

Section 2

Chapter 7 - Videogames as educational tools

Theoretical Framework

7.1 The NTeQ model

The use of COTS videogames in education has several characteristics in common with the integration of technology into the educational process in general and into the class in particular. That is why the NTeQ model (Lowther & Morrison, 1998), which provides guidelines on how to integrate software and technology into the classroom, is considered as the most appropriate.

NTeQ stands for "iNtegrating Technology for inQuiry", and includes the following elements:

- 1. Specify Objectives:** What learning objectives will your students achieve from completing this lesson?
- 2. Computer Functions:** Match objectives to computer functions/activities.
- 3. Specifying a Problem:** What problem will your students be solving?
- 4. Data Manipulation:** How will data be used? Briefly describe each manipulation activity.
- 5. Results Presentation:** How will students present their results?
- 6. Activities During Computer Use:** What will they do while at the computer?
- 7. Activities Before Computer Use:** Prepare for computer use (e.g., brainstorming).
- 8. Activities After the Computer Use:** Reflection on learning.
- 9. Supporting Activities:** May include review of prior learning, required research and reading, and enrichment activities.
- 10. Assessment:** Rubric to describe performance standards.



Van Eck (2008) has adapted the basic elements of NTeQ to the use of COTS videogames in the classroom. It is a model that has already been implemented and proved effective (Becker & Gopin, 2016). Specific videogames that were included in the educational process followed the NTeQ model. For example, *American Farmer* was used for teaching agriculture economics, *Contraption* for teaching Physics and *SimCity* for teaching Geography and Civil Engineering (Van Eck, 2008).

After applying the NTeQ model to integrate COTS videogames in classroom, Van Eck (2008) identified some key considerations:

- the very time-consuming procedure of finding and evaluating COTS videogames,
- getting familiar with the selected videogame. In general, teachers should have adequate knowledge and experience of videogames, as well as good knowledge of the particular game they intend to use in class,
- designing the lesson as well as its evaluation. Often, the majority of the time spent with a lesson that uses a COTS videogame is actually spent around the game rather than in it.

In general, the guidelines of NTeQ model can address weaknesses and limitations related to a real-world classroom, such as time limitation, lack of technological infrastructure and the curriculum. In order to apply the NTeQ model (Morrison & Lowther, 2005), teachers should have appropriate technological skills and be able to combine the roles of the designer, manager and facilitator. Teachers can be informed about this model through several existing examples of its application in the classroom, which include the use of COTS videogames. Templates and heuristics are also available for exploitation.

Students' interaction with the videogame is expected to create different approaches towards its integration into the class. Therefore, teachers, without violating the fantasy of the game, must take into account students' feedback. Students' feedback will not only impact their role as educators but also their role as lesson designers. As lesson designers, teachers have to apply design modifications on the fly.

A second important issue regarding the implementation of the model, is related to the students who should hold an active role. In order for this to happen, students should take on the role of a

researcher and thus search for information, formulate and test hypotheses. This process should be initiated in the game world and be transferred to the classroom.

Another issue arising from the application of the NTeQ principles is that the computer is not used for computer's sake but rather as a tool that improves learning through problem solving. Roles and technological tools should be considered - even when this is not the case - as part of the game rather than the real world.

The principles of NTeQ model concern student-centered learning based on problem-solving within original contexts that incorporate the use of technology. Authenticity is determined not through the context of the real world but through the context of the game. Therefore, any additional activities aimed to fill the gaps of the game should also be game-like and based on problem solving. Although the characters and the environment in the games can be imaginary, the skills that can be developed are similar to those encountered in the real world. For example, in the *World of Warcraft*, imaginary creatures, such as elves and dwarfs, give lessons for diversity acceptance, communication, negotiation and resolution of problems.

The last component of the NTeQ model refers to the multimodality of media (video, image, sound, text) that can enrich the environment of a videogame. Additionally, enrichment of the game environment is extended through the immediacy of the characters' dialogues and the distribution of the information. This distribution requires players to gather resources and information from multiple sources and locations in the game environment. Therefore the key in this component is the manner in which these resources are encountered and the role that they play in solving a problem.

7.2 Exploitation of videogames in educational procedure: Issues and possible solutions

According Van Eck (2008), in case a teacher wants to integrate an entertainment videogame into their class, they have to address some issues that may improve the expected learning outcomes. These issues are described in this Section.

7.2.1 Students



The first issue that needs to be taken into account has to do with students, who should not always be considered as "digital natives". Even if they are "digital natives", it is uncertain whether they can play digital games. Therefore, the first practical step of the teacher is to use a questionnaire in order to find out which of the students play games and what kind, how often they play, which games they would like to play and include in the class. Students' feedback should be used by the teacher both as a tool for the selection of the videogames and as criterion to put students into groups and create the accompanying educational activities.

