

# IMPACT OF A VIRTUAL ZOO ON THE LEARNING AND EFFECTIVENESS MOTIVATION OF CHILDREN WITH READING DIFFICULTIES IN THE INITIAL PHASE OF LITERACY

## IMPACTO DE UM ZOOLOGICO VIRTUAL NA MOTIVAÇÃO DE APRENDIZAGEM E EFICÁCIA DE CRIANÇAS COM DIFICULDADE DE LEITURA NA FASE INICIAL DE ALFABETIZAÇÃO

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**Abstract:** In this paper, it was verified the effectiveness of a virtual zoo in the learning (reading) process of children in the initial phase of literacy. Pre- and post-test were applied using a synthetic didactic material, in which the linguistic capacity of letter recognition is considered. The pre-test was performed by 74 children between seven and nine years old, 37 girls and 37 boys. Twenty of these children, 12 girls and 8 boys, showed reading difficulties. These children performed the post-test after using the virtual zoo. They were separated into two groups, experimental (GE) and control (GC), with GE performing all phases of the virtual zoo (being, word recognition, syllables and letters of the alphabet), while CG used only the letter recognition. The number of attempts was recorded. The T-Student statistical test showed that the virtual zoo provided a significant improvement (bilateral  $p \leq 0.05$ ) in the post-test in relation to the pre-test. During the intervention with the virtual zoo, aspects of children's motivation / playfulness and behavior were also evaluated. The results showed that the implemented characteristics acted significantly different in the motivation of girls and boys.

**Keywords:** Elementary Education. Human-computer Interface. Interactive Learning Environments. Media in Education. Teaching/learning Strategies.

**Resumo:** Neste artigo foi verificada a efetividade de um zoológico virtual no processo de aprendizagem (de leitura) em crianças na fase inicial de alfabetização. Foram aplicados pré- e pós-teste usando um material didático sintético, no qual é considerada a capacidade linguística de reconhecimento de letras. O pré-teste foi executado por 74 crianças entre sete e nove anos de idade, sendo 37 meninas e 37 meninos. Vinte dessas crianças, sendo 12 meninas e 8 meninos, demonstraram dificuldade de leitura. Estas crianças realizaram o pós-teste após usar o zoo virtual. Elas foram separadas em dois grupos, experimental (GE) e controle (GC), sendo que GE executou todas as fases do zoo virtual (sendo, reconhecimento de palavras, sílabas e letras do alfabeto), enquanto GC usou apenas a fase de reconhecimento de letras. O número de tentativas foi registrado. O teste estatístico T-Student mostrou que o zoo virtual proporcionou uma melhora significativa ( $p$  bilateral  $\leq 0,05$ ) no pós-teste em relação ao pré-teste. Durante a intervenção com o zoo virtual, também foram avaliados aspectos de motivação/ludicidade e comportamento das crianças. Os resultados mostraram que as características implementadas atuaram significativamente diferentes na motivação de meninas e meninos.

**Palavras-chave:** Educação Fundamental. Interface Homem-computador. Ambientes Interativos de Aprendizagem. Mídia na Educação. Estratégias de Ensino/aprendizagem.

## Introduction

Specialists in education believe that teaching methods must also include computer games, because the game, besides being the most natural way for children to learn about the world around them, also computer in general exercises a great fascination at them. Computer games are differential, attractive and interactive methods that can pleasantly help in the learning process of children with learning difficulties (AMATE, 2007; LILLEMUR, 2009; BEAVIS & O'MARA, 2010; CASTELHANO et al., 2013; CASTRO et al., 2014; GRANIC, 2014; BEAVIS, 2014; ALMEIDA et al., 2019; MATOVU & NAKAYIZA, 2019; BISSACO et al., 2020; CRUZ NETTO et al., 2020). They act as agents of transformation and language concept incorporation and socialization (ALMEIDA et al., 2019).

It's known that the cognitive formation is built during the individual's lifetime and ludic and plays are elements of great influence in the articulation of his mental mechanisms (WEBER, 2010; BAVELIER et al., 2011; WEST, 2018; PAVAN et al., 2019; BADDELEY et al., 2019; GOTTSCHALK, 2019). Therefore, games consolidate mental schemes that are already formed, and they also provide pleasure and/or emotional balance, stimulating the intellectual autonomy growth. They can also provide the exercise of thinking and it is understood as an intentional and imaginary human act, which aims to change the present and the reality although doing it respecting the rules (PIAGET & INHELDER, 1969; BEAVIS et al., 2015; CRUZ NETTO et al., 2020). During the reading learning process, it is essential to use texts with real meaning for the child, exploring her imagination through motivating environment (MIELONEN, 2009).

The importance of ludic cannot be disregarded in this process, since, according to Vygotsky (1980), it can exercise significant influence in the language, thinking and concentration development of the child. Through ludic, curiosity is stimulated, which leads to action and to initiative and self-confidence acquisition. The child acts spontaneously when playing and she uses all acquired knowledge when motivated by challenge. Furthermore, new mental schemes can be created while she continues playing. The child notices that the act of making a mistake while playing is not negative, but it contributes to attention and concentration focus development, stimulating her learning. Mistakes committed while playing a game produce fewer frustrating results than the ones committed in front of teacher, parents, or mates.

Hence, computer game constitutes a valuable tool for learning by the activity and motivation that it provides (PALHARES & GOMES, 2008; AL-AZAWI, AL-FALITI & AL-BLUSHI, 2016). Literature shows that children who have used computer since they are very young think differently. They develop "hypertext minds" since their cognitive structures do not act in a sequential manner only. They have parallel reasoning, which makes them active participants instead of passive observers. This generation of "player" is faster in answering to expected and unexpected stimuli, since computer games can highlight abilities such as: discovering rules by observation, trial and error, proof hypothesis, among others (PRENSKY, 2001; PRENSKY, 2005; HAMARI et al., 2016).

According to the Organization for Economic Co-operation and Development (OECD, 2002), teaching methods that use computer games can stimulate intellectual autonomy growth in the children, since those students that are difficult to motivate in classroom or that have difficulties to execute certain tasks in traditional classes participate in a surprisingly active manner when they are presented with teaching strategies using ludic methods (having fun and playing) and/or using computer (OECD, 2002; VERA, 2007; ADAMS, 2007; PAPASTERGIOU, 2009; GOTTSCHALK, 2019; MATOVU & NAKAYIZA, 2019).

To confirm what was exposed, the present article shows a literature review that mentions contemporary studies about computer educational games developed to help in the learning process of children. It exposes the benefits, the motivation and the effectiveness that games are able to provide, besides the importance of considering sex gender preferences during the development.

In this way, Mioduser et al. (2000) developed a study to help children with reading difficulties to acquire the linguistics capacity of giving meaning to the written text. They used an education software that approaches linguistics capacities such as: letter recognition, word recognition and phonological conscience. The children were divided into three groups: the

first group used the game; the second group could use only the printed material and the third group had no access to additional intervention. Results clearly indicated that children with reading difficulties that received intervention through educational computer games had a significant improvement when compared with the results of those children that did not use the games. They had better performance in the tasks of phonological conscience, word recognition, among others. Furthermore, the game helped to motivate children in accomplishing general academic activities. The authors attested, then, that children motivation while playing is due to the characteristics presented in the computer games, such as, interactivity, immediate feedback, sense of being in control, among others. The following literary review shows the importance of taking into consideration preferences of girls during the development of computer games.

