Co-located collaborative learning video game with single display groupware

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(Received 13 June 2008; final version received 15 September 2008)

Role Game is a co-located CSCL video game played by three students sitting at one machine sharing a single screen, each with their own input device. Inspired by video console games, Role Game enables students to learn by doing, acquiring social abilities and mastering subject matter in a context of co-located collaboration. After describing the system’s ludic and gaming structure, we present an experiment conducted in a kindergarten situation, whose results are subjected to a usability analysis. We conclude that a console video game for learning applications such as Role Game can easily be operated by 6-year-old students who are yet to learn to read or operate a computer. Console multiplayer games designed for learning are shown to be a powerful device for collaborative work in the classroom while maintaining its attractiveness to the gamer. They are consistent with the need to align learning software with the school curriculum, creating a socio-technical environment that can support meta-design and social creativity in an educational setting. Our findings thus confirm McFarlane’s view that they “provide a forum in which learning arises as a result of tasks stimulated by the content of the games, knowledge is developed through the content of the game and skills are developed as a result of playing the game”.

Keywords: collaboration; video games; multiple mice; CSCL

1. Introduction

Game playing in its diverse forms constitutes an important part of children’s cognitive and social development, and more specifically, of their learning experience (Csikszentmihalyi, 1990). A child learns through playing with others, creating and improving his or her zone of proximal development, because such play tends to involve more complex activities than those the child experiences in daily life (Vigotsky, 1976).

An engaged gamer wants to keep playing and is willing to concentrate on the game tasks. Because engagement, and possibly obsession, is a necessary part of the learning process, an engaged player in a school context will be better able to concentrate on learning tasks (Bransford, Brown, & Cocking, 1999). Thus, learning, knowledge and skills are developed as a result of playing the game (McFarlane, Sparrowhawk, & Heald, 2002).

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There is research, however, which shows that instructional games do not always lead to the desired motivational properties and instructional gains (Hays, 2005). Even users' preferences, needs and expectations are essential considerations in video-game design (Fabricatore, Nussbaum, & Rosas, 2002) and, authenticity, collaboration and learning by doing are key characteristics of effective educational games (Kiili, 2007). Motivational learning should not be muddled with extrinsic reasons of gaming, such as attractive avatars, excitement of the game or the competition involved (Hamalainen, 2008). There has to be an alignment with the school curriculum and the environmental conditions that favours learning (Gros, 2000). The challenge is thus to achieve a mix of recreation and learning in a single entity (De Aguilera & Méndiz, 2003). Essential is also the role of the teacher which changes from delivering subject-based curriculum to students with a low degree of autonomy, to a facilitator encouraging exploratory work that allows pupils a degree of autonomy, intervening at the right moment so the students' creative flow is not lost (Robertson, 2008).

The question is no longer if games help learning, but what kind of learning and how (BECTA, 2007). We can summarise it with (Amory, 2007) words: “Educational computer games should be relevant, explorative, emotive, engaging and include complex challenges; support authentic learning activities that are designed as narrative social spaces where learners are transformed through exploration of multiple representation, and reflection; be gender-inclusive, include non-confrontational outcomes and provide appropriate role models; develop democracy, and social capital through dialogue that is supported by means of computer mediated-communication tools; and include challenges, puzzles or quests, which form the core of the learning process, where access to explicit knowledge, conversations and reflection results in the construction of tacit knowledge”.

Social interactions are important for sharing ideas and constructing and shaping understanding, and are fundamental to educational development (Cole & Stanton, 2003). When individuals work together on a common problem they communicate and mobilise knowledge, energy and motivation (Zurita & Nussbaum, 2004). In addition, creative activity grows out of the relationship between individuals and their work as well as their interactions with others (Fischer, 2005). Collaborative learning (CL) environments have proven to confer many benefits in achieving learning objectives, social results, positive interdependence and motivation, with students acquiring new skills, ideas and knowledge through working together (Zurita, Nussbaum, & Salinas, 2005).

Nevertheless, collaboration does not appear by itself when a group of people work on the same virtual environment. Some scaffolding is required to improve the interactions and learning results possible with Computer Supported Collaborative Learning (CSCL) (Nussbaum et al., 2008). However, there is a risk of over-structuring learners' interactions so that their “natural” interactions and problem-solving processes may be disturbed, interactions may become too didactical or distracted from the actual goal, and the scaffolding cognitive load for the learners may be hard to cope with (Dillenbourg & Jerman, 2007).