7.2.2 Teachers

Teachers must be prepared to organize both technically and pedagogically the environment in which the game will be utilized, whether it is the school lab, the classroom or the computer at the students' home (in case the videogame will be played after class). So, teachers need to be familiar with the hardware and software that is going to be used, but also with the curriculum and the expected learning objectives.

Most importantly, teachers must ask themselves if the amount of time and work needed justify the learning potential of using a COTS videogame in teaching.

7.2.3 Searching for suitable videogames

The next action is to search for suitable videogames through online e-shops or game stores, or the V4T online database¹ with videogames and apps which provides detailed information on various videogames and apps as well as evaluation on their educational potential and possibilities of use in classroom.

However, a good source of information regarding games could be the students themselves who play games and who can provide teacher with very useful relevant information in short time. Then the teacher has to link the game to the curriculum as mentioned in the Sub-section 7.3.7. This process is difficult because COTS videogames do not provide information on possible courses they could be used in (Van Eck, 2008). The *Zoo Tycoon* is an example of a game that could be used in

¹ <https://v4t.pixel-online.org/videogames.php>

biology, zoology or environmental studies, but it could equally be used in economics, mathematics, business and marketing.

During this stage, it is equally important for teachers to check issues regarding privacy, game content and internet safety. Teachers that prefer to use mobile and web games for learning should consider that, unlike console games, mobile and web games are not rated by the Entertainment Software Rating Board (ESRB)². Without age and content ratings to consult, there is little guidance about potentially inappropriate game content.

Even within a single game, server settings and players' behaviour may determine whether the experience is safe and age-appropriate. For example, *Minecraft* public servers can be restricted to a “white list” of approved players. Server extensions can be installed to prevent offensive language. Chat functionality can be allowed or turned off or set to public only, to prevent private communication between individual players. Players can be permanently banned for griefing, bullying and other rulebreaking (Solomon, 2016).

Luckily, there are review web sites that could help teachers decide which games are most suitable and safe for children. These sites, such as Common Sense Media³ rate games based on appropriateness of the content for different ages as well as the quality of the content taught in the game.

7.2.4 Game evaluation

First step in this process is to study reviews and ratings for the game in specialized web sites. The V4T online games database¹ is a good place for a teacher to start because it contains videogames and apps, evaluated by experts and commented by educators, that can be exploited in classroom teaching. It is also important to consider reviews by users who have been engaged in a game for long time.

As part of the game evaluation, it is advisable to also consider issues related to the required software updates as well as problems arising from shifting students to different work stations in the laboratory. A common problem that occurs in this case is when students shift to another work

² <https://www.esrb.org>

³ www.common Sense Media.org

station and thus cannot find the files they had previously stored in a different computer. If the game allows storing useful information under a username, then there is reduced likelihood of losing assets related to the previous gameplay. Also, it should be considered that cloud-based games minimize (or eliminate) requirements that have to do with school hardware and software updates.

Other issues that have to be taken into account when evaluating a COTS videogame for use in the classroom are the existence of in-game violence, any kind of discrimination, violation of personal data security and privacy.

Another issue that might need consideration is the language of the game. Usually, COTS videogames support English and might not support other languages, so this could pose difficulties to students that are not familiar with English. Of course, this is not a problem if the game is going to be used in English learning classes.

While research on the use of games in the classroom including both COTS and educational games, is growing, the research on selection methodologies is still in its infancy. Gopin (2014) has proposed a framework for evaluating the educational potential of COTS videogames. This framework evaluates games regarding the following three different perspectives:

1. Define the **learning goals** of the game,
2. Analyze the **motivational strategies**,
3. Analyze the **learning strategies**.

Related to these perspectives, the framework proposes a series of questions to be asked, as for example:

- 1. Define the learning goals of the game:** What new **skills** and/or **knowledge** should players have when they complete the game?
- 2. Analyze the motivational strategies:** Is the core mechanic satisfying? Does the game provide interesting, meaningful choices to the player? Does the game provide clear goals? Are players rewarded when they do something right? Is there feedback when players make a mistake? Does the game fantasy reinforce the learning goals?



3. Analyze the learning strategies: Does the game reflect how newfound skills and knowledge can be used in real life? Does the game require players to master lower level skills before progressing to harder challenges? Does the game promote critical thinking/problem solving? Is the core mechanic inherently connected to the learning content, or can the player succeed at the game without learning anything new? Does the game provide help “on demand” and “just in time?”

These questions give teachers a better understanding of how a specific COTS videogame can be used as a learning tool. The underlying principle of this framework is whether a specific game can or cannot support a specific learning experience.

It is important to note that none COTS videogame can be considered as either “good” or “bad” for learning. It really depends on what a teacher wants to teach with the game (Becker & Gopin, 2016).