The study presented by Wood (2005) aimed to evaluate the effectiveness of software developed for reading words when applied to children in the initial phase of literacy (80 children aged 5 to 6 years). The results of the study suggest that software designed to aid reading can collaborate with the learning of these children.

Virvou et al. (2005) described VR-ENGAGE game developed to teach Geography using sensor stimuli such as written and sound messages to help in the children learning. He uses computer technology incorporating elements presented at adventure games into pedagogical approaches with questions such as: capital cities, country location, among others. To win, the child needs to explore all environment stages answering several questions about Geography. The authors showed the pleasantness and motivational value that virtual environment can provide in the specific content acquisition process in the schools. They concluded that educational games can help children who present academic performance lower than the expected as much as the ones considered insubordinate in the classroom.

Carr (2005) verified that girls are less enthusiastic for computer games. The author and her team composed by pedagogues and specialists at developing games attested, in her study, that girls have motivations and interests different from the boys. Girls like characters with smooth voice (FLANAGAN, 2005; LEMISH, 2015) and colorful details in the setting, while boys prefer darker colors (HEEMSKERK et al., 2005). According to Carr (2005), girls like adventure, action, and concentration games, sequential tasks and games that offer rewards. They also enjoy those games that allow character selection, and they prefer characters with young, extrovert, adventure, and independent appearance. The author observed that boys prefer physically strong characters, while girls have a declared aversion toward aggressiveness, and they appreciate to accomplish tasks in collaboration with other girls.

The study of Quaiser-Pohl et al. (2006) showed that girls prefer games involving planning, strategy, and reasoning, while boys prefer action and adventure. Furthermore, according to Heeter et al. (2009), most of the existing computer games focus on topics, issues, and characteristics of male interest. According to the authors, boys seek the most aggressive and competitive games than the girls, and in general, they prefer fight games, but they consider these violent games improper for girls. The authors mentioned that in the game industries, men are predominant in the developing area and if more women were involved in the projects, more girls would likely be attracted. They concluded saying that educational computer games have great potential when they are projected to pay attention to gender preferences.

Bottino et al. (2007) reported an analysis of cognitive activities of children during the resolution of problems with the use of computer games. Elementary school children among 7 and 10 years of age were divided into three groups according to their instruction degree to set the difficult level for the pedagogical activity to be accomplished. Children used their logic and strategic abilities to finish each task during about one hour per week. Teacher observed student's reaction as they played and asked them to explain the strategies used during each task. The study showed that games involving logic and strategic abilities can positively contribute to the development of the reasoning abilities of the children.

Lim (2008) showed Quest Atlantis game which approaches Math, English and Science, including citizenship concepts. The mission is to save ecological, social, and cultural city decay due to the inconsequent search for prosperity and modernization. These challenges were

linked to Math, English and Science basic contents. The author recorded his observations of the children behavior regarding the approached contents in the game. He also recorded their motivation about the interaction among participants, objectives, and sequence of the game. Tests were applied to determine their motivational level based on their scores, which were: high, medium, and low. The author discussed in his study that including citizenship theme in the educational game contents might have contributed for the motivation and learning of the children.

Ecalte et al. (2008) compared the benefit of educational games that teach through words containing syllable units in contrast with those that teach through non segmented words. Children with reading difficulties participate in three tasks using pre-test/intervention/post-test, which are: written word recognition, word reading aloud and word orthography. Results indicated that in the first year of reading learning, children were able to recognize syllables easily in segmented words.

Papastergiou (2009) showed that the use of computer games should not be underestimated and that, during the work of development, the developers should seek not only the collaboration of pedagogues, but specially the collaboration of children to help them to mold the games according to their preferences, specific issues and real needs.

Hence, the literary review showed that educational computer games can motivate juvenile learning, mainly those approaching contents and interventions developed for help children with learning difficulties. It showed also that these games became more effective when implemented with characteristics that pay attention to gender preferences. However, most of commercial electronic games that seek to simulate reality put the player as protagonist instead of a mere character of the game, using 3D (three-dimensional) tools (VIRVOU et al., 2005).

Although these games have these characteristics, they were not created for pedagogical purposes. Still, regarding electronic games and educational computer games available in the market it is noteworthy the lack of games that consider girl preferences. Most of the games pay first attention to characteristics that please boys, such as, character with several physical abilities, main purpose of killing and repetitive sequences. It lacks, then, female characteristics, such as setting colors, character's appearance and voice, among others (TSANG, 2001; CALVERT, 2003; HEETER, 2009).

Some commercial games have characters with characteristics that please girls. However, although those games seek to pay attention to characteristics of girl preferences, they do not have educational focus. Nevertheless, 3D game is particularly interesting for educational area due to the higher immersion of the player, who become a protagonist in the game and who must face the existing challenges to reach the end of the game. Hence, the hypothesis that a virtual zoo could fascinate girls was raised, and through casual research the preferences of 86 girls who were at the initial phase of literacy were surveyed. Their preferences regarding setting colors, character's voice and appearance, among others, were verified to be taken into consideration during the implementation of a virtual environment that simulated a zoo.

This concept approach was linked to motivational aspects presented in electronic games and that please girls, such as: reasoning, problem solution, among others. Furthermore, a zoo was taken into consideration for being able to go beyond classroom space, since environment outside school is considered more than simple leisure and walks. They can enrich and make learning potent (WESTERA, 2019).

The simulated situations that can be experienced in these environments offer a symbolic "dive", promoting the passage to the symbolization and the concret, as mentioned by Vygotsky (1989). At last, to help girls with reading difficulties, a multidisciplinary team compound by psychologists, pedagogues and computer engineer collaborated to idealize an environment that could approach needed contents to elementary school and that could be pleasant to girls based on the bibliographic research about girl preferences and on the casual research accomplished.

Thus, this paper presents the effectiveness of a virtual zoo with three-dimensional graphic interface to help the learning of children with reading difficulties approaching in a ludic way, situations that work the difficulty in linguistics capacities needed in the two first circles of

elementary school, such as global recognition of words, syllables and letters that form words. It proposes also to pay special attention to female interests and preferences.

## **Materials and Methods**

### **Research Project**

The study presents a virtual zoo with three-dimensional graphic interface that approaches educational contents and that was implemented with ludic resources and characteristics that please girls aiming to motivate their learning. It also presents the effectiveness that the environment provided for their presented reading difficulty. They were divided into two groups: experimental group (EG) and control group (CG) and participated in the intervention with the virtual environment. EG participated in all phases of the environment (word, syllable, and alphabet letter recognition) while CG participated only of the recognizing letter phase approached in pre and post-test. This project was approved by the Comitê de Ética em Pesquisa (Ethics Committee in Research) involving human being (CAAE-0107.0.237.000-07, Processo CEP/UMC 106/2007) and all participants (parents, teachers, and school principal) subscribed the respective Term of Free and Clear Permission.

