ONLINE COMPUTER GAMES AS COLLABORATIVE LEARNING ENVIRONMENTS: PROSPECTS AND CHALLENGES FOR TERTIARY EDUCATION

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ABSTRACT
This study is aimed at presenting a critical overview of recent research studies on the use of educational online games as collaborative learning environments in Tertiary Education (TE), namely higher education and vocational training, with a view to identifying: a) the elements that online games should include in order to support fruitful and sustainable constructivist and collaborative learning experiences within TE institutions; b) the impact of online games on students’ motivation, academic performance and collaborative practices; c) the impact of the use of online games for educational purposes on faculty workload, teaching and assessment practices, and management of classroom dynamics; and d) the challenges that TE institutions face when new, very learner-centered, but also potentially addictive and distractive, learning modes, such as learning through online games, are introduced into the various curricula. The study also examines certain practical and technical issues related to the use of online games in TE, such as the costs of the software needed and the adequacy of the computer and networking infrastructures.

INTRODUCTION
In our knowledge-based society, independent and life-long learning skills, such as problem solving and critical thinking skills as well as communication and teamwork skills, are becoming increasingly essential (Oliver & McLoughlin,
This fact, combined with the diverse needs of adult learners, questions the traditional faculty-centered educational models used in Tertiary Education (TE) institutions, calling for a transition to learner-centered models where students are seen as active, lifelong members of learning communities (Duderstadt, 1998). In particular, a need is expressed for the adoption of constructivist approaches to learning in TE given that those approaches provide contextual learning environments comprising meaningful tasks, which encourage the active construction of knowledge by learners through learners’ experiences and social interactions, and which are likely to favor the acquisition of the aforementioned skills as well as the transfer of those skills to real-life situations (Papastergiou, 2006).

Internet and Web technologies can potentially support the creation of such environments providing tools that enable the creation of online learning communities, independent of time and space limitations (Papastergiou, 2006).

Several researchers (e.g., Begg, Dewhurst, & Ellaway, 2004; Delwiche, 2006; Herz, 2001; Pivec & Dziabenko, 2004) argue that a specific mode of networked learning, learning through online games, constitutes a promising constructivist learning paradigm that should be embraced by TE institutions with a view to providing students with powerful active learning environments and lifelong learning concepts. In recent years, various forms of online games, such as immersive, massively multiplayer online games (MMOGs), have emerged. The players of such games learn not only through interacting with the game environment, but also through interacting among each other forming virtual communities both within the game environment and around it (Begg et al., 2004; Delwiche, 2006; Herz, 2001). For instance, within the game environment, players form online teams, the members of which share information in order to develop team strategies in the game, whereas around the game environment, players form online game communities where they dedicate considerable time in sharing game-related knowledge and software, in modifying and expanding the game, and in teaching each other game-related issues. A new collaborative networked model for teaching and learning is hence created, which is believed to be more powerful than the traditional model of classroom instruction and the conventional online learning facilities used in TE, such as threaded discussion boards (Herz, 2001). Furthermore, this game-based learning model is much more motivational for today’s students, who have grown up immersed in computer games, than formal academic education is (Prensky, 2001). In fact, many researchers (e.g., Facer, 2003; Kirriemuir & McFarlane, 2004) have already stressed the important role that computer games play in young people’s lives and the special fascination and deep sense of engagement that those games provoke in them. Nevertheless, the game-based learning model is not without problems. For instance, a frequently mentioned drawback of online games is their highly addictive nature, which sometimes results in players spending more time in those virtual environments than in their physical environments with human beings (Delwiche, 2006).
According to Lepper and Cordova (1992), the combination of the motivational value that games have on young people with the learning of academic subjects can make the latter more effective. A question that thus arises is how the power of online games could be exploited for learning purposes within TE at the same time bypassing the drawbacks of those games. A solution could be the design and development of educational online games, namely online games specifically designed and created for learning purposes, and their mindful incorporation in the teaching and learning processes in TE institutions with a view to rendering the learning of curricular subjects more appealing and effective for students. In fact, in recent years, new games are increasingly being designed for learning in an effort to use the technologies employed by game developers to capture students’ attention and enthusiasm for educational purposes (Klopfer, 2005). Furthermore, educational games increasingly attract the interest of researchers in areas such as educational technology and the didactics of the various disciplines. One of the main reasons for this increased research and development interest in computer games for learning purposes is that those games are believed to have the potential to support innovative constructivist-inspired models of learning, such as learning-by-doing, exploratory learning, problem-based learning, situated learning, and learning through participation in communities of practice (Facer, 2003; Shaffer, Squire, Halverson, & Gee, 2004), which contrast with the traditional lecture-based model of teaching that is today considered ineffective in ensuring that learning actually takes place (Facer, 2003). It, thus, seems that computer games offer a powerful new medium to support learning in the information age (Kirriemuir & McFarlane, 2004). This assertion holds especially true for educational online games, which, relying on the inherent capabilities for communication, interaction, and resource sharing provided by the Internet and the Web, can offer increased opportunities for collaborative learning and knowledge construction through social interaction.