7.2.5 School infrastructure

Once teachers have selected the appropriate COTS game, they have to check if the hardware and software of the class or laboratory where the course will take place fulfils the requirements of the particular game. Many COTS games assume up to date equipment that schools often do not have (Becker & Gopin, 2016). Security and safety of the laboratory must be considered, too.

7.2.6 School community

School administrators may prove an obstacle to the educational exploitation of COTS games, if they are not convinced that videogames could add to the educational procedure (Becker & Gopin, 2016). Additionally, teachers may have to deal with parents' skepticism about this kind of videogames use. Regarding this issue, it is advisable to inform students' parents from the beginning about the reasons that a videogame has been selected as a learning tool and its expected impact on the learning procedure.

7.2.7 Lesson design

The evaluation and selection of a videogame is followed by the design of the lesson in which the game will be integrated. Since COTS videogames are not designed to be included in a course

curriculum, teachers should examine the range and the detail in which the game addresses a specific topic.

Any inaccuracies or imbalances between the content of the lesson and the videogame may cause a cognitive conflict. Therefore, teachers have to identify if a game has inaccurate content or if additional content is needed in conjunction with what the game already offers. To this aim teachers can design activities that will fill the gaps or handle the misconceptions of the game. These activities (before, during or after gameplay) should extend the game and not have the form of lecture. Any additional guidance on the game or learning material should be relevant to the game spirit rather than resemble ordinary educational material (Van Eck, 2008).

It is important to offer students the initiative to contribute to the design of activities that are 'situated' within the game world and are logical extension of the game. For example, instead of providing additional educational readings for missing or accurate information, it is preferable to motivate students to assess the veracity of game information, find and provide missing data. In this way they are not getting out of the game world and the engagement, or else "flow", that is so important in these cases, is not being disturbed (Van Eck, 2006).

During the phase of lesson design, it is also crucial - given that it is technically feasible - for the teacher to decide the points of the game where it can be paused and restarted. This helps all students to complete the phases of the game during the lesson in a smooth rate without deviations. However, many games are not suitable for use in a period-oriented format and, in order to be effective, need more time than is traditionally available (Van Eck, 2012). Some COTS videogames can be broken up into shorter playing sessions, but many cannot.

7.2.8 Curriculum

Teachers have to decide at what stage of the learning process the videogame will be integrated. This decision should be taken in the light of the specific course curriculum and its learning outcomes. For instance, a videogame can be utilized before the lesson, in order to help teachers organize the learning content, or during the lesson, using it for practice on relevant examples. Otherwise it can be utilized after completing a lesson module either as assessment tool or in order to put together the lesson concepts and content.



The alignment to the course curriculum can contribute to the partial use of the game in individual sections of the curriculum. However, this can be accomplished only if students are able to continue from the last point they stopped the game and don't have to start from the beginning each time. Therefore, if the game evaluation shows that the videogame is difficult to blend together with the curriculum then teachers should not use it.

7.2.9 Student assessment considerations

In formal educational settings, usually students' assessment is accomplished by presenting the learning objectives at the beginning of the lesson and then using a pre-test and post-test to assess learning. However, when using a game in the learning procedure, students' expectations are different; they mainly expect to play and not to learn. So, their assessment needs to be established within the game (Van Eck, 2008).

Objectives should be presented as part of the materials that accompany the game, through the game characters that communicate with the player, cinematic episodes between levels, or non-verbal actions within the game that make students realize how they need to act (Van Eck, 2008).

Therefore, as objectives are communicated indirectly, assessment of achievement of learning goals should be indirect and occur continuously throughout the game, rather at the end. Assessment should reflect the element of imagination and the problem-based nature of game-based learning. In addition, students have the opportunity to constantly practice their knowledge within a game, since they are always being asked to do something and feedback is given to them to reflect. Hence, assessment in the game and practice often look the same and occur in close proximity to one another, being differentiated only by the presence of feedback and opportunities to reflect on that feedback (Van Eck, 2008).

Other types of assessment methods that can also be considered are the observation by the teacher, essays where learners are asked to reflect on their experience, out-of-game problem tasks very similar to game tasks, etc.

7.2.10 Class management



Regardless of how other learning activities are structured in classroom, COTS game-based learning could be more effective if students work in groups rather than individually. Students' collaboration makes them more responsible on their learning and can facilitate problems solutions.

However, splitting students into groups, requires more effort from the teacher at the beginning, who has to provide instructions to the students and also must have designed the lesson for groups following a project-based approach. To this aim, teachers should design projects that are authentic to the problem and the game space, whereas students should undertake the roles and characters who would be involved in those projects in the game and real world (Van Eck, 2008).

