Virtual Companions and 3D Virtual Worlds: Investigating the Sense of Presence in Distance Education

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Abstract. Distance Education (DE) still have some challenges to be considered similar to the face-to-face mode of instruction regarding the quality of learning, including the lack in promoting the sense of presence. This research investigates whether a differentiated media support, complementary to the traditional Virtual Learning Environment (VLE), composed by the integration of 3D Virtual Worlds (3DVW) and Conversational Agents, in the role of a Virtual Companions, can promote the student's sense of presence in order to contribute with the learning process in DE. A quasi-experiment pilot study was conducted with 36 students enrolled in the Financial Management discipline from a DE formal course. A 3DVW was developed in the light of the pedagogical model of Experiential Learning, in the form of a role-play simulation. The results reveal that although the students positively evaluated the experience in the 3DVW, it did not stimulate the sense of presence as expected. However, better performance rates were diagnosed for students who had the help of the Virtual Companion.

Keywords: Conversational agents · Virtual worlds · Virtual companion · Sense of presence · Distance education

1 Introduction

Distance Education (DE) is increasingly being distinguished as a teaching modality capable of providing with great efficiency, effectiveness and quality of the yearnings of knowledge diffusion. By allowing access to formal education via Internet, it is possible to flexibilize the formation of individuals in time and space, learning rhythms and formative itineraries, which makes this the fastest growing instruction mode in the world [1]. It is already regulated adopted in the most varied educational levels; the number of DE students increases by about 5% each year [2].

However, in general, DE still has the challenge to move away from a widespread impression that it's quality of learning is lower than a face-to-face mode of instruction. As highlighted by De Metz and Bezuidenhout [3], DE students often experience a

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sense of lack of confidence in learning, which is particularly true for beginners, who are using an online platform for the first time. Among the reasons for this phenomenon, some are discussed in the next subsections.

1.1 The Lack of Individualized Monitoring

Most classrooms (in face-to-face education) contain students who, at one end of the spectrum are bored, and at the other side are overwhelmed and lost. This situation becomes more difficult to manage in the DE, since teachers do not have the face-to-face contact that allows to visually identify who these students are and take the proactive measures [4].

This happens often due to administrative and financial constraints, or even due to the inherent logistics characteristic of the DE. In this modality, the same teacher is in charge of attending, remotely and simultaneously, a massive amount of students, something around 200 [3], which is beyond reasonable for close monitoring of activities. In addition, the tutors end up spending much of their time reading posts from forums and tasks, and verifying student participation in the Virtual Learning Environment (VLE), performing informational and administrative roles, reducing the time spent engaging in actual interaction or fulfilling the important social role [5].

1.2 The Limitations of the Traditional VLE

For centuries, the text was considered the primary format for teaching scientific material, and books the main tool. Similarly, computers are often used as high-technology books that present large amounts of information in text format [6]. In this sense, it is common to observe that the web-based VLE traditionally used typically focus on providing students with information, tasks and files, making them face a mainly textual course, despite the vast technological innovation available for use. In the South Africa University, for example, the VLE still only allows asynchronous communication, which means delayed communication through discussion forums or questions and answers [3]. These environments are also known as Learning Management Systems (LMS), and a widely used example is the free open source software MOODLE (Modular Object-Oriented Dynamic Learning Environment).

1.3 The Lack of Professional Practices

Education in the 21st Century is increasingly emphasizing professional and vocational preparation, with the creation of real-world learning experiences, accompanied by greater attention to the development of the skills needed to make the individual a lifelong learner, who can effectively adapt to new situations and respond to changes in circumstances [7].

However, also exacerbated by the physical distance of the student, the professional practices are usually neglected in DE, which is also largely due to cost constraints inherent to traveling students to the practice field, in the case of public education. Dede [8] emphasizes that, this way, knowledge often becomes “insert”, in which people do not know how to apply the abstract principles they have memorized to solve real-world

problems. The lack of resources to carry out professional practices prevent that more practical courses be offered in DE, such as the Technical Course in Tourist Guide.

1.4 The Lack of Student's Sense of Presence

The traditional VLEs also lack the promotion of the student's sense of presence, enhanced by the physical distance from the educational environment and its infrastructure. Witmer and Singer [9] define the sense of presence as the "subjective experience of being in one place or environment, even when one is physically situated in another." The authors suggest that an increase in the feeling of "being there" (closer to the content) leads to improvements in learning, which has been validated, for example, in the studies of Mikropoulos [10] and Tüzün and Özdinç [11], although there is not a consensus in literature regarding this possibility.

Against the preceding, this research proposes to develop and investigate the use of media support, complementary to traditional VLE, involving the combination of technologies with greater potential to act in the mentioned problems. That is, it allows individualized monitoring, more interactivity, teach through practical experience and stimulate the student's sense of presence, in order to verify how this support can leverage improvements in the DE learning process. More specifically, we seek to analyze how the stimulus to the student's sense of presence when interacting with instructional content using 3D Virtual World (3DVW) and Conversational Agents can contribute to the learning process. Thus, the research question is: *is it possible to contribute to the Distance Education student's learning process by promoting the sense of presence?*

2 Theoretical Framework

2.1 3D Virtual Worlds and Conversational Agents

The dynamics of Human Computer Interaction (HCI) generally do not include immersion, i.e., the system's ability to decrease stimulation to the real world and increase the stimulation of the synthetic world [12]. Typically, the user sits on a terminal and communicates through interface devices (such as a mouse or keyboard) [9]. However, technologies that allow this kind of experience are on the rise.