However, despite the increasing enthusiasm of researchers regarding the alleged educational potential of online games, there is a lack of a synopsis and critical analysis of the empirical evidence gathered so far from the application of educational online games in real courses in TE institutions. This, in turn, could provide further insight into the impact of those games on faculty, students, and the educational processes in TE as well as into the design features that online games should have in order to cover the needs of faculty and students and to support successful and pedagogically sound learning experiences. Such an investigation could further our understanding of the way in which educational online games should be designed and incorporated into TE courses.

**AIM OF THE STUDY**

This study is aimed at presenting a critical overview of recent research studies on the use of online games as collaborative learning environments in TE with a view to identifying:
a) the elements that online games should include in order to support fruitful and sustainable constructivist and collaborative learning experiences within TE institutions;
b) the impact of online games on students’ motivation, academic performance, and collaborative practices;
c) the impact of the use of online games for educational purposes on faculty workload, teaching and assessment practices, and management of classroom dynamics; and
d) the challenges that TE institutions face when new, very learner-centered, but also potentially addictive and distractive learning modes, such as learning through online games, are introduced into the various curricula.

The study is also aimed at examining certain practical and technical issues related to the use of online games in TE, such as the costs of the software needed and the adequacy of the computer and networking infrastructures.

METHOD

Literature searches in major bibliographic databases (e.g., ISI Web of Knowledge, ACM Digital Library, Science Direct) were conducted in September 2007 with a view to identifying articles relevant to the use of educational online games in TE. The searches were focused on recent research studies (i.e., published after 2000) that addressed the design of online games which were specifically tailored for educational purposes (i.e., not existing or commercially available games) and which supported student experimentation and collaboration as well as the evaluation of the games with groups of students who had used the games in parallel with their regular courses. The located studies were overviewed and the elements incorporated in the design of the respective games, as well as the main findings of the studies, were summarized into common themes using the aforementioned research objectives as a guide.

In what follows, the located studies are presented first. Afterwards, the design elements and main outcomes reported in those studies are presented and critically discussed.

USES OF EDUCATIONAL ONLINE GAMES IN TE

In recent years, several research studies have examined the use of collaborative educational online games in the teaching and learning processes of various disciplines within the context of regular courses in TE. In this section of the article, those case studies and respective games are presented.

FINESSE (Finance Education in a Scalable Software Environment) (Michaelson, Helliar, Power, & Sinclair, 2001) is a Web-based portfolio management game that
has been used in an undergraduate accountancy course. Within its distributed
learning environment, which is designed with a view to encouraging authentic
and collaborative learning relevant to portfolio management strategies, students
can work in groups. Each group has to manage a portfolio of equities with a
given notional value and can buy and sell shares of investment trusts, while
also having access to real-time stock-market data, which can inform student
decision-making. The game enables a human tutor to monitor student per-
formance, and includes tools for student-tutor and student-student interaction.

_Breast Cancer Detective_ (Roubidoux, Chapman, & Piontek, 2002) is a Web-
based game on breast imaging specifically designed for undergraduate medical
students in radiology. It is oriented toward the clinician’s point of view, and
encourages case-based and problem-based learning in an effort to offer students
real-life experience, which is difficult to achieve through traditional textbooks.
The game can be played by two students or by one student and a cyber-player,
and comprises 16 case-problem scenarios incorporating radiographic images and
multiple-choice questions. Students earn points when they successfully solve
problems related to the presented cases.

