

## Educational use of 3d virtual environments: primary teachers visiting a romanesque castle

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The study focused primary teachers views on the educational use of Virtual Environments (VEs). A 3D reconstruction of a Portuguese Romanesque castle, XII Century, was developed. A sample of 21 teachers explored the VE. The study intended to construct a detailed description of the exploration process implemented by the school teachers and to elicit their perspective on the educational potential of the VE. Globally, the data suggests the existence of a strong correlation between usability and sensory presence. In terms of educational use, the teachers stated willingness to use VE technology, although the data suggests a direct relationship between a traditional pedagogical approach and a bigger reluctance to use the VE. After experiencing the VE, all the teachers were capable of identifying some of its educational advantages but still described difficulties in actually implementing the technology in their classes.

**Keywords** virtual reality; virtual environment; sense of presence; usability;

### 1. Introduction

Recognizing the impact of technology on our society and the challenge it represents to schools it's nothing new. The possible threat presented by the new technologies to institutions as schools is also their biggest asset [1]. They represent both opportunity and demand of change of the educational paradigm [2]. The commonly called Virtual Reality (VR) or Virtual Environments (VE) has grown as a leading technology in terms of educational potential as it redefined the Human-computer communication [3-9].

As with any technology, it's a case of "good" educational use. The construction of a new teaching paradigm, which does not reinforce old teaching strategies, depends on teachers and their theories of teaching [2, 10-11]. The underlying theories of those who design and of those who use the tools interact, determining the potential learning experience presented [12].

Are teachers ready to use the new technologies, such as Virtual Reality and Virtual Environments, constructing a new educational paradigm? Or will they insert them in the old one, wasting its potential for change? What are their views on this technology? This study addresses teachers' perspectives about immersive VEs in educational settings. It comprised designing and building a 3D reconstruction of a Portuguese Romanesque castle, XII Century, to demonstrate several medieval military architectural features and to offer an insight about the Templars, and a multiple method study of the teachers experience in/with the VE.

### 2. Virtual Reality, Virtual Environments and Education

#### 2.1 Virtual Reality and Virtual Environments

Although there isn't one consensual definition for Virtual Reality (VR) and Virtual Environments (VE), a distinction has been attempted between the two concepts. VE is a wider concept than VR, although VR was first introduced. The distinction between the two started with the need to differentiate what was being built by researchers from the media and commercial concepts [13]. The

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1 more generic term Virtual Environment also became useful to widen different experiences with  
2 different levels of immersion that emerged from the development of the technology. Auld's defini-  
3 tion of VR is now useful to understand what a Virtual Environment is: "(a) computer simulation  
4 of an environment with which a participant can interact. The environment can be real or imagi-  
5 nary, it can be represented with text or with graphics, and there is an implicit element of interac-  
6 tion between the participant and the computer- generated environment" [14]. VR could be seen as  
7 a specific type of experience, in Bricken's words: "the best way to think about the experience of  
8 VR is to look around the physical reality each of us inhabit" [5]. Being sense of presence the main  
9 objective of every VE, VR can be understood as the ultimate most complete experience [7].

10 Being able to offer immersive experiences, first person perspective, with subjects and concepts  
11 otherwise inaccessible (size, transduction and reification [15]), the Virtual Environments may  
12 become rich contexts for situated learning, allowing "(...) us to create from our experiences the  
13 kind of knowledge that has hitherto been accessible only through direct experience of the world,  
14 never through computer interfaces, desktop VR, or any of the third-person experiences that pre-  
15 dominate in school" [15]. Osberg (1997) states that "the goal is to design and present authentic  
16 learning opportunities in which individuals have the freedom and the opportunity to ground their  
17 experience in a manner appropriate to them" [16]. To accept that "constructivism provides the  
18 best theory on which to develop educational applications of VR" [15] also implies recognizing the  
19 technology's potential to assure the "invisibility of mediating technologies necessary for allowing  
20 focus on, and thus supporting visibility of, the subject matter" [17].