CSCL programs can be operated either at a distance or face to face in a co-located or co-present setting such as a classroom. Co-located collaboration “allow students to interact directly, see each other’s expressions and gestures, therefore communicate more effectively” (Bricker, Tanimoto, Rothenberg, Hutama, & Wong, 1995). It also facilitates interactivity and simulation (building virtual words). Co-located CSCL can be implemented through a wireless network of handheld devices
(Zurita & Nussbaum, 2004) or single-display groupware (SDG) (Tse & Greenberg, 2004). In the latter case, a small group of co-located users collaborate, sharing one computer with a single display and simultaneous use of multiple input devices (Stewart, Bederson, & Druin, 1998).

Today’s computers are designed on the assumption that a single person interacts with the display at any given moment, manipulating the mouse exclusively while the others present are passive onlookers with no operational control of the machine. With SDG, co-located users collaborate through a single computer with multipoint or multiple mouse technology (Pawar, Pal, & Toyama, 2006) each individual using their own mouse but sharing the communal display.

In video games, SDG has been employed from the beginning. Two or more users, each with their own joystick connected to a single console, share the same screen on which they interact. From a CSCL perspective, SDG provides an opportunity to improve support of existing forms of collaborative work, introducing computing capabilities through a ubiquitous channel. Multiple co-located persons, each with their own input device, can interact simultaneously on a single communal display, thereby multiplying the amount of interaction per student per PC for the cost of only a few extra mice (Pawar, Pal, Gupta, & Toyama, 2007). This is highly attractive for schools in developing countries where high student-computer ratios are a common problem.

Much research has been conducted on the advantages of SDG in school learning (Abnett, Stanton, Neale, & Ó'Malley, 2001; Bier & Freeman, 1991; Bricker et al., 1995; Inkpen, Booth, Gribble, & Klawe, 1995; Pawar et al., 2006, 2007; Stanton and Neale, 2003; Stanton, Neale, & Bayon, 2002; Stewart et al., 1998; Tse & Greenberg, 2004; Pawar et al., 2007; Scott, Mandryk, & Inkpen, 2003; Patra, Pal, Nedevschi, Plauche, and Pawar, 2007). “The necessity of sharing can promote communication amongst the students. Physically separating students to work individually on computers tends to discourage communication” (Bricker et al., 1995). “In some situations, learning is not necessarily best when one student works on a single computer. Rather, the environment of multiple students collaborating around a single computer provides unique interactions that can result in improvements both in achievement and in attitude towards the task. One way this can happen is through students having to verbalise their ideas in order to work together. This elaboration reinforces the learning process (Inkpen et al. 1995). With SDG, “children immediately understand the idea of multiple mice and cursors, are not confused by multiple cursors on screen, and with mice remain engaged throughout” (Pawar et al., 2006). There is some evidence that the use of multiple input devices improves motivation, effectiveness of task completion (through parallel or co-operative work), equity of activity and time on task (Stanton et al., 2002).

This study presents a SDG video game application called Role Game. Its purpose is to support elementary school students as they strive to master course content while also learning to work collaboratively in small groups. Because of the students’ young age, the process has not only to be educational but fun and simple as well. To achieve these objectives, a number of mathematics and language goals were defined within a collaborative ludic environment. The corresponding game activities were organised in such a way as to align with the scheduling of the course curricula set by the schools. To ensure the emphasis was on collaboration over competition, the following meta-goals for the game were also defined:

- All members of a given group have the same goal, which can only be reached by all of them simultaneously. No member can “win” by defeating their group peers.
No group member can achieve the objectives of the activity on his or her own. Reaching the game’s goals requires the participation of all members. Thus, the objectives can only be accomplished through collaborative work.

The collaborative game application was tested twice a week for an entire semester on the kindergarten class of an underfunded school in Chile’s poorest urban area. The participating students had not yet learnt how to read or use a computer. In the remainder of this study, Section II introduces Role Game, Section III presents a theoretical framework followed by a usability analysis and Section IV sets out our conclusions.

2. Role Game

2.1. Objectives

Role Game’s pedagogical objectives are to count, recognise and order objects. Such skills facilitate a wide range of specific basic mathematics and language learning goals. A complementary objective of the game is to develop social and communication abilities.

Because Role Game is implemented with SDG, players can play face to face, a work mode that promotes communication between the group members. The collaborative game activity is designed in such a way that the children must plan a strategy and then distribute the various tasks among themselves in order to reach the game objective (Figure 1).

2.2. Description

Role Game participants are divided into groups of three co-located players. With only two members in a group, the players tend to merely converse while with four or more, too many viewpoints emerge and convergence to a group consensus is difficult. In groups of three, however, a momentum develops in the conversation and the peers (i.e. fellow group

Figure 1. Co-located CSCL with SDG.
members) are obligated to arrive at an agreement. Peers must interact and play together in such a way as to overcome ludic barriers and achieve the academic objectives. Each player has their own mouse that moves an avatar with abilities differing from those of their peers’ avatars. These abilities allow them to support their peers in getting around obstacles. For example, the Hipno avatar can put monsters to sleep, the Alpi avatar can climb and help the others climb hills and rocks, and the Rafti avatar can cross and help the others cross rivers.