3DVW are a category of Virtual Reality (VR) technology, defined by Nevelsteen [13] as time-shared, non-paused simulated environments in which many agents can virtually interact with each other, act and react to things. The difference from VR technology itself is that 3DVW does not provide a fully immersive experience, as it does not exclude external audiovisual stimuli and thus does not require additional devices as Head-Mounted Displays (HMD). For that reason, they are more accessible to large scale educational contexts as DE.

In 3DVW users are represented by avatars (personification in the environment), which allow performing actions similar to those performed by real people, such as walking, running and gesturing [14]. Real world physical characteristics such as gravity and wind, and the addition of behaviors to the 3D objects of the environment, enable the development of activities that mirror the real context.

Several platforms have been existing since late 2000's for the development of 3DVW, such as Active Worlds, Second Life (SL), OpenSimulator (OpenSim) and Open Wonderland, being the last two open source. The OpenSim platform is the one used in this research, giving its large community of developers. Linden Scripting Language (LSL) is the default scripting language in SL and OpenSim, which also uses the OpenSimulator Scripting Language (OSSL). Through these programming languages, 3D objects can acquire behavior and become sensitive to events, such as being touched. They also enable the interconnection with external systems, through Hypertext Transfer Protocol (HTTP) requests.

Because they are open and multi-directional, the experience of each individual in a 3DVW will be unique. Thus, they provide a more student-centered approach, who moves in its own rhythm (personalized learning), developing autonomy. For instance, students are free to literally "walk" and see a demonstration from different perspectives (angles), contributing to the active construction of knowledge [15].

Researches have already investigated the above assumptions to benefit learning. Ijaz et al. [16] compared instructional methods for unsupervised learning of the same content (in this case, History), and found that students who used 3DVW scored 21% better who made use of text, and 25% more than the group that used video. Nevertheless, the authors emphasize that learning in 3DVW is a less time-efficient approach compared to traditional methods. Englund [17] corroborates, saying that although it is initially time-consuming to acquire the skills and knowledge necessary to navigate and teach in 3DVW, the benefits offered, especially for DE students, may be greater than these obstacles.

Virtual Companions. Despite the mentioned advantages of 3DVW, as they become larger, with many places available to visit, guidance is needed so that students can find places, people or avatars relevant to the educational objectives [18]. According to Chen et al. [19], the navigation in open environments imposes irrelevant cognitive load. Thus, in their study, the students exposed to guided exploration significantly outperformed the ones exposed to unguided exploration. This is in accordance with Mayer's multimedia learning theory [20], which establishes that aids to stay oriented during navigation within a VLE avoid additional cognitive activities that are unnecessary.

The Non-Player Characters (NPC) feature available in 3DVW platforms, appear as a possible solution to this impasse. As highlighted by Burden [21], they are script-controlled avatars that have the same capacity for interaction as the human-controlled ones, allowing them to play a variety of roles, such as receptionists or guides. Also, they can monitor user interaction with the learning objects to ensure that it occurs accordingly [18].

As 3DVW allows the interconnection with external software, if configured, a student can send and receive instant messages to a Conversational Agent (chatbot) while inside the 3DVW, which can, upon receipt, be associated with the behavior of a NPC, so it begins to act as a Virtual Companion. This research explores this potential employing AIML (Artificial Intelligence Modelling Language) technology, interconnecting the Program-O open source software to the OpenSim 3DVW.

Kim [22] reveals that with the advances in HCI technology, the construction of anthropomorphized "looking-like" agents draws attention to the possibility of building

relationships with the student. She suggests the term Pedagogical Agent as Learning Companions (PALs), defining them as those who identify with the student's actions as if they were colleagues or friends. The Virtual Companion is the terminology adopted in this research, by giving the NPC the ability of dialogue and the role of a companion. This choice is due to the less invasive character, maintaining the freedom and autonomy of the student in the 3DVW, which is especially important when it comes to the target public that is investigated, composed of adults.

2.2 Sense of Presence

According to Witmer and Singer [9], the sense of presence refers to experiencing the computer-generated environment rather than the actual physical location: the computer world becomes the user's world. For Slater and Wilbur [23], individuals with a high sense of presence will experience the virtual environment as the reality more involving than the surrounding physical world, to the point of considering it as a place visited and not as images viewed.

From this argument, it can be affirmed that the sense of presence involves the person's commitment to the "suspension of disbelief" that he is "somewhere else" [24]. Coelho et al. [12] corroborate, stating that there seems to be a compromise between man and machine in the experience of presence. Thus, Bouvier [25] suggests that it is not only with the technique that we will be successful in promoting the sense of presence, highlighting the importance of the emotional aspect.