## 22 2.2 Presence and Usability

23  
24 The importance of the sense of presence in VEs [13, 18-19] is also relevant for it's educational  
25 uses. The level of immersion is considered a crucial factor in determining the educational poten-  
26 tial of VEs [5-6, 15, 20-22].

27 According to the International Society for Presence Research [23], presence is a psychological  
28 state or subjective perception in which even though part or all of an individual's current experience is  
29 generated by and/or filtered through human-made technology, part or all of the individual's perception  
30 fails to accurately acknowledge the role of the technology in the experience. It can be defined as "the  
31 perceptual illusion of nonmediation" [24]. Presence is a property of an individual and varies across  
32 people and time; it is not a property of a technology or one of the technologies commonly referred to as a  
33 medium, although technologies or media with specific constellations of characteristics are likely to evoke  
34 a similar set of presence responses across individuals and across time [23]. Sense of presence is a multi-  
35 dimensional concept. The several dimensions which have been proposed are being empirically tested in  
36 terms of validity. Major proposed dimensions include: physical/spatial presence, sensory presence, so-  
37 cial realism, engagement, social presence and social actor within the medium [23]. A large number of  
38 possible causes, of some or all of the different types of presence, have also been proposed, related to the  
39 form, content and user of the media/technology characteristics [23]. The causes may function individu-  
40 ally or in various interactions to evoke presence.

41 The multidimensionality of presence and it's psychological nature imply significant challenges when it  
42 comes to developing valid and reliable measures of presence. There are two general approaches: subjec-  
43 tive and objective [25]. Subjective measures of presence require study participants to produce a con-  
44 scious, introspective judgment regarding their experience. Objective measures of presence record study  
45 participants' physiological and/or behavioral responses that are logically correlated with their relevant  
46 psychological responses.

47 Usability assessment is also a fundamental task in terms of VE design and development [13,  
48 18-19], even if standard usability engineering and HCI evaluation techniques do not directly address the  
49 usability problems introduced by these new applications [19]. Closely related to the HCI, usability  
50 determines, in part, the acceptability of the VE [19]. According to Nielsen [4], usability mainly refers  
51 to learnability, efficiency, memorability, errors and satisfaction.  
52



1 the integration process of the computer in the classroom [27]. Simultaneously, the two subjects that  
2 described didactic systems closer to the "new didactics" [26], belong to the group with higher sense of  
3 presence. They also described computer use and perceived computer's role in education more integrated  
4 with their daily teaching. Besides the use of the computer as a support tool to their work outside the  
5 classroom, which all the interviewed subjects mentioned, they reported using the computer with the  
6 students in their classrooms. Sense of presence and usability didn't present significant relations with  
7 teaching models and conceptions of the subjects. Still, the two subjects closest to the objectivist tradition  
8 scored lower than the average on the usability evaluation, with the biggest difference at the satisfaction  
9 dimension. These teachers also belong to the group that felt the lowest sense of presence. All the sug-  
10 gested VE activities for classroom use weren't very original, mostly mimics of the free exploration used  
11 in the experience, which probably can be explained by the total absence of previous experience with VE.

12 Regarding usability evaluation, users seemed globally satisfied, all usability questionnaire items  
13 scored positive evaluations. Satisfaction dimension scored higher than learnability, users seemed particu-  
14 larly satisfied with the position and movement tracking feature provided by the HMD and first-person  
15 perspective. User global satisfaction is positive correlated with easiness of the system use, satisfaction  
16 with Cyberpuck use, easiness of locating themselves (i.e. knowing where they were and where every-  
17 thing else is inside the VE), satisfaction with the position and movement tracking feature provided by the  
18 HMD, satisfaction with the stereoscopic 3D perspective, easiness of perception of the sounds' point of  
19 origin and position, satisfaction with global image quality, satisfaction with first-person perspective and  
20 learnability to move the body and head in the physical world considering that the HMD was cable con-  
21 nected with the CPU. Interviewees stated preferring to explore the VE with the immersive system. Still,  
22 almost all subjects believe that it would have been easier using screen-keyboard-mouse. However, only  
23 two subjects mentioned some annoyance with HMD-CPU cable and only one subject stated some diffi-  
24 culty with the Cyberpuck manipulation. All these difficulties were referred by subjects which presented  
25 low sense of presence. Easy of use seems related to sense of presence.