As with any video game, Role Game moves the players through increasingly more complex levels as they get better at playing it, posing even more difficult ludic obstacles. The game itself takes place in a space consisting of a map with zones defined by objects that illustrate flow, like a river, objects that block, as a rock and objects that are at different levels, like mountains; enemies, like monsters or animals; pedagogical objects that must be captured to attain the pedagogical objectives, like letters, signs and numbers; and elements called blockers that block and unblock the objects to be captured, like keys and flags. The avatars move within this map as they work collaboratively towards the objectives. Group achievement is measured in terms of energy (collaborative points) while pedagogical achievement is scored in terms of points. All of these game elements are listed and defined in Table 1.

The following example illustrates the various components of Role Game and how it is played.

Imagine that a game is underway and that the pedagogical objective of the current level is to capture the three letters forming the word “ICE” in the proper order, with an additional letter, “S”, as a distracter. The map for this level, shown in Figure 2, contains the four letters plus a key that acts as a blocker and is divided in two by a river. These and the remaining elements can be summarised as follows:

- Objects to be captured: the letters “I”, “C” and “E”, with “S” as a distracter.
- Avatars: the three avatars are located on the right bank of the river. Their abilities are defined such that Avatar 1 can capture the letters “I” and “S”, Avatar 2 can capture the letter “C” and Avatar 3 can capture the letter “E”.
- Abilities: Avatar 3 has the ability to cross blue zones and Avatar 1 the ability to put enemies – in this case, the dog – to sleep.
- Blocker: located on the left side of the river; blocks the four letters. It is represented as a red key.
- Obstacles:
  - Blue zone: a river in the middle of the map running north to south.
  - Brown zones: two elevated zones, one in the top right corner and the other in the bottom right corner.
  - Green zone: the rest of the map.
  - Enemy: a dog patrolling the letter “C”.

Each player can only control their own avatar using their own mouse. The only way the players can move their avatars is to click on the desired location. The many possible interactions in the game are set forth in Table 2. Each one is described in terms of a result that depends on certain preconditions and is realised through a specific action.

The design of the game levels must be such that the players are forced to collaborate in order to overcome barriers and evade dangers and thereby achieve the pedagogical objective. It must also promote the development by the players of a collaborative strategy.
Table 1. Elements of role game.

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>Each level has a specific pedagogical objective, which is to capture pedagogical objects in a specified manner.</td>
</tr>
<tr>
<td>Map</td>
<td>Set of zones with different rules determining how the avatars move through them.</td>
</tr>
<tr>
<td>Zones</td>
<td>Zones define the obstacles on the map: rivers, mountains, rocks.</td>
</tr>
<tr>
<td>Enemies</td>
<td>Enemies are characters that walk across the map in a specific way. An avatar that touches an enemy dies.</td>
</tr>
<tr>
<td>Avatar abilities</td>
<td>There are three avatars in the game, each with a specific ability different from those of the other two. These abilities can be constructed in such a way that the three avatars must work together according to a specific plan in order to reach the defined objective.</td>
</tr>
<tr>
<td>Pedagogical objects</td>
<td>Entities represented by images that can be captured by the avatars.</td>
</tr>
<tr>
<td>Blockers</td>
<td>Pedagogical objects can be blocked or unblocked. Only when unblocked can they be captured. An object is unblocked when an avatar is placed over its corresponding blocker.</td>
</tr>
</tbody>
</table>

There are three kinds of objectives and activities:
- **Sequence**: objective is to capture objects in a specific sequence; e.g. capture letters of a word in the correct order.
- **Count Objects**: objective is to capture a specific number of objects in any order; e.g. capture five apples.
- **Recognition**: objective is to capture specific objects; e.g. capture the circles in a universe with different geometric shapes.

There are five types of zones:
- **Green**: Neutral ground; avatars can walk through it safely.
- **Blue**: Avatars entering this zone die unless they have the specific ability to pass through it.
- **Brown**: Avatars cannot enter this zone from another zone. An avatar that is in the brown zone can move freely within it, but cannot leave it without the specific ability to do so.
- **Black**: Avatars cannot enter this zone.
- **Red**: All avatars entering this zone die.

Any animated character: dragon, dog, etc. The three specific avatar abilities are:
- Putting an enemy to sleep by touching it, thus eliminating a threat to the other avatars.
- Walking through blue zones and helping the other avatars without this ability move across them as well.
- Entering and leaving brown zones and supporting the avatars without this ability to enter or leave.

Letters
Signs
Numbers

Keys
Flags
and prevent attempts by individual players to isolate themselves or play alone. Progress should only be possible through mutually supportive actions.