In this context, it must be outlined the distinction between immersion and presence. Slater and Wilbur [23] suggest that immersion is an objective and quantifiable description of what any particular system provides. Already the presence is a state of consciousness, the (psychological) sense of being in the virtual environment. In other words, it is the potential psychological and behavioral response to immersion. However, the question of whether more immersion produces greater presence and when that happens is still left open [26].

Attention and involvement are responses associated with the sense of presence [27]. This is because, "to be present in an alternative world, our attention must be focused there, not in the real world" [28]. Romano and Brna [29] affirm that the sense of presence gives the virtual experience the same value as a corresponding real one, allowing to transform it into learning in the real world. Thus, they argue this is one of the key features necessary to ensure the transfer of knowledge from the virtual to the real world. Waterworth and Waterworth [26] are more reasonable, considering that it sometimes helps performance, depending on the nature of the task.

Among the methodological approaches for measuring presence, subjective, through post-tests (self-report questionnaires), and objective ones, through behavioral and physiological measurements (cerebral electrical activity, for example), are available. Subjective classifications are the most widely used, due to the less invasiveness and no use of body sensors. Considering the remote target audience of this research, this is the approach adopted, selecting the instrument proposed by Witmer and Singer [9].

As a differential of the research already done [10, 11], a comparison is made between media with different potentials of interactivity, with a target audience of formal DE students, with the use of Experiential Learning as a pedagogical model.

3 Method

A mixed methods quasi-experimental pilot study was conducted in a real educational context, with a sample of 36 students enrolled in formal courses offered in the DE. Although qualitative results were obtained, the quantitative results are the scope of this paper.

3.1 Materials

The 3DVW used in this research is part of the AVATAR Project [30], from the Universidade Federal do Rio Grande do Sul (Brazil). The service runs in a client-server mode; the client must install a viewer, which is the software that graphically renders the 3DVW. For this purpose, it was selected the Singularity viewer version 1.8.7, since it is free, robust and have Portuguese language support.

Kolb's Experiential Learning [31] is the pedagogical model chosen to guide the construction of the 3DVW, seeking to give the DE student the opportunity to apply what s/he learns in the course. Within the spectrum of Experiential Learning, role-play in VLE has been explored in recent years, which involves participants adopting a specific role, aiming to learn about it and the consequences of their actions. We assume that by identifying with a character, within a context that makes sense, students will tend to put themselves in its place and, in a sense, experience that, contributing to the sense of presence.

The 3DVW was developed towards the Financial Management discipline. It consists of a building that simulates an accounting firm, called C-Company (Fig. 1), including all the usual office furniture and divisions, as reception area, hallway, living room, small and large offices. It has a narrative that revolves around the context of this fictitious company, where the student avatar receives the role of a first-day trainee in its admission process, and is challenged to develop an understanding of the complexities of the work world, passing through its five sectors: Human Resources Board, Marketing Board, Executive Board, Administrative Board and CEO Office.

Kolb [31] suggests a non-linear cycle of experiences and reinterpretations carried out by the student, composed of four stages. The way that each of the stages was contemplated in the 3DVW is briefly presented in the sequence.

Concrete experience: students are inserted into a practical situation of their future professional life (post-training), which contextualizes the knowledge.

Reflective observation: as they experience this, students makes observations about the simulated work routine and interpret the situations.

Abstract conceptualization: students are asked to apply the theoretical knowledge acquired in the course to give continuity to the activity, responding to quizzes.

Active experimentation: at the end, students receive a different role within the simulation, being asked to respond to a slightly more complex exercise.

Seeking to provide students with the freedom to choose an appearance that best represents them. First they are instructed to walk into a corridor to pick a new avatar if desired. This moment also gives a period of recognition of the controls. Next, they are instructed to enter the C-Company building to begin the activity, being placed in the first phase of the Kolb's Cycle [31], *concrete experience*.

Fig. 1. The entrance of the 3DVW activity, C-Company building.

At this point, the Virtual Companion named Jimmy comes to meet the student avatar and presents himself as a colleague in the same role, following him/her throughout all the interaction. The chatbot knowledge base was previously created, including general social interactions and contents of Financial Management (percentage, simple interest, compound interest, amortization systems, among others). The natural language interaction occurs by typing messages in the chat bar of the viewer.

Several other NPCs with their own names are arranged throughout the simulation. They "populate" the C-Company and in some cases express themselves bodily (simulating typing on the keyboard) and textually, participating in the narrative. In this sense, the student moves on to the phase of *reflective observation*, in which s/he analyzes the scenario and begins to understand the work routine of an accounting firm.

The 3DVW has some aspects of gamification (similar to games): the practice is divided into phases. That is, the student must complete each phase before moving on to the next. However, by avoiding a lock and the use of rigid rules, the system allows them to continue even if they make mistakes.

At each room of C-Company, the avatar which represents the boss tells the student to sit in a chair to begin a quiz composed of three multiple-choice questions, adapted from an actual exercise list from the Financial Management discipline. The quiz was developed using the Heads Up Display (HUD) device available in 3DVW platforms, which temporarily attaches an object in the user's screen. By starting the quiz, the camera of the viewer is adjusted, so the user has a frontal vision of the table, that is, facing the chief, giving a more realistic view.