### **Participants**

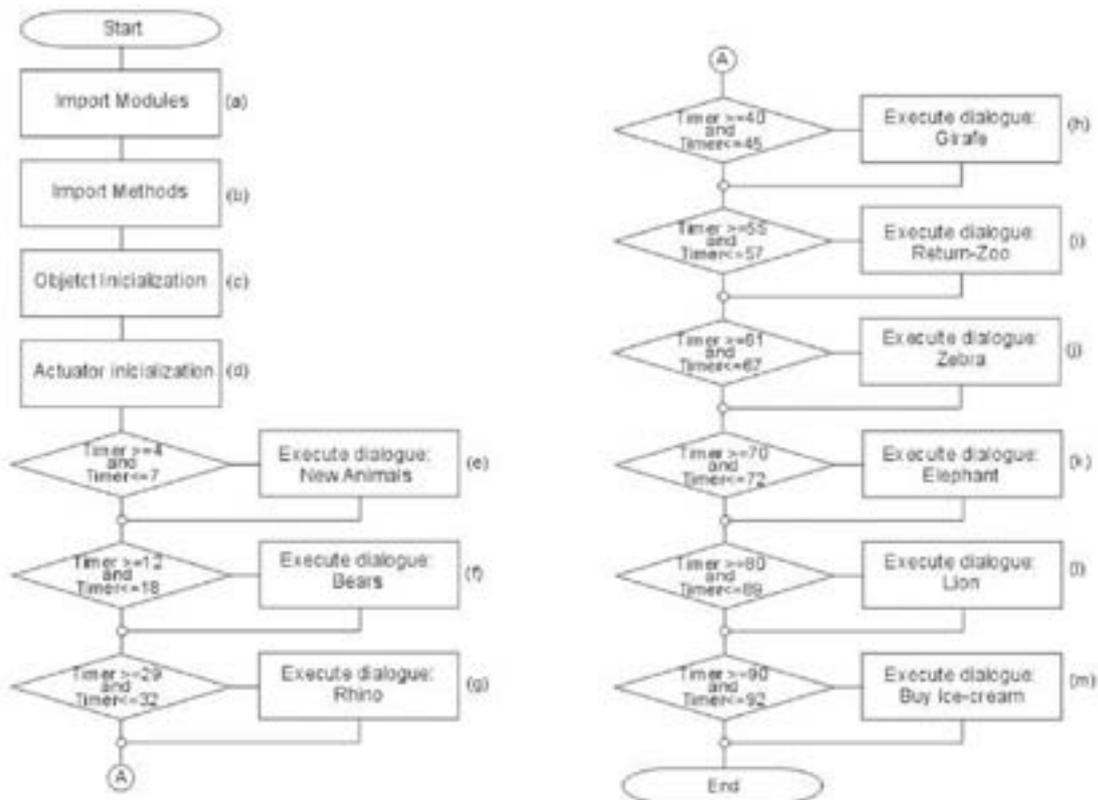
Pre-test participants were 74 children, 37 girls and 37 boys between 7 and 9 years of age. Test took place during school time in the public school in Poá city (Sao Paulo/Brazil). Pre-test identified 20 children with reading learning difficulty and confirmed that they presented an academic performance significantly lower than the expected. Those children participated in the intervention through the virtual zoo and post-test. Statistical analysis with T-Student test compared their performance before and after virtual zoo intervention.

### **Virtual zoo graphic interface**

A three-dimensional (3D) graphic interface was used for the virtual zoo implementation to provide a user higher immersion and colors as visual tips to help in the proposed challenge solution. Blender 3D, Python and GIMP softwares were used for the system implementation. Blender 3D was used because it allows the development of multiplatform 3D applications, such as Windows, Linux, among other operational systems. It has modeling resources, animations (Armature and IPO) and renderings with stable graphics of high quality as performed by Silva & Frère (2011) and Scardovelli and Frère (2015).

Animations made with Armature allowed bones to be associated to the vertices of the models. This way, geometric transformations applied to the bones were reported to the objects whose vertex was associated. In the animations accomplished through IPO curve (InterPOLation) the parameters of the geometric transformations (scale, rotation, and translation) were changed differently in the objects. The creation of interactive settings, objects sensitive to mouse and keyboard clicking were synchronized through "game engine" of Blender 3D (mechanism for game development). Virtual zoo logic was implemented in Python, a program language (Figure 1) that allows interaction and object and setting creation such as camera change, crash detection and simulation of the law of the physics.

Figure 1. Game introductory phase flow chart



Source: Prepared by the authors

GIMP software was used to create texture maps, a system known as UV Mapping, which consists of determining what texture part must be attributed to each polygon of 3D object, where to each polygon vertex is attributed to a bi-dimensional (2D) coordinate related to the image. This resource was used to character modeling, setting items, among others, to provide more realism to the computational system. The objects visualized at short distance were modeled as three-dimensional objects, while that to the objects visualized at long distance was applied landscape resource by the low detailing level needed.

Thus, landscape technique was used for back images and distant objects whose detail is not so important. This contributed to reduced modeling time and demanded less computational effort. Virtual zoo soundtrack (character's voices, music and sound related to the environment) was created through Audacity software. These sound effects were added to provide more realism to the settings. Musical rewards were also included in the environment to keep children interest and attention, motivating them to acquire fundamental contents not assimilated yet. Furthermore, female characteristics, such as setting colors, appearance, character's voices, among others, were implemented to motivate particularly the girls.

### Game Script

A multidisciplinary team compound by psychologists, pedagogues and computer engineers collaborated to a script idealization in order that the virtual zoo could approach contents needed to elementary school and that were pleasant for girls based on the bibliographic surveys and casual research accomplished.

The theme zoo was used to go beyond classroom space, since environments outside school are more than simple places for leisure and walks.

Virtual environment was implemented with female characteristics to stimulate player to get into the scene and interact, such as setting colors, character's appearance, happy look, among others (TSANG, 2001). The game begins when the main characters Meg and her cousin

Gabi, arrive at the zoo to know the new animals. They see two boys planning trick; however, they decide to continue in their walk. The virtual zoo has six animals: lion, zebra, giraffe, bear, rhinoceros, and elephant. They are individually arranged among trees, banks, and other features to enrich the setting look.

In the introductory phase, player recognizes zoo environment, objects and animals through a pattern road. While passing by the animal cages, Gabi mentions each animal name and makes comments about them. This stage works the linguistics capacity of identifying reading purposes and functions of the text contextualization through the conversion of spoken word toward the read form Ecalte et al. (2008). After concluding this phase, Meg and Gabi go to the ice-cream shop near the lake. Soon they note that the boys took the animal identifying plaques away.

In the phase 1, the player mission is to go around the zoo looking for the plaques that have the animal names to replace them correctly. When locating each plaque (Figure 2), the players will visualize a screen with the image of all animals. Through the arrow keys from the keyboard, she needs to position the red circle to select the animal correspondent to the plaque she has just found (Figure 3).

