Problem-based Virtual World Design for Virtual Reality Education
An Experiment with the Opensimulator Platform for Second Life-based Virtual Worlds

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Abstract: In this paper we present our current efforts with a novel, problem-based learning paradigm for academic-level education on topics related to Virtual Reality. The paradigm embraces problem-based learning principles and methods, adopts methodologies and technologies pertaining to the Second Life online virtual environment and relies on the use of exclusively free software, namely, the OpenSimulator platform for Second Life-based virtual environments. We have applied the paradigm for the purposes of a BSc-level course module on Virtual Reality and have evaluated its educational impact and appeal to students through a questionnaire-based survey.

1 INTRODUCTION

Virtual Reality is the scientific field whose object is the design and operation of virtual worlds. Virtual Reality has numerous applications, in fields such as simulation, entertainment, art, education and others.

Thanks to its capacity to support complex, dynamic and, recently, shared simulations with online access capabilities, Virtual Reality is an ideal option for educational applications. However, even though Virtual Reality has been put to actual use as an educational aid extensively until today, its potential as a means to teach, and practice with, topics related to Virtual Reality itself, including virtual world design, real-world application, technical administration, product promotion, etc., does not seem to have been as thoroughly investigated.

In this paper we present our current efforts with a novel, problem-based educational paradigm (Barrett and Moore, 2010) aiming to advance academic-level teaching of Virtual Reality-related topics. The proposed paradigm relies on the use of shared virtual worlds accessible online and realized using exclusively free software – namely, the OpenSimulator platform for Second Life-based virtual environments (OpenSimulator, 2012) – and has a strong focus on self-directed learning, collaboration and well-meant competition. We have applied the proposed paradigm in the context of a BSc-level course module on Virtual Reality during the academic year of 2011-2012 in the Department of Informatics, University of Piraeus, Greece.

2 RELATED WORK

Relatively recent technological advances in Virtual Reality have enabled non-expert user access to large-scale, multi-user virtual virtual worlds, such as Second Life. Due to that and thanks to a range of representation and interaction abilities, Virtual Reality has been, and is still being, extensively used as an educational aid, in areas such as training (Johnson et al., 1998), tutoring (Aylett et al., 2005), childcare (Albin-Clark et al., 2012), and others. In several cases there is specific focus on problem-based learning (for example, machinima production in Second Life (Brown et al., 2008), human-computer interaction education (Koutsabasis and Vosinakis, 2012), and others).

However, the potential of Virtual Reality applications as learning grounds for topics related to Virtual Reality itself as a scientific field, such as application life-cycle management, collaborative virtual world design, administration and operation, product promotion, etc., does not seem to have been thoroughly investigated. Attempts involving game engines such as the Unreal Engine and the Unity Engine have been employed on occasion; however, these are burdened by the fact that they demand a high level of technical expertise and platform-

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specific knowledge from students, which has a negative impact on the educational process as it diverges the students' attention to technicalities.

3 METHODOLOGY

Our motivation behind the educational paradigm presented in this paper was to provide students with all skills necessary to be able to address real-world situations in which the desired outcome is a virtual world, or a part of a virtual world, of specific and actual practical and, perhaps, commercial, value. These skills include the ability to:

1. plan the entire endeavour, from the initial requirement analysis to design, implementation and final presentation,
2. allocate and make optimal use of all required resources, including software, virtual world space, virtual world design assets, programming elements, time and human collaborators,
3. coordinate a team of collaborators working remotely and on diverse locations not attached to any sense of office space,
4. provide early evidence to the client party (contractor, instructor, etc.) in support of the endeavour's timely and effective progression as well as its success potential, and
5. present the final product to the client party, making clear that all original goals were attained and ensuring the party's full ability to benefit from the product as originally intended.