Students were given 10 min to answer each quiz. For each right answer a point was assigned, and at the end of each phase the score was given (from 0 to 3). Scripts capture the score of each student, recording it in an external database. At the end of the quiz, the messages pronounced by the chief indicate the next room where the student should go, and so on, in a concatenation of events.

To help with the quiz resolution, a "Help" button was placed among the answer options. When clicking it, the student's chair rotates to the front of a screen, and s/he is

instructed to touch it to play a short didactic video related to the subject matter. While seeing the video, the quiz stays hidden until the student touches the button "Back to Quiz". There is also a "Calculator" button to help the student. In this context, the student is inserted in the *abstract conceptualization* stage of the Kolb's Cycle [31], in which s/he is required to apply/confront the theoretical knowledge acquired in the course to continue the activity.

When the quiz starts, the Virtual Companion automatically appears on the side of the boss's chair (in front of the student's field of view). He can perform two categories of emotional expressions, briefly described as follows.

Congratulations. When a student experiences success, admirable emotions are expressed, with the desired effect of the incentive. Thus, in case of a correctly answered question, Jimmy expresses happiness, both verbally and bodily, by clapping or jumping, presenting congratulatory messages (i.e. "Nice! Well done.") (Fig. 2).

Fig. 2. Jimmy performing the congratulations expression after a correct answer.

Support. When a student experiences failure, emotions that indicate sadness or disappointment are triggered, with the desired effect of building empathy and expressing support. Thus, in the case of a wrong answer, Jimmy expresses himself bodily by lowering his head or bringing his hands to his face (Fig. 3), in addition to verbally encouraging messages (i.e. "No problem, let's try again…"). Jimmy also suggests the use of "Help" material, pointing his arm to indicate the corresponding button.

The simulation culminates with the student reaching the goal of obtaining the internship, arriving in a large room where several "employees" (NPCs) are already actively "working" (typing on their keyboards), with a workstation reserved for the student. By touching on the computer screen of the workstation, the student receives his/her results in the activity (Fig. 4). Also, a big screen at the back shows the ranking of all participants in the activity, sorted by decreasing order.

Thus, at the end of the path the student is in the stage of *active experimentation*, in which s/he evolves to the role of a trainee hired by the company. When sitting at the

Fig. 3. Jimmy performing support expression after an incorrect answer.

Fig. 4. Student sitting at the workstation to "start the internship".

reserved workstation, s/he is also required to solve a somewhat more complex activity, on the topic "amortization systems", which consists fulfilling a spreadsheet in the screen. The whole activity has a duration estimated in 40 min.

3.2 Subjects

The research took place in the context of the Technical Course in Administration, offered in DE at a public institution in Brazil, in the context of the Financial Management discipline, which has a workload of 75 h divided in five months. The convenience sample consisted of 36 students with a mean age of 34 years (M = 34, SD = 9.2), being 14 (∼39%) male and 22 (∼61%) female. The type of media support was the independent variable and the sense of presence and the learning outcomes were the dependent variables. Thus, subjects were divided into the following groups/conditions of equal size.

Control Group: traditional VLE.
Experimental Group: 3DVW.
Real Experimental Group: 3DVW with the Virtual Companion.

Each group had similar distributions of gender and average grade, which was analyzed considering the mean grade in the last 10 disciplines ended by the time of the experiment (Control Group M = 7.78, Experimental Group M = 7.76, Real Experimental Group M = 7.82, p = 0.954). Therefore, the groups can be considered homogeneous or statistically equal.

3.3 Instruments

The data collection instruments are summarized in Table 1. The items that compose the Presence Questionnaire and the Agent Value Questionnaire were translated from English into Portuguese by the first author, who afterwards sent the original and translated versions to a judging panel composed of three Brazilian PhD in Informatics in Education with fluency in the English language, who agreed with the consistency of the translation and the appropriateness of the statements to the public investigated; that is, that they could be easily and autonomously interpreted by the DE students.

The questionnaires were delivered online using the free Google Drive forms service; it contained the free informed consent emphasizing that there were no right or wrong answers and that they should remember their impressions regarding the activity to respond to each question as honestly as possible.

3.4 Procedure

First, the researchers contacted the course's coordination, presenting the 3DVW, that was tested by the professor of the discipline. The institution then formally authorized the research conduction, proposing it as an extra activity in which students were given partial course credit for participation. An exploratory study previously conducted in the same context supported that decision [35].

Given that the access to the 3DVW was designed to be remote and individual to better infer the sense of presence, it was desired for the subjects to install the viewer in their own Personal Computers (PC). To do so, they should have sufficient hardware and Internet bandwidth. The Singularity viewer site contains the following system requirements: dual-core CPU, NVidia or ATI/AMD graphics chip, 2 GB RAM, Windows XP or later. As for the bandwidth, it was desired at least 2 Mbps.

Students were invited by e-mail messages, which informed the research objectives, the requirements for participation, the voluntary nature of their participation, as well as about the total confidentiality and restricted use of any information collected. As they answered it, they were randomly assigned to one of the groups.

The instructions for downloading and installing the Singularity viewer, as well as the necessary settings to access the 3DVW from their PC were delivered in step-by-step video tutorials. For the Control Group, the same didactic materials (videos) and quizzes were placed in the traditional VLE, in a space specific destined for the study. The activity had a duration of approximately 45 days, inside the time-space of the Financial Management discipline.