**Figure 2.** Player locates the hidden plaque “LION”



**Source:** Prepared by the authors

**Figure 3.** Player moves the red circle to select the animal



**Source:** Prepared by the authors

In case the selection is incorrect, the player listens to a sound effect containing a narration where Gabi encourage her cousin Meg to try again. If the selection is correct, the player

visualizes animal and its identifying plaque (Figure 4). Besides that, she also listens to a sound effect with a positive narrative congratulating her for the task accomplished. Game continues until all plaques are placed properly.

**Figure 4.** Image displayed when player identifies the LION properly



**Source:** Prepared by the authors

Phase 2 starts executing a movie with the ironic laugh sound of the boys. Player mission in this phase is to recover the plaques with syllables that form the animal names of the zoo (Figure 5). This phase works the linguistics capacity of knowing how to read words compound by syllabic structures (CEALE, 2005).

**Figure 5.** Player locates the hidden plaque "RHI"



**Source:** Prepared by the authors

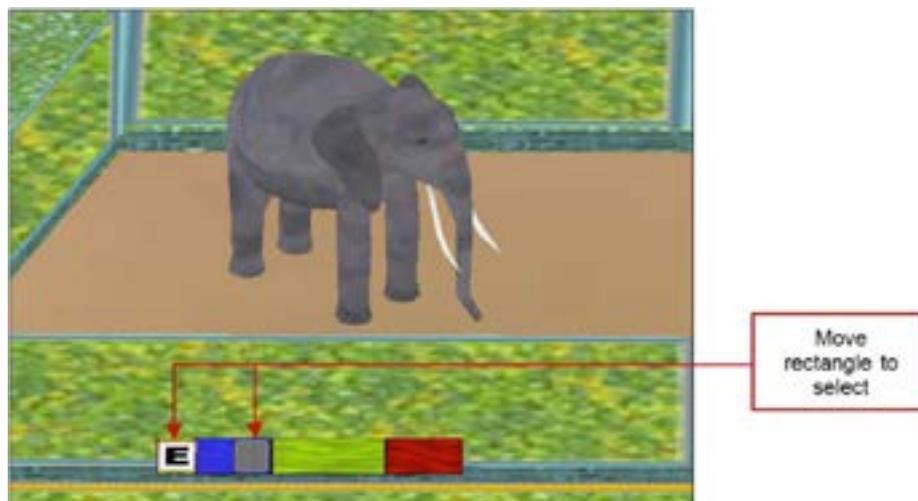
In phase 3, player has the mission to locate plaques with letters that form the animal names (Figure 6) and properly select the location of the plaque that was found, as Figure 7 illustrates. The placement of "E" plaque will be considered correct for both suitable positions. After replacing the letter plaques building the animal names properly, the player recovers the ring and the colorful crystal earrings.

Figure 6. Player locates the hidden plaque “E”



Source: Prepared by the authors

Figure 7. Screen to select the correct place of “E” syllable from ELEPHANT



Source: Prepared by the authors

Thus, linguistics capacity for recognizing the alphabet and the different types of letters are worked in this phase (CEALE, 2005).

### ***Virtual environment validation***

Literature does not present a pattern process to validate educational games effectiveness in the learning process of children with reading difficulty. Thus, the effects of the virtual environment developed through tests accomplished with children who presented low academic performance were evaluated. For that purpose, some parameters based on educational public policy available by Brazilian federal government were used, as well as statistical analysis, records of children behavior and motivation/pleasantness, evaluation from specialists and volunteers.

## Test with children

Pre-test was also applied as didactic activity to 74 children: 37 girls and 37 boys, among 7 and 9 years of age and from at least two years of literacy from a regular public school.

## Test application procedures

School principal, teachers, employees, and students all collaborated for the test success. For that, a calm classroom usually used for reinforcing classes was reserved so that children could accomplish the tests individually. Teachers of those children said that they could beforehand indicate what children presented reading difficulty. However, pre-test tool was applied to all children to identify which of them have difficulty in the linguistics capacity approached by the virtual zoo.

The teachers just confirmed obtained results after pre-test, which involved existing words in exploratory tests created and made available by Education State Office. Children were sent from classroom to reinforce classroom, where the author of the research tried to talk to them to make them more relaxed and establish a friendly relationship, keeping a positive posture and showing true interest while listening to them. A form with name, age and grade was filled up for each child.

Following that, the author asked what animals the child knew and made notes of their answers as well as of their additional comments. She also explained that she brought them a game with animal images without identification and she needed help to identify them building the names with letters spread over the table. To make sure that the child knew all animals to be worked, she presented the images and asked them to identify them orally. Same sequence of animal appearance was followed during the pre-test as well as the intervention with the virtual environment. Teachers of the children who presented difficulties confirmed results obtained during the pre-test. Then, twelve children with reading difficulties were selected to participate in the phases of intervention with virtual environment and post-test.

They were divided into 2 (two) homogeneous groups taking into consideration their average age and the fact that there has been at least two years from their school literacy. These groups were named EG (Experimental Group) and CG (Control Group). It is important to highlight those tests and intervention with virtual environment described in this paper took place while the children from both groups were submitted to the traditional teaching contents correspondent to their grade. In all phases of intervention children (EG and CG) were allowed to have up to four attempts to properly place the plaques, depending on each child need.

Children were sent to accomplish the intervention with the virtual environment and post-test, both groups experimental (EG) and control group (CG) at the same time alternately. Each child accomplished pre-test in about 15 minutes. Children of control group took about 40 minutes to accomplish the intervention and children of experimental group took 2 hours. Each child took about 10 minutes to accomplish post-test. Tests took place in a period of about two weeks for pre-test and two weeks for the intervention with virtual environment. Finally, post-test was accomplished in a period of two days.

## Pre-test

Pre-test level of difficulty corresponds to the last phase of virtual environment, that is, alphabet letter identification. It consists in a synthetic material compound by six metal bases like a picture frame, containing animal images fixed by magnets, as well as a set of individual letters with magnet in the opposite side so that can build each animal name. The images are relative to each of the six existing animals in the zoo setting of the virtual environment.

Children receive a metal plaque with the image and a group of letters related to an animal. They receive instructions to position the received letters and, even by attempts, to build up a word using all the letters. All children (EG and CG) have two chances to place the

letters correctly. However, scoring was made considering the name of attempts, that is, one score when getting it right at the first attempt and 0,5 score when getting it right at the second attempt. Otherwise, scoring was null.

### **Intervention with virtual environment**

The intervention with the developed virtual environment has the following phases: (i) Introductory phase – association of the word read with the image; (ii) Phase 1 – word global recognition; (iii) Phase 2 – syllable knowledge; and (iv) Phase 3 – alphabet letter identification. Children of EG group participated of the intervention involving all phases of virtual environment in about 30-minute sessions to each phase. Children of CG group participated only in phase 3, that is, they located letters spread over the zoo setting to build up the six animal names without accomplishing the initial phases (introductory, 1 and 2).