26 Users suggestions pointed the improvement of sound and image quality, facilitation of understanding  
27 the VE space (i.e. access to "you are here" map). Content analysis of the interviews also identified orien-  
28 tation, knowing where they were inside the VE, as the subjects main problem. The symptoms felt by user  
29 and the sensory presence are positively correlated with usability.

30 In terms of presence, our findings show that users felt an important sense of presence. In a scale from -  
31 2 to +2, the average evaluation of all questionnaires items and, consequently, all presence dimensions  
32 was positive. Our findings suggest that users felt like "being there" (Spatial presence: 1.14), believed that  
33 the VE does or could exist in the physical world (Social realism: 1.19) and that VE sensory characteris-  
34 tics matched those of the physical world (Sensory presence: 1.02). Nevertheless, users weren't totally  
35 involved (Engagement: 0.24) and the will to talk with the virtual actors wasn't very intense (Social Pres-  
36 ence: Social Actor within the Spiritual medium: 0.83). Interview data confirms the above. High sense of  
37 presence users felt a strong social realism, spatial presence and engagement; social presence was globally  
38 low, virtual agents are mentioned as the element that felt less real; engagement and willingness to sus-  
39 pend disbelief differences between high and low sense of presence groups were relevant, high sense of  
40 presence group failed every time in determining the duration of their experience and stated more propen-  
41 sity to be emotionated. Finally, five interviewed subjects associated experience realism to the sense of  
42 movement inside the VE, sense of movement inside the VE as the aspect that felt more real, what can  
43 help to explain the relevance of spatial presence.

44 Concerning the consequences of the experience, increase of salivation (1.65) and ocular fatigue (1.66)  
45 are the more relevant symptoms felt by the users. However, none of the average scores is worrying (1 =  
46 never and 4 = many times). In addition, we registered an almost total absence of vomits and muscular  
47 pains, together with an extremely low frequency of headache, dizziness and vertigos. In the interviews,  
48 none of the subjects mentioned any of these symptoms.

49 Crossing the data from the 21 teachers experience with the VE with their computer skills scores, we  
50 may conclude that users that rarely use the computer and feel little comfortable with its use did present  
51 high levels of presence and assessed usability in a positive way. In the interviewees group, with scores  
52 below global averages, both in frequency and comfort level, the low sense of presence group scored

1 higher on the comfort level and no relevant differences were found related to frequency of use. Prior  
2 knowledge with computers may influence sense of presence, diminishing it.

### 4 5. Conclusions

6 In the present, game-engine VE is a low cost, accessible and flexible hypothesis to develop and use 3D  
7 VE for educational purposes. Primary teachers seem opened and interested to experiment these tools,  
8 even if they aren't familiarized with it. Experimenting and using the tools seems urgent to base their  
9 development of models for classroom use. All things considered, the tools are extremely important but  
10 the teacher is still the key of educational change.