Table 1. Data collection instruments.

Instrument	Description
Presence questionnaire	The instrument by Witmer and Singer [9] is composed of 32 items, with a 7-point Likert scale response options. The items referring to the use of sounds and haptic sensor were withdrawn, as they were not contemplated in the 3DVW, resulting in a total of 19 items, as validated by the University of Quebec in Outaouais (UQO) Cyberpsychology Lab [32]. For the Control Group, a further six questions related to the experience with 3D environments were excluded, leaving 13 items. The instrument is composed of five constructs: realism, possibility to act, interface quality, possibility to examine, and self-evaluation of performance
Student perception of the 3DVW activity questionnaire	To capture feedback from the students about the 3DVW experienced, some questions were adapted from Rico et al. [33], which evaluated three different characteristics: (a) usability, (b) levels of the user agreement with the educational value of the tool, and (c) user satisfaction with the interface. The instrument is composed of 11 items, between open and closed questions, with 5-point Likert scale response options
Agent value questionnaire	To evaluate the Virtual Companion, it was adapted the questionnaire from Kim et al. [34], with 10 items of 5-point Likert scale response options
Institutional records	An analysis of the student's academic performance was considered (mean grade), comparing it with the final mean grade obtained in the discipline in which the approach was applied (Financial Management), verifying possible increases or decreases among groups
Performance in the 3DVW activity	The performance of the student in the 3DVW activity (average of hits in the quizzes) was also considered to allow a preliminary view of learning achievements

4 Results

Descriptive and inferential statistics techniques were performed with the data obtained using the SPSS version 18 software, considering the level of significance of 95% (p-value). Normality tests of Shapiro-Wilk, Liliefors, Anderson-Darling and Kolmogorov-Smirnov were applied to base the decision for parametric or non-parametric tests.

The presentation of the results was organized by instrument. Each subsection shows the number of students in the sample (n), as some instruments considered three, two or one group of 12 students each.

4.1 1 Presence Questionnaire (N = 36)

The Cronbach's alpha coefficient obtained for the Presence Questionnaire was 0.856, indicating good reliability. The results revealed that the Control Group (M = 5.47, SD = 0.59) scored higher than the Experimental Group (M = 4.87, SD = 1.13), which in turn scored lower than the Real Experimental Group (M = 5.07, SD = 0.78).

Analyzing the results by construct, the same pattern was observed, with an exception for the "possibility to examine", which was higher for the Experimental Group than the Real Experimental Group.

Yet, Kruskal-Wallis's test comparing the total means and medians of the three groups maintained the null hypothesis of equality ($p = 0.241$, $p = 0.112$).

The same test was applied to analyze each question individually in the cases of three groups, and the Mann-Whitney's test in the cases of two groups, considering the integral values of each item. As a result, a significant difference was observed with respect to the Question 3 *"How natural were your interactions with the virtual environment?"* ($p = 0.046$), indicating that the positive value obtained by Control Group was statistically superior to the other groups.

4.2 Student Perception of the 3DVW Activity Questionnaire (N = 24)

Seven questions of this instrument had 5-point Likert scale response options. Cronbach's alpha test revealed a coefficient of 0.826, demonstrating good reliability of the answers. The means obtained were very proximal in Experimental ($M = 4.00$, $SD = 0.68$), and Real Experimental groups ($M = 3.99$, $SD = 0.57$), reflecting an overall positive experience.

In order to verify a possible correlation with the Presence Questionnaire, the Spearman's test considering the total means of the experimental groups indicated a significant moderate positive correlation ($r = 0.686$, $p = 0.000$), as shown in the dispersion graphic presented in Fig. 5. The evidence suggests that the higher the average score in the Presence Questionnaire, the higher the average score in the Student Perception of the 3DVW Activity Questionnaire (and vice-versa). However, it is worth noting that this does not show a cause-effect relationship.

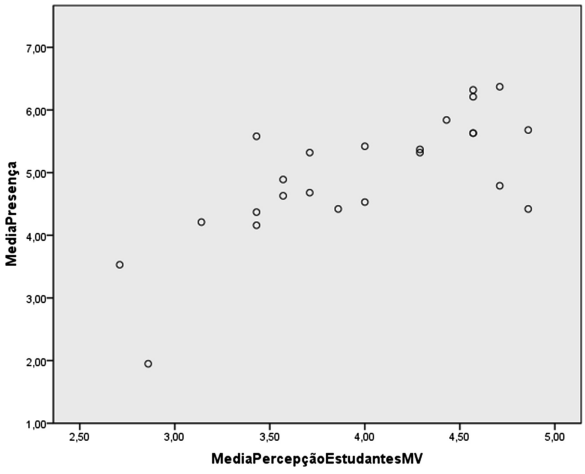

Fig. 5. Dispersion graphic from the presence questionnaire and student perception in the 3DVW activity questionnaire.

Students were also asked on how much time they considered their length of stay in the 3DVW, with objective response options ordinarily categorized. As a result, more students from the Real Experimental Group (n = 10) affirmed to remain more than 30 min, as compared to the Experimental Group (n = 7).