### **Post-test**

Synthetic material was again used to accomplish post-test. Mistakes committed by the children were recorded to verify any significant improvement in their performance due to the intervention through the zoo setting of the virtual environment. Each child had only one chance to correctly place the letters and build each of the six animal names worked in the zoo setting. After building each word, the child made an oral reading of the syllables indicated by the researcher to establish a relation between the built words and their reading, as the exploratory test available by the government instructs.

### **Data analysis**

A statistical analysis was made to establish a comparison among recorded data of EG and CG groups for the building of each of the six animal names during pre and post-test. Group scoring was computed taking into consideration the values pondered according to the number of children attempts. EG and CG group data were considered parametric according to the Shapiro-Wilk normality test.

BioEstat 5.0 statistical software was used to verify the significance among groups through t-student. Results were considered significant when they were equal or inferior to 5% ( $p$  bilateral  $\leq 0,05$ ). It was expected that this analysis presented a significant improvement in the learning of EG group by having executed all phases of intervention through the zoo setting of the virtual environment.

### **Complementary instruments**

Seeking to complement the effectiveness of the developed virtual environment, records of pleasantness/motivation and behavior were made, as well as specialist and volunteer evaluations as following described.

### **Pleasantness/motivation record**

Records of children pleasantness/motivation categories in relation with virtual environment settings were made through a questionnaire. After playing, children were asked if they liked a lot (LLO), liked (L), showed indifference (I), liked a little (LLI) or not liked (NL) the implemented items in the virtual environment, which are: characters and their physical characteristics (sex and age); theme and implemented challenges in the environment (searching for the plaques and identifying the animals); fantasy (plot, setting and adventure of the girls); colors (light and happy, pleasant, flowers and tips); sound effects (environment sound, speech, character's voice) and others (interaction among players, mouse and keyboard usage).

These records were made to confirm through the chi-square test ( $c^2$ ) if exists relationship between sex gender and pleasantness as well as to verify if the implemented characteristics in the virtual environment motivate girls to play, which can contribute for their learning.

## Behavior Recording

The author recorded which character children selected and asked them if they had computer at home and if they were used to playing. After that, she filled up a form with data about their behavior during the interaction with situations experienced in the virtual environment, such as: external stimulus distractions; unwillingness to stop playing; asking to extend time pre-established to play; asking to play again; showing difficulties to start the game; positive verbalization about situations implemented in the virtual environment; interest demonstrated for the interactive activities; asking for help; easily learning how to use the virtual environment controls.

## Evaluation by specialists

The implemented virtual environment was evaluated by specialists (pedagogues and psychologists) who individually gave their opinion about the existence of characteristics related to their topics.

Pedagogues verified if the educational contents present in the virtual environment approached linguistics capacities, according to the criteria established by the Education and Culture Ministry (MEC); if the employed ludic method can help the learning of the players and if the virtual environment can stimulate their logic reasoning, memory, and creativeness.

Psychologists, in turn, observed the existence of rules and limits, if the environment place the players in win or lose situations, if it positively works losing frustration and if the implemented characteristics considering the preferences of girls can motivate them to accomplish the proposed activities.

Furthermore, individual tests with volunteers were made to evaluate the graphic interface quality, playability, usefulness, among other characteristics considered important by game experts.

## Results and Discussions

### Pre-Test (Experimental Group - EG)

Table 1 presents the performance record of children belonging to the experimental group (EG) during pre-test, that is, values computed according to their number of attempts to build the six animal names. It also shows that the time they spent after the first and/or second attempts to build the six animal names varied from 6 to 28 minutes.

**Table 1.** Computed values considering EG children attempts during pre-test

Children	Rhinoceros	Elephant	Giraffe	Zebra	Lion	Bear	Time (min)
1	0,5	0,0	0,5	0,5	1,0	0,0	06
2	0,0	0,0	0,5	0,0	0,5	0,0	18
3	0,0	0,0	0,0	0,0	0,5	0,5	22
4	0,0	0,0	0,0	0,5	1,0	0,0	20
5	0,5	0,0	1,0	1,0	1,0	0,5	06
6	0,0	0,0	0,5	0,0	0,5	0,5	28
7	0,0	1,0	0,5	0,5	1,0	1,0	08
8	1,0	0,5	1,0	1,0	1,0	1,0	06
9	0,5	0,0	1,0	0,5	1,0	0,5	08
10	1,0	1,0	0,0	1,0	1,0	1,0	17

\* 1,0 = Got right at the first attempt \*\* 0,5 = Got right at the second attempt \*\*\* 0 = Made mistake at the second attempt

Source: Prepared by the authors

### Pre-Test (Control Group - CG)

Table 2 presents the performance record of children belonging to the control group (CG) during pre-test, that is, values computed according to their number of attempts to build the six animal names. It also shows that the time they spent after the first and second attempts to build the six animal names varied from 5 to 28 minutes.

**Table 2.** Computed values considering CG children attempts during pre-test

Children	Rhinoceros	Elephant	Giraffe	Zebra	Lion	Bear	Time (min)
1	0,0	0,0	0,0	0,0	0,0	0,0	16
2	0,0	0,0	1,0	0,0	1,0	0,5	15
3	0,5	0,5	1,0	1,0	1,0	0,0	05
4	0,5	0,0	0,0	1,0	1,0	0,0	06
5	0,0	0,5	0,0	0,0	0,5	0,0	28
6	0,5	0,5	1,0	1,0	0,5	0,0	23
7	1,0	0,5	0,0	0,0	1,0	1,0	06
8	0,0	0,0	1,0	1,0	1,0	1,0	05
9	1,0	0,0	1,0	0,0	1,0	1,0	05
10	0,0	0,0	0,5	0,0	1,0	1,0	15

\* 1,0 = Got right at the first attempt \*\* 0,5 = Got right at the second attempt \*\*\* 0 = Made mistake at the second attempt

Source: Prepared by the authors

### Intervention through the virtual environment

Initially, the researcher presented to the players the virtual environment screen that contains the instructions for the game. She also informed them that they should select among the five available characters. Experimental group (EG) were explained that they should watch, without interacting, an introduction that tells the story of the game and then they could start playing. Players received help concerning rights and wrongs through the implemented feedbacks in the environment setting.

### Post-Test (Experimental Group - EG)

Post-test accomplishment again used synthetic material and then, players had only one attempt to build the six animal names. Table 3 shows if children of EG group were able to build the name of each one of the six animals and were able to accomplish the syllable oral reading of every word properly. It also presents that the time children spent to execute the task varied from 5 to 13 minutes.

**Table 3.** Animal name formation, reading and time spent by EG at post-test

Children	Rhinoceros	Elephant	Giraffe	Zebra	Lion	Bear	Reading (Y/N)	Time (min)
1	1	1	1	1	1	1	Y	05
2	1	1	1	0	1	1	N	08
3	0	0	1	0	1	1	N	13
4	1	1	1	1	1	1	Y	11
5	1	0	1	1	1	1	N	05
6	1	0	1	1	1	1	N	15
7	1	1	1	1	1	1	Y	05
8	1	1	1	1	1	1	Y	05
9	1	1	1	1	1	1	Y	06
10	1	1	1	1	1	1	Y	09

\* 1 = Able to build the word and 0 = Not able to build the word

Source: Prepared by the authors

### Post-Test (Control Group - CG)

Table 4 shows if children of CG group were able to build the name of each one of the six animals and if they were able to accomplish syllable oral reading of all words properly. It also shows that the time children spent to execute this task varied from 5 to 19 minutes.