_Planet Oit_ (Saini-Eidukat, Schwert, & Slator, 2002) is a multiplayer, role-
playing simulation-based geology game, which has been tested with under-
graduate geology students. It is built using Multi-user Object Oriented Domain
(MOO) technology. Students assume the role of geologists on an expedition to
a newly discovered planet. They are assigned authentic exploratory geologic
goals of ascending difficulty (e.g., to locate a certain mineral) and are provided
with field instruments (e.g., log book to record findings) in order to conduct
observations and experiments by the same scientific methods as a geologist
would. The game comprises a scoring mechanism, multiple difficulty levels,
and software agents that tutor students by providing assistance when needed. It
enables students to collaborate at a distance and to use expensive equipment
difficult to access in the real world.

_FSS_ (Financial System Simulator) (Santos, 2002) is a Web-based simulation
game for the introduction of undergraduate economics students to the conse-
quences of monetary policy. Groups of students that represent nations interact
with one another in a global economy. Each nation issues five economic decisions
per week. The simulation runs weekly, incorporating all group decisions and
random shocks of the week, and provides students with the newly computed
equilibrium values of their economy’s macroeconomic variables. Students can
thus observe the real-time performance of their economies, which is based on their
own decisions and those of their peers. The game comprises various rooms such as
the “decision room” to support decision making among group members and the
“economics statistics site” to allow study and further analysis of real-time data.

_Age of Computers_ (Natvig & Line, 2004) is a Web-based game, inspired from
real-time strategy games, designed to introduce postgraduate information tech-
nology students to computer fundamentals through problems linked to computer
history. Within the game, students explore different “epochs” of computer history (e.g., the “Transistor Age”), read and search for relevant information, engage in problem solving, interact among them, and receive points and feedback on their solutions. Students have to solve all the problems of an epoch in order to enter the next one, which ensures an appropriate pedagogical order of the introduced topics. The game offers human tutors the possibility of helping students and monitoring each student’s learning progress during the semester.

Simulation Game on Data Bases (Connolly, Stansfield, & McLellan, 2006) is an online collaborative game aimed at teaching computing students techniques and skills relevant to database analysis and design. It comprises real-world video case studies that present students with authentic organizational problem scenarios (e.g., the organization of a library) as well as accompanying interactive visualizations (e.g., animated construction of an entity-relationship diagram) and online learning materials. Students can also interact with the characters of the video case studies by asking various types of preset questions, the answers to which may influence the problem situation.

PIDstop (Eikaas, Foss, Solbjørg, & Bjølseth, 2006) is a set of dynamic simulation-based online games that has been tested with groups of mathematics, physics, and engineering students. The games convey knowledge on harmonic oscillations, magnetic levitation, hydrodynamic forces, and non-linear controllers through the respective interactive simulators embedded in them. Students assume playful tasks (e.g., they study magnetic levitation by having to vary the current to control the vertical position of a magnetic levitation train), access background material, manipulate the learning resources (e.g., vary initial conditions), view results in different ways, and engage in self-assessment and assessment activities while enjoying standard game features (e.g., different skill levels, high score list).

Simulation Game on Artificial Intelligence (Hingston, Combes, & Masek, 2006) is an animated online game with simulated physics for teaching Artificial Intelligence (AI) principles to computer science undergraduates. Students, individually or in groups, through programming in Java, develop intelligent controllers for simulated vehicles (e.g., saucers with a limited supply of energy), which compete in a tournament. The simulation includes a real-time visualization of the contests as well as tools for the animated illustration of the workings of students’ programs, which enables students to directly observe the results of their programs and modify their programs accordingly. The game is designed to offer collaborative, experiential, immersive learning experiences, to reflect the real-world cycle of software development, and to deepen understanding of AI concepts.