When considering total mean values of the Presence Questionnaire and the Student Perception of the 3DVW Activity to correlate with **time**, the Spearman's test revealed that the sample correlation, although not significant (p = 0.088, p = 0.344) is negative, allowing us to infer (with caution) that the greater the sense of presence and the more positive the perception of the 3DVW, the lower was the student's residence time in the 3DVW (r = −0.356, r = −0.202).

A question about the location of access to the 3DVW was also elaborated, trying to diagnose if the students were actually able to install and configure the viewer in their own PC, as initially conceived. Most of the students (∼58%) accessed it from the DE Center, who were equally distributed between the two experimental groups. In Brazil, a DE Center is a place where students have access to an informatics laboratory to take face-to-face tests and to perform activities, where a tutor (a professional in the course area with pedagogical experience) is available to help.

4.3 Agent Value Questionnaire (N = 12)

The Cronbach's alpha coefficient for this instrument was 0.964, which is considered highly reliable. It was obtained an overall positive mean (M = 3.8, SD = 1.1), denoting the students' general agreement with the positive characteristics provided by the Virtual Companion.

The Spearman's test maintained the null hypothesis of a correlation between this instrument and the Institutional Records (p = 0.672), but showed a moderate positive significant correlation with the Presence Questionnaire (r = 0.737, p = 0.006) and with the Student Perception of the 3DVW Activity Questionnaire (r = 0.610, p = 0.035), considering the total mean values. This probably means that the positive posture from students was consistent across instruments.

4.4 Institutional Records (N = 36)

It was observed that the student performance in the discipline where the study was applied (Financial Management) decreased for all the groups. The Wilcoxon Signed Ranks' test for paired samples rejected the null hypothesis of equality (p = 0.000), indicating that this difference is statistically significant. However, the biggest difference occurred for the Control Group (2.22 points), as shown in Table 2.

Table 2. Difference in institutional records and the discipline mean grade.

Groups	M institutional records	M discipline grade	dif
Control group	7.78	5.55	2.22
Experimental group	7.76	6.17	1.55
Real experimental group	7.82	5.97	1.84

To investigate a possible correlation of the performance in the Financial Management discipline with the Presence Questionnaire, the Pearson's test considering the total means values per group revealed the existence of a moderate negative significant correlation ($r = -0.381$, $p = 0.022$). That is, the more positive grades were obtained from those who reported lower rates of the sense of presence.

4.5 Performance in the 3DVW Activity (N = 24)

A small number of students (n = 10) concluded the activity in the 3DVW, responding to the 15 objective questions set in the environment. However, this number was superior in the Real Experimental Group, composed by the majority of its members (n = 7). In contrast, most of the Experimental Group students did not complete the activity. This result is in accordance with the time spent in the 3DVW, as more students from the Real Experimental Group stayed for more than 30 mins.

Considering the total score obtained in the 3DVW activity, in a universe of 15 possible points per user (one point per question), the average performance was also better in the Real Experimental Group, although with a higher standard deviation ($M = 9.29$, $SD = 2.60$, as compared to $M = 5.67$, $SD = 1.25$). Nevertheless, as more students from the Real Experimental Group concluded the activity, this might have contributed with this result. In addition, the Mann-Whitney's test maintained the null hypothesis of equality between groups ($p = 0.317$).

5 Discussion

The results demonstrate that the overall sense of presence was higher for the Control Group than for the experimental ones. That is, students who did the activity in the traditional VLE reported a higher sense of presence than those who used the 3DVW. This unexpected result may be associated with the higher level of complexity involving the conditions with the 3DVW, together with the novelty factor and the subjects' lack of familiarity with the new tool. The statistical test showed that in fact, students considered the interactions more natural with the VLE than with the 3DVW. It might also indicate a weakness of the instrument used to measure the sense of presence, which might not have been adequate to compare cross-media conditions, that is, different types of media support.

Considering the experimental settings, the Real Experimental Group scored slightly higher than the Experimental Group in the Presence Questionnaire, showing a positive influence of the Virtual Companion to approximate the student or get him/her more involved/engaged with the educational content, which is in agreement with the fact that they stayed longer in the 3DVW. However, the construct analysis revealed that the possibility to examine was better contemplated in the Experimental Group, indicating that the Virtual Companion possibly hindered this aspect in the sense of presence.

Conversely, time was inversely correlated (not significantly) with a higher sense of presence and with positive evaluations regarding perceptions of the 3DVW activity, meaning that the students who stayed less time gave higher scores in those instruments. This result shows that the activity time must be well weighted so students don't get

bored and lose their attention, focus and interest, which can directly reflect on their overall sense of presence and satisfaction.

Also, students from the Real Experimental Group performed slightly better in the discipline where the study was conducted (Financial Management), considering the group's final mean grade. Although the activity in the 3DVW was very small when compared to the whole workload of the discipline, this result indicates some possible benefits of having the Virtual Companion in a 3DVW interaction, as the group which performed the same activity but without the Virtual Companion had a lower final mean grade. Also, more students from the Real Experimental Group finished the 3DVW activity, with higher overall performance, suggesting that maybe they were motivated by the presence of the Virtual Companion.

