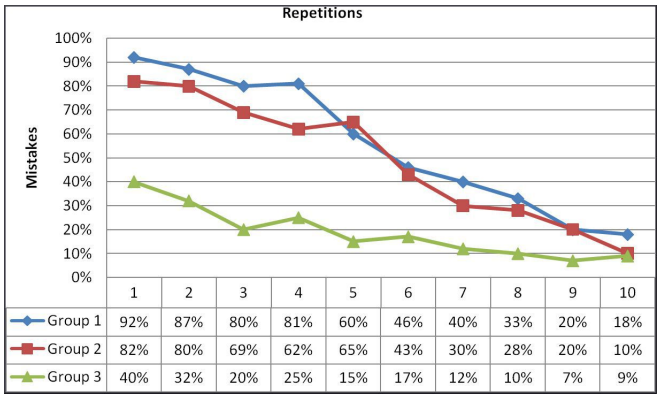
Thirty participants were interviewed separately about their perceptions of, and learning behaviours in civic rules before and after the exposure to *Be Civic* immersive serious game.

The participants were classified into three different group:

- *Children group* (Group 1). Between ten and fourteen years old, most of them don't know anything about civic rules. Furthermore, this group was formed by digital natives, so most of them know how to use a technology device like as cellphones, tablets, computers, etc. This group was constituted by four girls and six boys, all of them have ever played a videogame.
- *Youth group* (Group 2). Between seventeen and twenty one years old, many of them are driving beginners and they actually know some civic rules. As well as previous group they have skills around digital devices, so they use cellphones and computers all the time for entertainment, homework, research about hobbies, etc. This group was constituted by five girls and five boys, fifty percentage of them have ever played a videogame.
- *Adult group* (Group 3). Between thirty and forty years old, all of them are experienced drivers and therefore knew the usual civic rules. The most of them use cellphone only as communication way and a few of them use a computer for their work. This group was conformed by three women and seven men, only one of them have ever played a videogame.

Since learning is a subjective aspect, the performance have been evaluated individually, based on the testing of thirty participants from three different groups. For each participant ten repetitions were performed. Each repetition consisted of a user going from one specific

point of scenery (origin) to another specific point (destination), the goal was that all users accomplish similar path with similar challenge. According with each user's preference, one user can be a pedestrian or can be a driver, nevertheless, the option choice was kept during all repetitions. The figure 5 shows mistakes' percentage recorded from each repetition performed to each group evaluated.




| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|
| Group 1 | 92% | 87% | 80% | 81% | 60% | 46% | 40% | 33% | 20% | 18% |
| Group 2 | 82% | 80% | 69% | 62% | 65% | 43% | 30% | 28% | 20% | 10% |
| Group 3 | 40% | 32% | 20% | 25% | 15% | 17% | 12% | 10% | 7% | 9% |

**Figure 5.** Learning curve

| Gradient | | |
|---|---|---|
| Group 1 | Group 2 | Group 3 |
| -5 | -2 | -8 |
| -7 | -11 | -12 |
| 1 | -7 | 5 |
| -21 | 3 | -10 |
| -14 | -22 | 2 |
| -6 | -13 | -5 |
| -7 | -2 | -2 |
| -13 | -8 | -3 |
| -2 | -10 | 2 |

**Table 1.** Gradient between repetitions.

| Standard deviation | | |
|---|---|---|
| Group 1 | Group 2 | Group 3 |
| 6,7 | 7,3 | 5,8 |

**Table 2.** Standard deviation of gradients.

| Average | | |
|---|---|---|
| Group 1 | Group 2 | Group 3 |
| -8,2 | -8 | -3,4 |

**Table 3.** Average of gradients.

For children group, the percentage of mistakes decreased significantly as increasing the repetitions allowing an incremental learning curve. For youth group, the percentage of mistakes gradually decreased with each repetition, however, the difference between the first and the last repetition was not overwhelming. For adult group, the percentage of mistakes remained approximately constant for all replicates, showing that the learning gained was minimal.

While considering each step of curve as a line it is possible to obtain a gradient. Table 1 shows all gradients for each group, meaning that when a gradient is zero, there is not progress and not regression; when a gradient is under zero, there are less mistakes, so there is a progress; and finally, when a gradient is over zero, there are more mistakes, so there is regression. According to this establish values children and youth groups show a more accelerating and increasing learning than adult group, standard deviation (See table 2) and average (See table 3) of gradient clarify this affirmation.

These results indicate that when the higher is prior knowledge, learning capacity decreases exponentially.

## 4. Conclusions and future work

This paper describes the development of *Be Civic*, a Serious Games for civic's rules. The game was built into an immersive environment allowing a high degree of realism and immersion. Additionally the use of natural interfaces as conversational characters increase the presence of the user while playing.

To facilitate gameplay with as many different users, avatars and topics as possible, we have developed a generic software framework that supports: *Heterogeneity*, *Scalability*, *Portability* and *Collaboration*.

This work attempts to cover some of a game's features; not all of them have been covered because the game is still in beta version. However, there are several aspects to improve around the game and its evaluation. According with user's interviews it is possible to observe that: Adult group have problems with the game because their learning curve have regression due to they have made many mistakes; Children group and Youth group learned how to use the game very fast but it is not possible to guarantee that a good gamer will be a good civic person. Furthermore, a user can learn about civics's rules but he could not apply them to real life. As regards user's evaluations, we considered that it is necessary to make usability tests and include interviews with elderly adults.

Future works will be oriented to two different guidelines: gaming oriented, improving the domain-specific content, story script, fun and challenging features; and natural interaction oriented, improving the conversational character's architecture by adding intelligent skills. This kind of enhancement will turn the character into an intelligent agent giving it speech communication skills for discourse in smart environments as a virtual presenter.

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