Virtual Computer (Tüzün, 2007) is a three-dimensional (3D) online multi-user game that encourages experiential and inquiry-based learning, and has been used to introduce undergraduate education students to computer hardware and peripherals. It was built by means of a meta-game platform and uses a special client that combines a 3D virtual environment with a Web browser and a communication
window. The game scenario is articulated around a non-functioning giant computer. Students have to find out the reasons for its breakdown based on the learning content embedded in the game. They can also collect and submit information and interact among themselves and with Non-Player Characters (NPCs) with a view to accomplishing the various learning tasks dictated by the scenario.

_Mustakarhu_ (Hamalainen, 2008) is a virtual two-dimensional (2D) and three-dimensional (3D) collaborative online game that encourages goal-oriented learning and task-solving based on authentic problems with a view to simulating the context of real working life, where different professionals have to collaborate. The game has been used for the introduction of technology students into the process of design and surface treatment. Specifically, students, divided in groups, assumed tasks relevant to the design of four hotel rooms, having to solve relevant mathematical problems (e.g., calculation of the areas and costs of the materials) and to make decisions together within a practice environment that would be costly to arrange in real life. The game employs scripts (i.e., participants follow directions in undertaking shared tasks) in order to structure collaboration.

**FINDINGS OF THE OVERVIEWED STUDIES**

The studies presented in the previous section were overviewed with a view to identifying the design elements incorporated in the respective games as well as the major findings derived from the application of those games within real TE courses. The design elements and outcomes of the overviewed studies were summarized into five major themes, which are presented in what follows.

**Elements that Educational Online Games Should Include**

As derived from the design approaches followed in the overviewed studies, educational online games should constitute engaging virtual environments that offer students authentic, goal-oriented, challenging, exploratory, experiential, collaborative problem-solving learning experiences that reflect real-life situations that scientists or professionals of the respective field encounter in their everyday practice (e.g., Michaelson et al., 2001; Roubidoux et al., 2002; Saini-Eidukat et al., 2002). Such learning experiences, which are beneficial for students in terms of development of conceptual understanding and real world skills (Hingston et al., 2006), and which contrast the factual knowledge conveyed by traditional textbooks bridging theory and practice (Roubidoux et al., 2002), may otherwise be difficult, costly, time-consuming, or even dangerous to organize. Most importantly, games should offer students the opportunity to experience the way in which scientists and practicing professionals collaborate in teams within the context of real-life tasks (Hamalainen, 2008; Saini-Eidukat et al., 2002), given that teamwork is an integral part of contemporary practices both in science and in
the workplace. They should, therefore, support various modes of interaction and collaboration, such as student-instructor and student-student, and should cater for respective tools (Connolly et al., 2006; Hamalainen, 2008; Michaelson et al., 2001). However, as Hamalainen (2008) points out “collaboration does not emerge automatically when a group of people is operating at the same virtual environment.” In fact, in certain of the studies (e.g., Santos, 2002), problems in the collaboration among students were noted. Some structure should, thus, be provided, in the form of a pedagogical script embedded in the game narrative, with a view to somehow guiding students both in how to deal with their learning tasks and in how to interact with each other (Hamalainen, 2008). This structure could be linked to the level mechanism of the game, with the various game levels corresponding to different levels of the script in a pedagogically useful way (Hamalainen, 2008). For example, in “Planet Oit,” when students accomplish the exploratory goals that they have been assigned, they are automatically assigned new goals that require higher levels of expertise and collaborative decision-making (Saini-Eidukat et al., 2002).