**Table 4.** Animal name, reading and time spent by CG group at post-test

Children	Rhinoceros	Elephant	Giraffe	Zebra	Lion	Bear	Reading (Y/N)	Time (min)
1	0	0	1	1	0	0	N	11
2	0	0	1	0	1	1	N	12
3	1	1	1	1	1	1	Y	05
4	1	1	0	1	1	0	N	05
5	0	0	0	0	1	0	N	19
6	1	1	1	1	1	0	N	16
7	1	1	1	0	1	1	N	05
8	1	1	1	1	1	1	Y	05
9	1	1	1	0	1	1	N	05
10	0	0	1	1	1	1	N	10

\* 1 = Able to build the word and 0 = Not able to build the word

Source: Prepared by the authors

### Data analysis

Statistical analysis using t-Student test through BioEstat statistical software compared data recorded during pre and post-test by group (EG and CG) and by animal. Results were considered significant when equal or inferior to 5% ( $p$  bilateral  $\leq 0,05$ ) as described at Table 5.

**Table 5.** Comparison between EG and CG groups during pre and post-tests

ANIMALS	EC		CG	
	(p) Bilateral	Significance	(p) Bilateral	Significance
Rhinoceros	0,0032	Y	0,0521	Y/S
Elephant	0,0187	Y	0,0367	Y
Giraffe	0,0038	Y	0,0957	Y/S
Zebra	0,0238	Y	0,1678	Y/S
Bear	0,0038	Y	0,1933	Y/S
Lion	0,0810	Y/S	0,1678	Y/S

\* S = Significant and N/S = Not Significant

Source: Prepared by the authors

As expected, statistical analysis result showed a significant improvement in the experimental group (EG) learning due to the intervention with all phases of virtual environment when compared with results obtained in pre and post-test. In order to accomplish a statistical analysis of the time children spent to conclude tests it was used t-Student test with BioEstat statistical software which considered the result significant when equal or inferior to 5% ( $p$  bilateral  $\leq 0,05$ ).

Thus, it was noted that for EG group  $p$  bilateral = 0,0033, while CG group presented  $p$  bilateral = 0,0145. This shows that the time spent by the children from EG and CG groups decreased when compared to pre and post-test. After building the animal names, the researcher asked the children to read the words. It was observed that all children from EG and CG groups that correctly built the animal names were able to establish a relation with its reading. Howe-

ver, some children from both groups were not able to accomplish the associated reading, since they had built the word improperly.

When observing the analysis of the obtained results to all animals, EG group performance showed itself significant in relation to the obtained results from CG group, when comparing pre and post-test of children from these groups. Nonetheless, when observing children performance from EG group in relation to the animal "lion" it was noted that there was not significance when comparing results between pre and post-test, since only one child from CG group were not able to build the word properly during pre-test. This might have happened due to the media appealing existing about this animal, such as "Lion King" movie that presents a sequence of 3 animations, besides others that imitate them and also the sentence that places it as "The King of the Jungle", among others.

Regarding the animal "elephant" it can be observed that the results showed themselves significant also for the children of control group. From the 74 participant children of pre-test 20 of them were selected to participate for showing learning difficulties. This corresponds to 27%, what confirms the statistics presented in the literature of about 30%. From 20 children with learning difficulty, 9 children were girls (45%) confirming also the statistics presented in the literature that mentions about 40%.

## Complementary tools

### Pleasantness/motivation recording

A questionnaire recorded the 10 children (5 boys and 5 girls) level of agreement and disagreement related to the pleasantness category in relation to the zoo setting of the virtual environment. Children answers were computed (Table 6) and, after that, it was applied chi-square test (c2) with MINITAB statistical software. Results were considered significant when equal or inferior to 5% ( $p \leq 0,05$ ).

**Table 6.** Agreement or Disagreement Level

Categories	Observed Items	LLO		L		I		LLI		NL	
		F	M	F	M	F	M	F	M	F	M
Characters	Physical characteristics (sex, age)	4	0	1	0	0	4	0	1	0	0
Challenges	Taking plaques that identify animals	3	3	2	2	0	0	0	0	0	0
	Replacing at the correct place	3	2	2	3	0	0	0	0	0	0
Fantasy	plot, setting, adventure	2	5	3	0	0	0	0	0	0	0
	Boy's tricks	2	3	2	2	1	0	0	0	0	0
	Girl's adventures	5	1	0	3	0	1	0	0	0	0
Colors	Light and happy pleasant colors	5	1	0	3	0	1	0	0	0	0
	Flowers	2	0	3	0	0	3	0	2	0	0
	Tips	0	1	4	2	1	2	0	0	0	0
Sound Effect	Environment sound	2	0	3	1	0	4	0	0	0	0
	Noises	2	0	3	1	0	4	0	0	0	0
	Character's voice	1	0	4	1	0	3	0	1	0	0
Theme	Zoo theme	5	3	0	2	0	0	0	0	0	0
	Animals	2	4	3	1	0	0	0	0	0	0
Others	Mouse /keyboard easy usage	1	3	1	2	3	0	0	0	0	0
	Interactions among players	4	1	0	4	1	0	0	0	0	0
	Ice-cream shop	4	2	1	3	0	0	0	0	0	0

\* LLO = liked a lot; L= Liked; I=Indifferent; LLI = Liked a little and NL = Not liked

\*\* F = female e M = male

Source: Prepared by the authors

When analyzing these answers through chi-square test ( $\chi^2$ ), it was obtained  $p=0,002$  value. This implies that the null hypothesis of existing a relationship between variables (association) is accepted ( $p \leq 0,05$ ). Hence, there is a relation between sex and likeness of the presented characteristics in the implemented categories, as expected. However, categories that involves theme and challenges pleased both genders ( $p > 0,05$ ). It was expected that zoo setting pleased specially the girls, but it was noted that boys also appreciated some of the observed categories.

These observations are following as described. Four girls liked (one girl) a lot the physical characteristics of the game characters. Three girls liked a lot the challenge of looking for the plaques around the setting and replacing them and two girls liked the task. Two girls liked a lot the fantasy category and three girls liked the game plot, setting and adventure. Four girls were divided on the opinion of liking and liking a lot the boy's tricks, while one of them considered indifferent. However, all girls liked Meg and Gabi's adventures. All girls considered the colors light and pleasant and they also liked the flowers and the implemented tips. Most of girls liked a lot the implemented soundtrack in the environment. Zoo theme pleased all girls and most of them liked the animals that appear in the environment. In general, all girls had good interaction with all implemented items.