7.2.11 Evaluation of the impact on students

In the final stage, the whole lesson should be evaluated. The evaluation should not be limited to the learning outcomes related only to the content of the lesson, but also to higher-order learning outcomes such as problem solving, fluency in the course content, retention over time and not just immediate recall, as well as the speed of access to relevant knowledge (Van Eck, 2008).

Given the specific nature of the assessment in a game environment -as mentioned earlier- teachers could record and measure students' attitudes towards the content of the game, interest in a course-related job, transferability of knowledge to other fields and situations, differences by different demographic categories (Van Eck, 2008).

7.3 Advantages, strengths, challenges and restrictions in using videogames in formal educational contexts

The project "*Teaching with Games*"⁴ was a one-year survey supported by FutureLab, Electronic Arts, Microsoft and Take-Two, as well as the Interactive Software Federation of Europe (ISFE). The aim was to collect the views and attitudes of teachers and students towards using COTS videogames in schools. It aimed to identify the factors that would impact the use of these entertainment games in school and describe the processes by which teachers plan and implement game-based learning in existing curricular contexts (Sandford, Ulicsak, Facer, & Rudd, 2006).

The survey was carried out in England and Wales and consisted of two stages:

⁴ <https://www.nfer.ac.uk/teaching-with-games-using-commercial-off-the-shelf-computer-games-in-formal-education>

1. two surveys of representative samples of students and teachers aimed at revealing a broad overview of attitudes towards using COTS videogames for learning,
2. case studies of 12 teachers in four secondary schools (supported by Futurelab researchers) who prepared and implemented schemes of work in diverse subject areas using three COTS videogames (*The Sims 2*, *Knights of Honor* and *RollerCoaster Tycoon 3*) within formal classroom time.

The **key findings** from the survey are:

- The majority of teachers and students think that games would motivate students to engage with learning.
- The teachers and students in the case studies reported that using games in lessons was motivating. However, motivation is more likely to arise when students are using games that are familiar with, and when students have some degree of autonomy in playing the game.
- There are many technical obstacles to overcome when using the games in school. Technical support staff play a significant role in supporting teachers to overcome these difficulties.
- Teachers' concerns over curriculum and assessment were more influential in selecting the age of students to use games in lessons.
- Many teachers found the fixed length of lessons to be constraining in both the planning and implementation of game-based learning in schools.
- Students were expected to be more competent using the game in class than they actually were seen to be, which has an impact on teachers' lesson plans.
- Although teachers need a certain level of familiarity with a game to be able to use it in their lesson, achieving particular educational objectives through the use of the game is more dependent upon a teacher's knowledge of the course curriculum.
- The particular context in which a teacher worked – their experience, their teaching style, their familiarity with the curriculum and the wider culture of the institution – appears to have more impact on the successful integration of a game into classroom teaching.
- Using games in a meaningful way within lessons depended far more on the effective use of existing teaching skills. Teachers are required to take a central role in scaffolding and supporting students' learning through games.

- A game can be beneficial to teachers, if only it is accurate to a certain degree: there may be wider inaccuracies within the game context, but these do not necessarily exclude the game from being used meaningfully in a lesson.

Another relevant survey, involving teachers, college professors and technicians in the US and Canada, is presented here (Ritzhaupt, AD, & Gunter, E., 2010). The survey involved 137 people who were interviewed about 19 videogames (*Big Brain Academy, Brain Age, Civilization III, Dimension, Endless Grand, Theft Auto, Guitar Hero, Half-Life, Oregon Trail, Railroad Tycoon, Rise of Nations, SimCity, Super Mario Galaxy, The Sims, The Legend of Zelda, Trauma Center: Under the Knife, Wii Sports, World of Warcraft, Zoo Tycoon*). The research questions had to do with:

1. the characteristics that COTS videogames should have in order to attract teachers' interest in using them,
2. the advantages of integrating COTS videogames into a standard class, and
3. the limits that are likely to emerge when COTS videogames are included in a standard class.

The survey revealed the following **restrictions**:

- the use of a COTS videogame is not aligned with the academic standards and therefore the teacher might receive negative evaluation by their superiors.
- the existence of a prejudice against using COTS videogames in education.
- the lack of recognition of the educational value of COTS videogames.
- the lack of time to integrate videogames into the curriculum.
- the non-alignment with the curriculum.
- the lack of financial resources.
- the weak teachers' background in technology and in the use of videogames.

According to the survey, the potential **advantages** of using COTS videogames in education are the following:

- the enhancement of cognitive skills,
- the ability to solve complex problems,
- the acceptance of mistakes and learning through them,
- the ability to learn by doing.

This survey revealed some **qualitative features** such as increased communication between students and teachers, but also among students, the involvement of students in game design, their collaboration and teamwork.