Students have very high expectations and standards regarding educational online games, and compare those games to commercial products and other popular games that they play on the Internet (e.g., Natvig & Line, 2004; Roubidoux et al., 2002; Tüzün, 2007). Consequently, if educational online games are to support truly engaging and sustainable learning experiences, they have to include the main characteristics of the games that students play in their free time, namely advanced user interface, sophisticated graphic designs, compelling sounds, and immersive narratives. Otherwise, poor graphics or functionality may, for instance, decrease not only the motivational appeal but also the learning effectiveness of such games (Eikaas et al., 2006). Furthermore, a scoring mechanism is needed to add a competitive element to the game as well as a multiple-difficulty-levels mechanism in order to keep students with different levels of knowledge and expertise involved in the game, while providing them with feedback on their own progress and ensuring a pedagogically suitable order of presentation of the embedded learning material (e.g., Connolly et al., 2006; Eikaas et al., 2006; Natvig & Line, 2004; Saini-Eidukat et al., 2002). In addition, if an educational online game is to be systematically used within a course, it has to comprise integrated self-assessment and assessment facilities that enable students to monitor their own learning gains, and faculty to monitor student performance throughout the semester (Eikaas et al., 2006; Michaelson et al., 2001). Within the game environment, it is also crucial that appropriate scaffolding and assistance is offered to students through interaction either with human tutors (e.g., Natvig & Line, 2004) or with software agents and NPCs (e.g., Connolly et al., 2006; Saini-Eidukat et al., 2002; Tüzün, 2007). Another desirable feature is that, within a multiplayer environment, a student be able to observe and, thus, to gain ideas and learn from the actions performed by other simultaneous players (Saini-Eidukat et al., 2002) so that vicarious (i.e., observational) learning is encouraged.
For instance, in “Planet Oit” a student can watch another student performing a test on an object. Finally, an educational online game should be scalable in the sense that new learning material, problem scenarios, and learning tasks could be easily incorporated into it (Connolly et al., 2006). It should also have a small learning curve so that no significant time is lost in students’ initial orientation in it, and its design should be conceptualized around the time constraints of a course (e.g., a game designed for a course that lasts one semester should be able to be completed within this time span) (Tüzün, 2007). The aforementioned game elements and intended learning outcomes are summarized in Figure 1.

**Impact of Educational Online Games on Students**

In the majority of the overviewed studies (Connolly et al., 2006; Eikaas et al., 2006; Michaelson et al., 2001; Navig & Line, 2004; Roubidoux et al., 2002; Saini-Eidukat et al., 2002; Santos, 2002), quantitative methods (e.g., surveys) were used for the evaluation of the impact of the respective educational online games on students, whereas in the remaining studies either qualitative methods (e.g., interviews, field observations, and analysis of student-created artifacts, or both quantitative and qualitative methods (Hingston et al., 2006) were used. Most of the overviewed studies were based on quite small samples, which, however, can be explained by the type of the studies (interventions in courses), and only a few studies (Eikaas et al., 2006; Natvig & Line, 2004; Saini-Eidukat et al., 2002) included larger samples. It should also be noted that most studies were based on measures taken after students had interacted with the games, whereas only two studies (Michaelson et al., 2001; Saini-Eidukat et al., 2002) followed a pretest/posttest experimental design. The studies examined issues such as students’ acceptance of and satisfaction with the games, students’ views on their experiences and collaborative practices within the games, students’ self-reported learning from the game, and finally, the learning effectiveness of the games.

The overviewed studies agree in that students’ responses to the educational online games were very positive. Students clearly enjoyed the games and found them interesting, motivational, immersive, beneficial, and worthwhile (Hingston et al., 2006; Michaelson et al., 2001; Roubidoux et al., 2002; Tüzün, 2007). They felt that such games offer a realistic and useful way to learn (Hingston et al., 2006), which they consider particularly challenging because of the authenticity of the learning tasks, the opportunities for experimentation and visualization of the results, and the immediate feedback of the learning environment (Hamalainen, 2008). Students found learning through online games or through the combination of such games with other course activities more motivational than learning through traditional course activities and textbooks alone (Eikaas et al., 2006; Hamalainen, 2008; Natvig & Line, 2004; Roubidoux et al., 2002; Santos, 2002). The course instructors also affirmed that students’ active engagement in learning
Figure 1. Desirable elements and intended learning outcomes of educational online games.
was enhanced, and that the games kept students enthusiastic and motivated throughout the learning process (Hingston et al., 2006; Santos, 2002), while offering them opportunities to take control over their own learning, and to engage in information seeking, problem solving and decision making (Tüzün, 2007).