### 11 12 References

- 13  
14 [1] UNESCO (1996). *Educação: um tesouro a descobrir*. Lisboa: Edições Asa.  
15 [2] Perrenoud, P. (2000). *Dez novas competências para ensinar*. Porto Alegre: Artes Médicas.  
16 [3] Negroponte, N. (1996). *Ser Digital*. Lisboa: Editorial Caminho.  
17 [4] Nielsen, J. (1993). *Usability Engineering*. San Francisco: Morgan Kaufman.  
18 [5] Bricken, W. (1990a). *Learning in Virtual Reality*. Available, 7 May, 2000,  
19 <http://www.hitl.washington.edu/publications/m-90-5/>  
20 [6] Bricken, W. (1990b). *Training in Virtual Reality*. Available, 7 May, 2000,  
21 <http://www.hitl.washington.edu/publications/r-90-3/>  
22 [7] Cadoz, C. (1996). *A Realidade Virtual*. Lisboa: Instituto Piaget.  
23 [8] Kerckhove, D. (1997). *A pele da cultura*. Lisboa: Relógio D'Água.  
24 [9] Levy, P. (2000). *Cibercultura*. Lisboa: Instituto Piaget.  
25 [10] Félix, N. (1998). *A História na Educação Básica*. Lisboa: DEB/ME.  
26 [11] Kent T. & McNergney, R. (1999). *Will Technology Really Change Education? From Blackboard to*  
27 *Web*. Thousand Oaks: Corwin Press.  
28 [12] Duffy, T. & Jonassen, D. (1992). *Constructivism: New implications for instructional technology*. In T.  
29 Duffy e D. Jonassen (Eds.), *Constructivism and the Technology of Instruction: A Conversation* (pp. 1-  
30 16). Hillsdale: Lawrence Erlbaum Associates.  
31 [13] Stuart, R. (2001). *The Design of Virtual Environments*. Ft. Lee: Barricade Books.  
32 [14] Auld, L. (1995). *Differences Between 3D Computing and Virtual Reality, VR in the Schools*, 1, 3.  
33 [15] Winn, W. (1993). *A Conceptual Basis for Educational Applications of Virtual Reality*. Available, 15  
34 Sept., 2000, <http://www.hitl.washington.edu/publications/r-93-9/>  
35 [16] Osberg, K. (1997). *Constructivism in practice: the case for meaning-making in the virtual world*.  
36 Available, 15 Sept., 2000, <http://www.hitl.washington.edu/publications/r-97-47/index.html>  
37 [17] Lave, J. & Wenger, E. (1991). *Situated Learning*. Cambridge: Cambridge University Press.  
38 [18] Gabbard, J. & Hix, D. (1997). *A Taxonomy of Usability Characteristics in Virtual Environments*.  
39 Blacksburg: Virginia Polytechnic Institute and State University, Department of Computer Science.  
40 [19] Kaur, K. (1998). *Designing Virtual Environments for Usability*. Londres: City University  
41 [20] Byrne, C. (1993). *Virtual Reality and Education*. Available, 1 Sept., 2000,  
42 <http://www.hitl.washington.edu/publications/r-93-6/>  
43 [21] Rheingold, H. (1997). *Realidade Virtual*. Lisboa: Vega.  
44 [22] Winn, W. (1997). *The Impact of Three-Dimensional Immersive Virtual Environments on Modern*  
45 *Pedagogy*. Available, 15 Sept., 2000, <http://www.hitl.washington.edu/publications/r-97-15/>  
46 [23] International Society for Presence Research (2000a). *Resources for the Study of Presence: The Concept of*  
47 *Presence*. Available, 15 Nov., 2002, [http://www.temple.edu/ispr/frame\\_explicat.htm](http://www.temple.edu/ispr/frame_explicat.htm)  
48 [24] Lombard, M. & Ditton, T. (1997). *At the Heart of It All: The Concept of Presence*. *Journal of Com-*  
49 *puter-Mediated Communication*, 3 (2).  
50 [25] International Society for Presence Research (2000b). *Resources for the Study of Presence: Measuring*  
51 *presence*. Available, 15 Nov., 2002, [http://www.temple.edu/ispr/frame\\_measure.htm](http://www.temple.edu/ispr/frame_measure.htm)  
52 [26] Perrenoud, P. (1993). *Práticas pedagógicas, profissão docente e formação*. Lisboa: D. Quixote.  
[27] Sandholtz, J. H., Ringstaff, C. & Dwyer, D.C. (1997). *Ensinando com tecnologia – criando salas de aula*  
*centradas nos alunos*. Porto Alegre: Artes Médicas.