Correlation tests showed that students who more positively evaluated the activity in the 3DVW and the Virtual Companion had an overall higher sense of presence. That is, the more positive was the overall experience for the student, the higher was the reported sense of presence. Perhaps this shows a consistent positive attitude from students. In spite of this, the final mean grade in the discipline was inversely correlated with the sense of presence. That is, more positive grades were obtained from those inclined to report a lower sense of presence. Thus, giving that experimental groups reported a lower sense of presence, on the other hand it shows the benefits of students participating in a 3DVW activity to improve learning outcomes.

The majority of the students did not install the viewer in their PC as desired by the researchers, getting help in the DE Center. Public DE courses in Brazil are offered in municipalities with Internet beyond the ideal, with social quotas favoring the admission of the poorest. In this way, although the current great popularization of computer resources, the reality faced by the target subjects of this study does not allow to assume that they all have the minimum infrastructure conditions for 3DVW access, pointing the need to alternatives to take place.

6 Conclusion

DE grows exponentially over the years, but still have some challenges that put it into a disadvantage to face-to-face mode of instruction. More interactive media supports better approximate the advantages of face-to-face interaction while preserving the convenience of DE.

Among these new media supports, 3DVW have a significant potential for the development of the next generation of VLE, by bringing the unique characteristics of immersion and enhanced interactivity of VR technology, but without requiring the need of any additional devices as HMD, allowing to reach bigger audiences of students as in the case of DE.

This paper presented the results of a quasi-experimental pilot study conducted with 36 students enrolled in a formal course offered in DE modality, who accessed a technology different from the traditional VLE for the first time, namely a 3DVW with Conversational Agents in the role of Virtual Companions.

In conclusion, although students positively evaluated the experience in the 3DVW, it did not stimulate the sense of presence as expected. That is, we cannot say that the

sense of presence, as the way it was measured, increased with the use of the mentioned tool or if in fact contributed to learning.

As the user's sense of presence is a subjective experience that relies on a number of personal aspects, which in turn may be related to individual experiences, the small sample size is the major limitation of the study, which might have opened space to personal factors of the students to influence in the results. In addition, the extra credit involved in the activity may have influenced students to give positive (biased) reports.

In this sense, future research should be conducted with larger samples and longitudinal studies to diminish the biased report and the novelty effects. Also, as the instrument used to measure the sense of presence showed some weakness in comparing cross-media conditions, a different one must be selected. Thus, in the next phase we will use the ITC Sense of Presence Inventory proposed by Lessiter et al. [27] as a Cross-Media Presence Questionnaire, in a validated Portuguese version [36]. Equally important, it seems necessary some face-to-face moments of instruction in the DE Center previous to the 3DVW activity, installing and configuring the viewers so students can access it from there.

The research brings to light the benefits in using a new media support to act in some common problems faced by the DE students, but at the same time the difficulties of integrating a technology that is not part of the daily life of individuals.

References

1. Online Learning Consortium. The Distance Education Enrollment Report (2017). https://onlinelearningconsortium.org/read/digital-learning-compass-distance-education-enrollment-report-2017/. Accessed 29 Jan 2019
2. Gregori, P., Martínez, V., Moyano-Fernández, J.J.: Basic actions to reduce dropout rates in distance learning. Eval. Prog. Plann. **66**, 48–52 (2018)
3. De Metz, N., Bezuidenhout, A.: An importance–competence analysis of the roles and competencies of e-tutors at an open distance learning. Aust. J. Educ. Technol. **34**(5), 27–43 (2018)
4. Fletcher, J.D.: Technology, the columbus effect, and the third revolution. The design of instruction and evaluation: Affordances of using media and technology, 121 (2004)
5. Alencar, M., Netto, J.F.: TUtor collaborator using multi-agent system. In: Yuizono, T., Zurita, G., Baloian, N., Inoue, T., Ogata, H. (eds.) CollabTech 2014. CCIS, vol. 460, pp. 153–159. Springer, Heidelberg (2014). https://doi.org/10.1007/978-3-662-44651-5_14
6. Moreno, R., Mayer, R.E., Spires, H.A., Lester, J.C.: The case for social agency in computer-based teaching: do students learn more deeply when they interact with animated pedagogical agents? Cogn. Instr. **19**(2), 177–213 (2001)
7. McLaughlan, R.G., Kirkpatrick, D.: Online roleplay: design for active learning. Eur. J. Eng. Educ. **29**(4), 477–490 (2004)
8. Dede, C.: The evolution of distance education: Emerging technologies and distributed learning. Am. J. Dist. Educ. **10**(2), 4–36 (1996)
9. Witmer, B.G., Singer, M.J.: Measuring presence in virtual environments: a presence questionnaire. Presence **7**(3), 225–240 (1998)
10. Mikropoulos, T.A.: Presence: a unique characteristic in educational virtual environments. Virtual Reality **10**(3–4), 197–206 (2006)