Regarding the learning effectiveness of the educational online games, it should be noted that most of the overviewed studies were based on subjective measures, such as students’ views on their own learning gains attained through using the games or instructors’ views on those gains, whereas only two studies were based on more objective measures (Connolly et al., 2006; Saini-Eidukat et al., 2002), namely on students’ achievement in a problem solving test and students’ grades in the respective course. More specifically, in the study by Saini-Eidukat and colleagues (2002), the group of students that had used “Planet Oit” performed significantly better in solving geology problems compared to the other two groups of students that had not used the game. Connolly and colleagues (2006) compared the grades that three cohorts of students obtained in a course reporting a statistically significant difference in favor of the students that had used the game. Those findings suggest that educational online games can significantly enhance students’ academic performance. As deduced by the rest of the studies, the students themselves believe that the games had positive learning effects (Eikaas et al., 2006), enhanced their understanding of significant concepts pertaining to the subject matter of the courses (Hingston et al., 2006; Michaelson et al., 2001; Santos, 2002), helped them develop important skills related to the courses, and contributed to deeper learning (Hingston et al., 2006). Students also found learning through the games more efficient and effective than learning through conventional course activities and textbooks (Hamalainen, 2008; Natvig & Line, 2004; Roubidoux et al., 2002). Students’ feelings of self-efficacy and confidence with regard to the subject matter embedded in the games also improved, which is an important finding given that self-efficacy is positively related to performance (Hingston et al., 2006).

Finally, as far as student collaboration is concerned, the data drawn from students’ answers and instructors’ observations and experiences are limited and equivocal. In the study by Michaelson and colleagues (2001), students felt that the game environment improved their ability to work as members of a group, and that the teamwork in which they had engaged improved both their communication skills and other skills relevant to the specific subject matter. In Tüzün’s (2007) study, the immersive game environment did not absorb the majority of students, who engaged in social interactions and collaborated well in various tasks within the context of the game. In agreement with those findings, Hamalainen (2008) found that interaction and collaboration among students was intense within the game environment and that the pedagogical script that had been used did help all groups of students to advance in the game. However, Santos (2002) found that the game contributed only modestly to rendering group work easier, and that the students complained of a non-contributing teammate only less
frequently than in traditional group projects in the classroom. A solution to this problem might perhaps be the adoption of a more supportive and at the same time more individually demanding collaboration script. Table 1 presents a summary of the aforementioned findings.

**Impact of Educational Online Games on the Instructor**

The impact of educational online games on faculty has been much less investigated than the respective impact on students. The few studies that address the issue report that faculty provided very positive comments on this innovative learning mode (Connolly et al., 2006), which they viewed as a promising approach for course activities supplementing ordinary lectures (Natvig & Line, 2004). However, with the introduction of educational online games into a course, traditional teaching practices are challenged and the role of an instructor shifts from that of a conveyor of knowledge to that of a facilitator and manager of students’ learning activity (Tüzün, 2007), which implies that faculty pedagogical practices and mentality have to change in order to accommodate game-based learning.

As far as faculty workload is concerned, in the study by Natvig and Line (2004), the instructors, who had considerable experience in conducting laboratory assignments for very big classes, found the game that was used simpler to administrate than conventional laboratory courses. However, in the study by Connolly and colleagues (2006), although faculty felt that for small numbers of

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<td>Acceptance/appeal</td>
<td><em>Converging evidence:</em></td>
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<td>- Students’ responses to the games were overwhelmingly positive</td>
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<td>- Students have greatly valued game-based learning</td>
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<td>- The games improved students’ academic knowledge and skills</td>
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<td>Self-efficacy</td>
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<td>- The games improved students’ self-efficacy with regard to the subject matter</td>
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<td>Teamwork</td>
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<td>- The games greatly improved teamwork</td>
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Table 1. Impact of Educational Online Games on Students
students the workload of supporting student learning through the game would be similar to that of conventional teaching, they argued that larger enrollments would result in significantly higher workload. According to Tüzün (2007), the workload does remain considerable as the instructor has to monitor students’ activity, answer questions relevant to the subject matter and to the mechanics of the game environment, and balance student participation between playing and learning. Those findings are summarized in Table 2.