To that end, we adopted a problem-based learning approach for term assignments given to students of a BSc-level course module on Virtual Reality during the academic year of 2011-2012, which builds upon the following key factors:

1. Students were to work in teams of no more than 3 members.
2. Each team was to select a theme, without any restriction whatsoever imposed by the instructors, and commit to its realization.
3. Each team was allocated a specific area inside a persistent, shared virtual world accessible over the Internet, in which all teams could watch the efforts of their colleagues, communicate with everyone in the virtual world, exchange ideas and even adopt observed practices if they found them to be suitable for their own purposes.
4. Each team was to make key design decisions with a considerable potential impact on their success, in compliance with specific (but minimal) restrictions given during class. These decisions include design contracts, aesthetic options, functionality and means of interaction with the virtual world, additional multimedia content and building methodologies.
5. All teams were to adhere to common-sense fair-use practices: They were not to interfere with the work of their colleagues in any way and to not abuse the virtual world infrastructure according to specific guidelines presented to them during class.
6. Each team was to designate and commit to their own collaboration, communication and scheduling contracts.

Our intention with the above approach was to stir a strong feeling of responsibility and personal involvement with the success of a specific goal in each individual student, as well as to stress the importance of collaborative practices, both within the team as well as among teams.

Our virtual world infrastructure was based on OpenSimulator platform, an open-source, multi-platform, multi-user 3D application server based on the Second Life online virtual environment and available as free software. Students were given the opportunity to select their building areas on their own, on a first-come-first-served basis. We also reserved a central area for facilities to be used for teaching, demonstration, and information channelling purposes. All students were given precise details about how their assignments would be evaluated according to concepts and criteria presented and discussed during class. These include originality of the theme chosen, consistency with the chosen theme, design precision, compactness of the final product, variety of available means to interact with the virtual world, practical application potential and the degree to which the final product would succeed in generating an overall, subjective feeling of presence, interest, purpose and continuity to users experiencing it on their own.

4 RESULTS AND EVALUATION

During the term, we were pleased to see that most students began working quite early and on the basis of solid team-level coordination. Their involvement was constant throughout the time the virtual world was available, while their selection of subjects as well as their design and implementation approaches were diverse and imaginative.

Overall, the students' enthusiasm and the diversity and quality of their work provided us with strong evidence for the success of the approach and

its suitability as a means for academic-level education on Virtual Reality-related issues. However, in order to attain a more precise and thorough understanding of whether students felt the approach was beneficial (or not) on a number of different levels as well as how various factors had a positive or negative impact on their work and ability to fully benefit from the approach, we carried-out a questionnaire-based survey on a total of 58 students.

Each questionnaire contained 35 questions which were selected with an aim to identify the students' overall impression and feelings about the approach in general, as well as the perceived educational impact, the inherent elements of cooperation and competition, the concurrent online accessibility and remote-work model, the compatibility of the approach with an academic curriculum and its suitability and effectiveness as an educational methodology, the availability of documentation and educational resources, and the technical issues they faced during their efforts. More specifically:

- 100% of the students answered that they found the experience an overall pleasant one with 84% strongly arguing that that was the case. This is, of course, a very encouraging outcome, albeit unreliable on its own: further investigation must provide a clear picture on exactly why students saw the experience as a pleasant one.
- 62% of the students believe the approach had a strongly positive educational impact, 33% believe the impact was just positive, and only 5% believe that the impact was negative with none having a strong negative opinion. As the ultimate goal of the approach is to enable an effective educational paradigm, this 5%, however small, must be further investigated.
- 91% of the students saw the experience as a highly creative one and 5% as just creative. This is a very encouraging result as it clearly indicates that all students have experienced the increased creativity potential the approach – and Virtual Reality, as a consequence – represents.
- 91% of the students, of which 41% have a strong favourable opinion, would like to have the option to carry out assignments for other course modules (not necessarily related to Virtual Reality) based on similar approaches.