Considering the pleasantness of the boys, it was noted that four of them considered indifferent (and one liked) the physical characteristics of the game characters. Three boys liked a lot the challenge of looking for the plaques around the setting and replacing them, and two of them liked. All boys liked a lot the fantasy category that involves the plot, the setting, and the adventure. Three boys liked a lot the boy's tricks in the game and two of them liked. However, just one of them liked a lot Meg and Gabi's adventures, while three liked and one considered indifferent. One boy liked a lot and three liked the implemented colors in the environment.

On the other hand, one of them considered colors indifferent. Two boys considered the flowers that appear in the setting indifferent, while two boys liked a little. One boy liked a lot the implemented tips, two like and still two of them considered indifferent. One boy liked the implemented soundtrack in the environment while the others considered indifferent. One of them mentioned he did not like Meg and Gabi's voices. Zoo theme and animals that appear in the environment pleased all boys. In general, all of them had a good interaction with the implemented items. Thus, it was noted that the game specially pleases female public, but it also has potential to attend male public.

## Behavior recording

The researcher filled out yet another questionnaire about children's behaviors during the intervention with "Meg's Adventures" virtual environment. This information is described in Table 7.

**Table 7.** Behaviors of children of EG and CG groups during the intervention

Behaviors	Nº of Children
Distracted with external stimuli	2
Did not want to stop playing	5
Asked extension of pre-established period	3
Wanted to play again	5
Showed difficulty to start the game	7
Verbalized positively about the game	14
Showed interest for the interactive activities	20
Asked for help	2
Learned how to use controls easily	20

Source: Prepared by the authors

One boy and one girl were distracted with external stimuli. However, their teachers confirmed that they had this characteristic. Five of the 20 children that participated in the intervention with the virtual environment did not want to stop playing and wanted to play again, although most of them understood that the other mates needed to participate too. Three children asked to extend time for the zoo setting, but the researcher told them that they would interact in the other settings. Three of the 20 participant children in the intervention with the virtual environment said that they have computer at home, but their parents and/or brothers did not allow them to play. Two children said that they used to play at friends/parents' house and other two told that they have never played in the computer.

Nevertheless, all of them easily used controls and showed interest for the interactive activities of the game. Most of them (14 children) were excited and voluntarily verbalized positively about the game. When asked if they liked the game or if there was something they did not like about the game, the others (6 children) said that they liked everything, music, colors, walking around the city, climbing the elevator at the mall and the animals. Two children asked for help, but the researcher explained that this was not allowed. One boy mentioned that it would be better if the main character was a boy. Some players insisted on looking for the plaques following the correct written word order, but the researcher informed them that it was not necessary.

During the intervention with the virtual environment, as one of the players built the "rhinoceros" word placing first the correct consonants, she was able to place the correct correspondent vowels easily. After concluding the game, the researcher told children that they could interact freely among the other settings. They were very excited and did not want to stop playing. According to Grando (2007), behavior record is a valuable tool for the teacher, since it allows him to know better his students by analyzing their reactions from the stimuli promoted by the game. It is important that the teacher seeks to establish intervention strategies that create the need for these written records, so that they do not become just a nonsense demanding for the game.

The record is an important tool to better place student for the analysis of mistaken moves (moves that could be better taken) and strategy construction. Hence, children's comments about zoo setting showed that they were full of enthusiasm were also recorded. Some of the comments are: "Look the aunt of the game!", "Today is my turn to play", "I liked to choose the character Gabi looking like me", "I helped Meg and Gabi to help zookeeper, and this was very cool", "It was so funny to look for the plaques of animal names", "I've never seen this game before. Is it possible to put two boys? I want to make a game like this."

## Interface evaluation by specialists

The implemented virtual environment was evaluated by five pedagogues, four psychologists and one psycho-pedagogue, who individually gave opinion about the existence of characteristics related to their topics. Psychologists agreed that the developed virtual environment really presents the needed characteristics for an educational game.

They observed in the virtual environment: (i) the existence of rules and limits, since player is delimited to a space, having to follow rules to keep playing and reach a new stage; (ii) it really places the player in win and lose situations, because of the possibility of making choices, the player can get the words and letters right or wrong. It also approaches the issue of losing bijoux and recovering it when a task is accomplished; and (iii) it positively works the frustration of losing, since there are sentences of encouragement and when there is an incorrect choice, player is encouraged to try to make it right. The only thing that player needs to do when she makes a mistake is to start over. She has other chances to make it right.

All pedagogues agreed that the implemented virtual environment: (i) have educational contents that approach linguistics capacities according to criteria established by Education and Culture Ministry (MEC); (ii) ludic can contribute with learning; and (iii) it can stimulate logic reasoning, memory, and creativeness of girls. They still noted implicit objectives in the game through comments, such as: "Great for literacy beginning, pre-syllabic and syllabic"; "It can

also be used to teach Spanish and English language”; “Virtual environment can help by creating a Proximal Developing Zone (ZDP)”. According to Vygotsky (1989), ZDP is the distance between what the child knows and the knowledge that she needs to build when helped by another person.

According to the pedagogues and psychologists that evaluated the virtual environment, there are ludic characteristic, educational content and situations that promote motivation and, consequently, contributing to the children learning. They attested that the environment places the players in situations of challenges, rules, and limits, since they are limited to a space, having to follow rules to keep playing and reach the new stage. According to them, the game also works positively the frustration of losing and the self-esteem, since there are sentences of encouragement and when there is an incorrect choice, the player is encouraged to try again, receiving other chances to make it right.

The implemented sound stimuli, in turn, can promote linguistics capacity learning needed to the approached reading. They can help any child, particularly those with reading difficulty in the initial phase of literacy and in the understanding of how words are built (letters, syllables, and words). Furthermore, they said that characters such as Gabi can supply teacher’s presence in moments of emotional want of children, who are only able to accomplish proposed activities when having company.

### Tests with volunteers

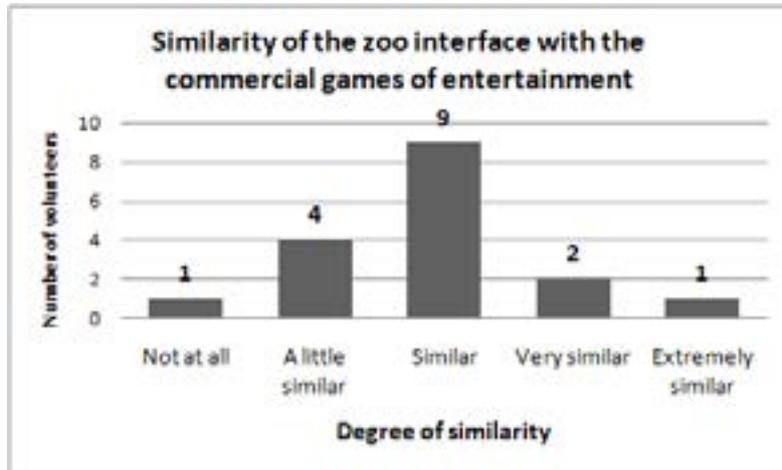
The 16 volunteer players, 9 women and 7 men, also appreciated the game. Most of the volunteers (76%) considered the game as funny (Figure 8), considering it attractive mainly due to the graphic interface, missions and challenges that were implemented, which 47% considered it similar, 24% a little similar and 2% very similar (Figure 9). Also, 1% of the volunteers considered graphic interface extremely similar with commercial games and yet 1% considered it not similar at all (Figure 10). Likeness for the main characters changed among extremely pleasant (12%), very pleasant (24%), having most of them (59%) considered the degree of normal pleasantness (Figure 11). Graphics showed that although game has been focused on female preferences, he was able to please in a balanced way the players of both genders.