11. Tüzün, H., Özdinç, F.: The effects of 3D multi-user virtual environments on freshmen university students' conceptual and spatial learning and presence in departmental orientation. Comput. Educ. **94**, 228–240 (2016)
12. Coelho, C., Tichon, J.G., Hine, T.J., Wallis, G.M., Riva, G.: Media presence and inner presence: the sense of presence in virtual reality technologies. In: From communication to presence: Cognition emotions and culture towards the ultimate communicative experience, pp. 25–45. IOS Press, Amsterdam (2006)
13. Nevelsteen, K.J.: Virtual world, defined from a technological perspective and applied to video games, mixed reality, and the Metaverse. Comput. Animation Virtual World. **29**(1), 1752 (2018)
14. Domingo, J.R., Bradley, E.G.: Education student perceptions of virtual reality as a learning tool. J. Educ. Technol. Syst. **46**(3), 329–342 (2018)
15. Johnson, W.L., Rickel, J.W., Lester, J.C.: Animated pedagogical agents: face-to-face interaction in interactive learning environments. Int. J. Artif. Intell. Educ. **11**(1), 47–78 (2000)
16. Ijaz, K., Bogdanovych, A., Trescak, T.: Virtual worlds vs books and videos in history education. Interact. Learn. Environ. **25**(7), 904–929 (2017)
17. Englund, C.: Exploring approaches to teaching in three-dimensional virtual worlds. Int. J. Inf. Learn. Technol. **34**(2), 140–151 (2017)
18. Soliman, M., Guetl, C.: Implementing intelligent pedagogical agents in virtual worlds: tutoring natural science experiments in OpenWonderland. In: 2013 IEEE Global Engineering Education Conference (EDUCON), pp. 782–789. IEEE (2013)
19. Chen, C.J., Toh, S.C., Ismail, W.M.F.W.: Are learning styles relevant to virtual reality? J. Res. Technol. Educ. **38**(2), 123–141 (2005)
20. Mayer, R.E.: Multimedia learning. Annu. Rep. Educ. Psychol. Jpn. **41**, 27–29 (2002)
21. Burden, D.J.: Deploying embodied AI into virtual worlds. Knowl.-Based Syst. **22**(7), 540–544 (2009)
22. Kim, Y.: Desirable characteristics of learning companions. Int. J. Artif. Intell. Educ. **17**(4), 371–388 (2007)
23. Slater, M., Wilbur, S.: A framework for immersive virtual environments (FIVE): Speculations on the role of presence in virtual environments. Presence: Teleoperators Virtual Environ. **6**(6), 603–616 (1997)
24. Slater, M., Usoh, M.: Presence in immersive virtual environments. In: 1993 IEEE Virtual Reality Annual International Symposium, pp. 90–96. IEEE (1993)
25. Bouvier, P.: The five pillars of presence: guidelines to reach presence. In: Spagnolli, A. et, Gamberini, L., éditeurs: Proceedings of Presence 2008, 246–249 (2008)
26. Waterworth, E.L., Waterworth, J.A.: Focus, locus, and sensus: the three dimensions of virtual experience. CyberPsychol. Behav. **4**(2), 203–213 (2001)
27. Lessiter, J., Freeman, J., Keogh, E., Davidoff, J.: A cross-media presence questionnaire: the ITC-Sense of Presence Inventory. Presence: Teleoperators Virtual Environ. **10**(3), 282–297 (2001)
28. Darken, R.P., Bernatovich, D., Lawson, J.P., Peterson, B.: Quantitative measures of presence in virtual environments: the roles of attention and spatial comprehension. CyberPsychol. Behav. **2**(4), 337–347 (1999)
29. Romano, D.M., Brna, P.: Presence and reflection in training: Support for learning to improve quality decision-making skills under time limitations. CyberPsychol. Behav. **4**(2), 265–277 (2001)
30. Avatar Project. Official website. http://www.ufrgs.br/avatar. Accessed 29 Jan 2019
31. Kolb, D.: Experiential Learning: Experience as the Source of Learning and Development. Prentice-Hall, New Jersey (1984)

32. Presence Questionnaire of Witmer & Singer validated from the Cyberpsychology Lab da Université du Québec en Outaouais (UQO) (1998). http://w3.uqo.ca/cyberpsy/en/index_en.htm. Accessed 29 Jan 2019
33. Rico, M., Ramírez, J., Riofrío-Luzcando, D., Berrocal-Lobo, M.: A Cost-Effective Approach for Procedural Training in Virtual Worlds. J. Univ. Comput. Sci. **23**(2), 208–232 (2017)
34. Kim, Y., Baylor, A.L.: PALS Group: Pedagogical agents as learning companions: the role of agent competency and type of interaction. Educ. Technol. Res. Dev. **54**(3), 223–243 (2006)
35. Krassmann, A.L., Kuyven, N.L., Mazzuco, A.E.R., Tarouco, L.M.R., Bercht, M.: Estudo Exploratório sobre Mundos Virtuais e Agentes Conversacionais na Educação a Distância. Revista Novas Tecnologias na Educação (RENOTE) **16**(2), 1679–1916 (2018)
36. Vasconcelos-Raposo, J., et al.: Adaptation and validation of the Igroup presence questionnaire (IPQ) in a Portuguese sample. Presence: Teleoperators Virtual Environ. **25**(3), 191–203 (2016)