Finally, for the successful integration of an online game into a course, it is important that students’ performance, activities, and work products (either individual or collaborative) within the gaming environment, and in relation to it, form part of the regular assessment of the course (Eikaas et al., 2006; Hingston et al., 2006; Michaelson et al., 2001). For instance, in the study by Michaelson and colleagues (2001), students’ assessment was based on students’ group use of the game, the portfolio strategies adopted within the game, an individual report on the game, and a presentation of the investment strategies that each group had employed within the game. In addition, in the study by Hingston and colleagues (2006), students’ performance in the game and the programs that students wrote for the game were components of the assessment of the course. Those examples indicate that online games can offer instructors interesting opportunities to design authentic and challenging assessment tasks that are grounded in real-life practice and require teamwork (Hingston et al., 2006).

**Challenges for TE Institutions**

According to Tüzün (2007), educational online game environments introduce a new social constructivist learning culture in educational institutions given that the major changes they bring into the learning processes, namely students being granted control over their own learning and offered ample opportunities for active learning and learning through peer collaboration, force instructors to

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abandon their traditional teaching models, which are no longer viable in such learner-centered environments. This is particularly important for TE institutions where the traditional educational models are today severely questioned and where innovative learning models are being sought. Educational online games could, thus, be viewed as vehicles for the re-engineering of educational models in TE.

On the other hand, one could also argue that the immersive and fun nature of gaming environments is addictive and could, thus, distract students from the learning process. However, in the overviewed studies, no such phenomena were reported with the exception of the study by Tüzün (2007), where certain students were found to be absorbed in the leisure activities of the game and distracted from the game’s learning activities, which implies that instructors have to monitor students’ gaming behavior so that a proper balance between playing and learning is maintained. An appropriate pedagogical script could also help in keeping this balance.

Finally, another issue that challenges traditional TE curricula is the fact that educational online games require considerable instructor and student time to be devoted to them, if they are to form an integral part of courses (Tüzün, 2007). In fact, in certain case studies (Santos, 2002), the students themselves expressed the view that they would have liked to have used the respective games for longer within the contexts of courses. This implies that the whole planning of TE courses has to change in order to accommodate this fun type of electronic learning.

Practical and Technical Considerations

As already mentioned, in order for educational online games to be really engaging for students, they have to be comparable to commercial games in terms of graphics and audio quality, friendliness of the user interface, and storyline sophistication. Furthermore, they should encompass motivational and pedagogically sound learning activities (Tüzün, 2007). However, as deduced from the reported experiences of the authors of the overviewed studies, the design and implementation of games with the aforementioned specifications is a very expensive, time-consuming, resource-demanding, and challenging task (Connolly et al., 2006; Roubidoux et al., 2002; Tüzün, 2007), whereas TE institutions usually suffer limitations of both time and budget (Eikaas et al., 2006; Natvig & Line, 2004). One possible solution could be the adoption of simpler technical solutions, such as 2D graphics (Eikaas et al., 2006; Natvig & Line, 2004), which, however, may have a negative effect on student motivation. Alternatively, TE institutions should seek models of extra funding to support the creation of educational online games (Tüzün, 2007). Finally, the successful use of online games for educational purposes presupposes that students have convenient access to adequately powerful computers and to fast and reliable Internet connections so that potential technical problems regarding the computing and networking infrastructure do not interfere with students’ learning experiences (Tüzün, 2007). Those exigencies are depicted in Figure 2.
Figure 2. Practical and technical requirements of educational online games.
CONCLUSIONS AND FUTURE RESEARCH PERSPECTIVES

This article was aimed at synthesizing recent research evidence on the exploitation of collaborative online games specifically designed for learning purposes in TE, at identifying the elements that those games should include in order to support pedagogically sound constructivist and collaborative learning experiences, and at evaluating the impact of educational online games on students and faculty as well as on the traditional curricular structures of TE institutions.

The afore-presented synthesis of empirical research suggests that educational online games should be geared toward the needs of TE courses providing relevant tools (e.g., scaffolding tools, individual and group assessment tools) and features (e.g., scalability, compliance with the time constraints of semester-long courses) at the same time combining popular game elements (e.g., challenging difficulty levels, compelling multimedia) with immersive narratives and appropriate pedagogical scripts. Those scripts should encourage and structure student activity and, most importantly, student collaboration around engaging, authentic, and goal-oriented tasks. Educational online games having those design features can offer students fruitful constructivist and collaborative learning experiences grounded in real-world practices that are encountered in the students’ respective academic disciplines.