Regarding two crucial aspects of the whole endeavour, namely, the elements of cooperation and inevitable (and hoped-for) well-meant competition due to students being constantly able to monitor the work of others as it took place:

- 47% of the students are strongly in favour of the collaborative scheme, while 31% are just in favour. However, 22% would have rather worked alone. It must be noted that this is not about teamwork: the formation of teams was optional as students were by all means allowed to work individually; rather, it reflects that a non-negligible 20% of the students felt uncomfortable with having to share the same work space with, and being under constant surveillance by, their colleagues.
- Along the above lines, 57% had absolutely no problems due to the fact that other users could navigate freely to and in their allocated areas. 28% were simply OK with it while an again non-negligible 15% were not, with a 5% having a strong negative opinion.
- 66% of the students declared that their observation of their colleagues' work made them revisit their original planning and and adjust their design goals and methods to at least some degree, while an additional 17% state that they completely changed direction for similar reasons. 18% were affected only a very little or not at all. This is a most remarkable result as it indicates that the inherent capacity of the approach to enable competition has affected a good 83% of all students who participated in the survey in spite of the fact that reconsideration of one's design goals and practices is always a decisive, risky, never-effortless option.

The survey also made it possible to draw useful conclusions on the aspects of concurrent online accessibility and the remote-work model:

- The online, concurrent access model is favoured by a marginal majority of 58%. The other 42% would have rather worked on a standalone server reserved for them or their team. We mean to investigate the nature of this result thoroughly. We believe that it has much to do with a variety of technical obstacles that arose during the term, which had an undoubtedly negative impact on the students' ability to access the virtual world and has, perhaps, lowered their confidence in the general practice of online access to a shared virtual world (which they are completely unable to manage in contrast with a fully-manageable local server).
- However, provided that the virtual world was available, the concurrent online access model had minimal negative impact (if any) to most students: A total of 83% answered that the

presence of multiple users in the virtual world did not hinder their ability to work without problems related to service availability, response latency, etc.

It must also be noted that, although students were largely responsible for resolving land- and building-related "disputes", unauthorised content replication issues, etc., there were certain occasions on which we had to intervene, as we believe any instructor coordinating a similar effort will have to do. For instance, on a few occasions, we had to deactivate pieces of scripting code that disregarded good programming practices (regardless of the relevant discussions during class) and, as a result, drained the virtual world server's resources. However, those occasions were rare and created no significant problems of any kind.

5 CONCLUSIONS AND FUTURE WORK

In this paper, we present our current efforts towards a novel, problem-based learning paradigm for academic-level education on topics related to Virtual Reality as well as our results from the application of the paradigm on a Virtual Reality-related BSc course module during the academic year of 2011-2012. Our approach aimed at the collaborative design of a shared, remotely- and concurrently-accessible virtual world and relies exclusively on free software tools based on the Second Life virtual environment, namely, the Open Simulator platform and Second Life-compatible viewers.

Based on our own subjective impressions of how students welcomed the novel approach as well as their collective opinions about it as expressed through a questionnaire-based survey, and in spite of numerous technical issues both we and the students faced during the term, we feel that the endeavour was overall successful and beneficial on different levels for most, if not all, of the students who participated. For this reason, we will maintain our commitment to the underlying paradigm while working to further augment its educational impact and systematize its applicability.

More specifically, we plan to adopt a similar approach for two course modules (one BSc-level and one MSc-level) during the academic year of 2012-2013. This will give us the opportunity to obtain richer evaluation data, investigate a potential correlation between different academic backgrounds and the paradigm's suitability, as well as enhance the assessment process by adopting more specific and robust evaluation criteria. We also aim to enhance the element of cooperation by assigning one region to each module adjacent to the region which was used in the case of the 2011-2012 BSc-level course module presented in this paper, so that all students are able to observe, and draw inspiration by, the work of other students. In addition, we aim to further expand the application of the paradigm by seeking cross-departmental and cross-institutional co-operations. In conclusion, we have already taken measures to prevent technical problems aiming to ensure that the proposed paradigm's potential educational benefits will not be hindered by inadequate infrastructure and lack of resources.

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