Figure 8. Game is funny



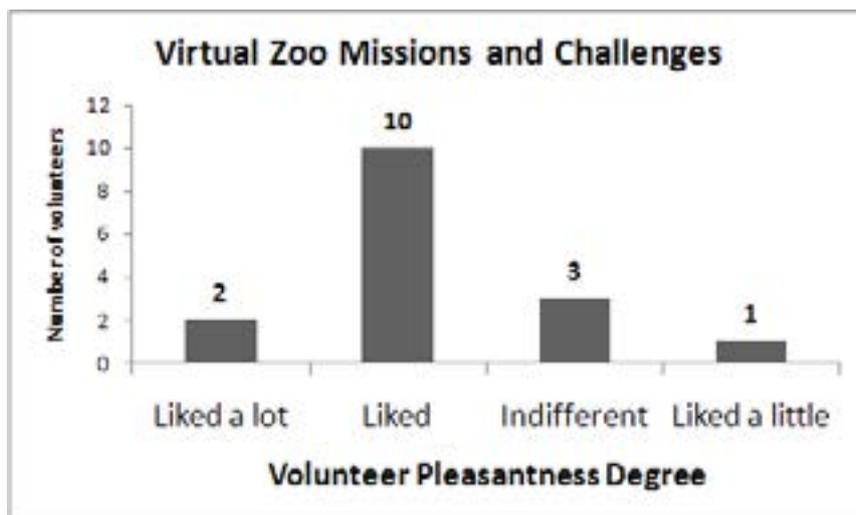
Source: Prepared by the authors

**Figure 9.** Similarity of graphic interface in relation with entertainment commercial games



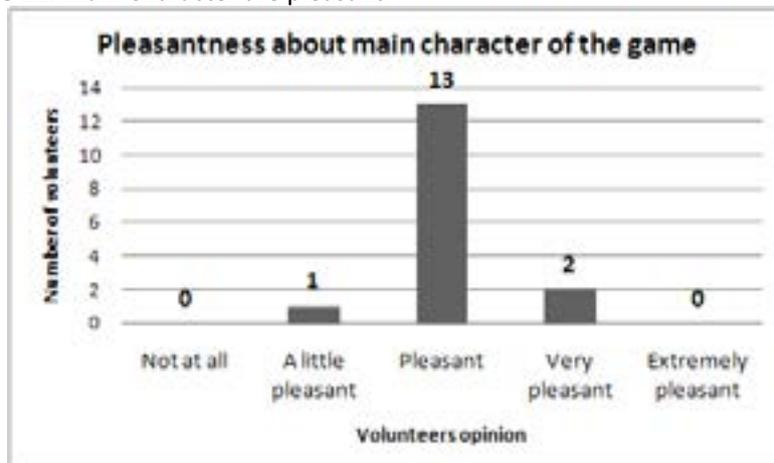
Source: Prepared by the authors

**Figure 10.** Mission/Challenges Appreciation found in the game



Source: Prepared by the authors

**Figure 11.** Main Character are pleasant



Source: Prepared by the authors

## Conclusion

The purpose of this paper was to evaluate the effectiveness of a computer game and its motivational effect at the approach of some linguistics capacity needed for children at the two first circle of elementary school, such as: knowing how to read and recognizing words, recognizing word syllables, identifying letters, recognizing vowels and consonants, and attributing them to the correct name. Besides that, the study analyzed the effectiveness of some implemented characteristics in the game that seek to pay attention to female gender preferences.

The study compared pre and post-test results through the game application as intervention in long term with children with reading difficulty. The result of the analysis showed a significant progress in the learning of children who participated in the research, which suggests an effectiveness of the virtual environment developed.

The accomplished pleasantness statistical test confirmed the existence of a relationship between sex gender and the implemented characteristics, which according to literature are attractive for girls. Children who use game were interested by the zoo theme and through supervision it could be seen that they were enjoying the playing very much.

The environment proposes to pay attention to girl preferences through an invitation to the stimulus of their natural curiosity, observed in the imagination and the creativeness fantasized by the character. It considers flower details and uses live and shining colors focusing female preference such as: pink, orange, and light blue. Finally, children verbalizations while playing were positive as well as their interaction with the environment. School team who allowed the test applications showed much interest and collaboration toward the study, because they saw that the intervention of technological tools plays an essential role in the learning process particularly for the students with learning difficulty.

According to the pedagogues and psychologists who evaluated the virtual zoo, as well as volunteer players, the virtual zoo provides player entertainment, attractiveness, and immersion in the plot, which promotes the learning of some linguistics capacities needed for reading. The implemented characteristics were appreciated by most of the volunteer players, who considered the virtual environment attractive mainly due to the plot, graphic interface and implemented challenges.

Thus, it was clear that the educational game developers need to be attentive about the multidisciplinary content and about the gender preferences of the players specially. However, the study showed that it is possible to fascinate children so that they learn the needed contents through computer educational games, since they are motivating. Hence, these game developers also need to be attentive about the multidisciplinary contents and particularly those that refer to the gender preferences. It also showed that the professionals linked to education need to recognize the educational value of games incorporating them properly to the didactic activities. Some limitations appeared naturally during the development of this study, for example, the short time available to accomplish the tests with the children.

The application of the intervention through the virtual environment with participation of a bigger sampling and the establishment of distinct education policy, such as municipal and private schools could provide different additional results what would give more support for the conclusions shown in this study. Once virtual environment showed to be capable of helping in the acquisition of the approached linguistics capacity, other educational contents can be implemented and tested as additional investigation. Different level of contents involving more words could also be worked. This justifies its implementation, since reading capacity significantly contributes for individuals to have more active attitudes in several daily situations.

The initial proposal was to develop a virtual environment capable of simulating a happy, fun, and challenging environment that motivated girls participating in the project who had reading learning difficulty. Results showed that the objective was achieved and that the developed tool did not need to be stigmatized since the implemented characteristics can reinforce any child fundamental content acquisition, and/or of being adapted to other specific pedagogical needs. Due to the effectiveness shown in helping these children, the implementation of virtual environment containing other linguistics capacities can show the same success.

Continuing this study seems to be much promising, since when results of the accompli-

shed statistical analysis are compared with the sampling of children that participated in this project it is observed that the data found in literature relating to learning difficulty are effective. Virtual environments can significantly contribute for the learning of girls with reading difficulty, preventively acting so that they can have more active attitudes before several daily situations and preparing them for the exercise of citizenship.

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