The outcomes of the overviewed studies corroborate the strong motivational impact that educational online games have on students and reveal that students value online game-based learning and prefer it to learning through conventional teaching media. However, although students themselves report satisfaction with game-based learning, which they view as being effective, more research on the real learning effectiveness of educational online games is needed given that there is very limited empirical evidence, based on longitudinal research designs and objective measures of student achievement, to support the positive impact of such games on student learning. In particular, the potential learning gains and the potential challenges of student collaboration within educational online game environments should be further investigated given that the relevant empirical findings are still limited and equivocal. Such further investigation would provide useful insight into the collaborative processes and configurations that may enhance student learning within an online game environment.

Regarding instructors, the overviewed studies suggest that educational online games are positively viewed by faculty as an interesting mode of electronic learning, which offers instructors interesting pedagogical opportunities at the same time challenging their traditional role in the classroom as well as their work habits and teaching models. However, the exact impact of online
game-based learning on instructors as well as the ways in which instructors could better support students engaged in online game-based learning both warrant more in-depth investigation, given that there is still a dearth of empirical evidence regarding those issues.

Finally, as deduced from the overviewed studies, educational online games introduce a new fun learning culture in TE and are particularly promising regarding the support of innovative, social constructivist learning modes, which challenge traditional educational models. However, the successful incorporation of those games into TE calls for a rescheduling of courses and a continuous maintenance of a balance between playing and learning. Furthermore, for educational online games to become integral parts of TE courses, apart from important practical issues that have to be addressed (e.g., development costs of the software needed, time limitations of existent curricula), close collaboration among educational online game designers and developers, faculty, and students is needed so that really engaging and pedagogically sound games that fully cover the needs of their intended target groups be designed and developed.

This study attempted to increase understanding of what, how, and why online games can be effective learning tools. The first question to be answered is what kind of educational online games need to be designed and developed for TE today with a view to optimizing learning outcomes. As deduced from the study, TE institutions need games where the virtual world, combined with the overall game narrative and fantasy, implicitly embed concepts and problem situations of the various disciplines under study, and offer students ample opportunities to construct and apply knowledge as well as to acquire and rehearse skills through, on the one hand, individual active exploration within the virtual environment, and on the other hand, social interactions and collaborative activity through appropriate multiplayer capabilities. Those social interactions, which are essential in the process of meaning negotiation and knowledge construction (Vygotsky, 1978), can take place both within the virtual game world during actual gameplay, and outside it as students discuss the game with their instructor and peers during the semester. It is also crucial that educational online games have the “look and feel” of the online games that students play outside academia, and that they maintain gaming in the foreground—while meeting educational goals in the background—so that student intrinsic motivation, which can enhance and expedite learning (Lepper & Cordova, 1992; Malone & Lepper, 1987), is maintained. The second question is how online games can be effective learning tools. An educational online game is not an effective learning medium on its own. Its successful incorporation as a profitable learning tool in TE depends on certain factors, which have been documented in the study. The most important guidelines that should be taken into account are as follows:
a) the game should match the learning objectives, subject matter, and assessment requirements of the course into which it is being introduced;
b) the game should not supplant the course into which it is being introduced, but should be seamlessly blended into the course, with game activities complementing and informing other, regular educational course activities, and vice-versa; and
c) the game should not be used occasionally within the course, but should be exploited with regularity and for a suitable period of time, so that students are allowed to get acquainted with and to explore, experiment, and develop strategies within the game environment.

The third and last question to be addressed is why online games can be effective learning tools. As suggested by the overviewed studies, the intriguing, immersive, competitive, and fun nature of educational online games can be very successful in sparking players’ intrinsic motivation, which, in turn, can increase engagement in and effectiveness of learning (Lepper & Cordova, 1992; Malone & Lepper, 1987). Furthermore, educational online games can offer players ample opportunities for active engagement and experimentation with the subject matter, for control and self-pacing of the learning progress, and for visualization of concepts through multimedia as well as high levels of interactivity both with digital educational content and with other humans, namely a variety of capabilities that all address essential individual and social dimensions of learning (Prensky, 2001).

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