As an example, Figure 3 shows how the players plan and carry out a collaborative action to overcome the barrier posed by the river. Avatar 2, which does not have the ability to cross blue zones, is helped across with the support of Avatar 3, which does have that ability.

Another example is shown in Figure 4. There, the pedagogical objects are unblocked by Avatar 3, which is placed over the blocker. This allows Avatar 1 to capture the letter

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### Table 1. (Continued)

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Points</td>
<td>Determines ranking of groups’ success. Two types of points can be won: Collaborative: Awarded for group energy. Every avatar death or error made in capturing objects is considered an erroneous collaboration and decreases group energy. If the group loses all its energy it must start over. Pedagogical: One positive point is won for every pedagogical object captured.</td>
</tr>
</tbody>
</table>

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Figure 2. Screenshot of Role Game.

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2.3. Role Game activities editor

As well as a video game, Role Game also provides a system development environment for building collaborative educational video game activities. This is done via a high-level Editor that is easy to use and affords considerable flexibility. Activities can be created and educational content adapted without having to actually program the different levels or ensure compatibility with Role Game’s files.

A screen shot of the Editor is shown in Figure 5. After specifying the game activity level in a drop-down box, the various elements of the activity are then defined using a
series of seven tabs for the different element types and configuration functions: Initial State, Objects to Capture, Blocking Objects, Actors, Objective, Enemies and Advance Configuration. Working the tabs from left to right, the teacher constructs the various interactions that make up the activity. This ordering of the tabs reflects a logical sequence that ensures the definitions necessary for the options on any given tab have already been made on the previous ones. As an example, in Figure 6 the map image would have to be defined before an avatar or object could be located.

Once all of the activity elements have thus been defined, the level is complete. A level can be modified later by the Editor where required. This capability means that a repository of levels can be created, any one of which can then be reused or adapted to new educational content by editing only those elements that need to be changed, thus simplifying the teacher’s task. As an example, a new level could be built merely by reusing a previously designed map and elements with a different defined objective.
3. Usability analysis

3.1. Research framework

As noted briefly in the Introduction, Role Game was applied twice a week over an entire semester (31 sessions of 45 minutes each) at an underfunded school in Chile’s poorest urban district to a sample of 36 kindergarten pupils, all aged six, who had yet to learn to read or use a computer. To ensure the activities prepared were aligned with the school curriculum, the teacher specified the various mathematics and reading activities for each game session.

A usability analysis was performed to assess the results of this experiment on the basis of three sets of observation guidelines. The first set measured the level of user satisfaction, covering both the motivational elements that make the game attractive to the users and the essential elements of the user’s expectations of video games following the framework proposed by Rouse (2001). This framework, which applies generally to all types of video games, consists of a set of elements describing why gamers play and what they expect from the games.

The second set of observation guidelines measured the system’s user efficiency, analysing effort required to master the software, hardware and the game strategies (Nielsen, 1994). With players of such a young age the ability to master the system is essential, as any significant complexities in its operation would render the activity unusable. Our purpose, therefore, was to understand which parts of the game were easily mastered by the children and which ones were not.

Finally, the third set of guidelines measured collaboration in the building of common strategies to accomplish the games’ objectives. They were based on the framework given in Zurita, Nussbaum and Sharples (2003), which defines coordination, communication, organisation, negotiation and interactivity as key elements of a collaborative process.

These findings were complemented by the observations in the teacher’s logbook and an interview with the teacher at the end of the experiment.
### 3.2. Analysis of user satisfaction

<table>
<thead>
<tr>
<th>Main elements motivating people to play video games (Rouse, 2001)</th>
<th>Experimental observation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Players want a challenge</strong></td>
<td>RG challenges players both in its ludic and its pedagogical objectives. Even though the experiment was embedded in an educational context, it was evident the students were very willing to meet the challenge of reaching the gaming and pedagogical objectives. Although the groups worked independently and no comparisons of their achievement levels were performed, some degree of competition was observed between them as they attempted to reach their objectives and finish earlier than the other groups.</td>
</tr>
<tr>
<td><strong>Players want a dynamic experience in which they can be in control inside an interactive environment</strong></td>
<td>RG allows players to interact with the game and with each other. They can make decisions about what to do and when to do it. The teacher observed that the children mastered the game elements (abilities, levels, points and enemies) and found them fun. It is important, however, that the activity difficulty level be well adapted to the groups’ success in achieving both the gaming and the pedagogical objectives.</td>
</tr>
<tr>
<td><strong>Players want bragging rights: the satisfaction of reaching objectives and being recognised by others.</strong></td>
<td>RG awards points when pedagogical objectives are achieved, and allows successful groups to move up to the next level. Students expressed satisfaction when they overcame obstacles, completed an activity level and won points.</td>
</tr>
<tr>
<td><strong>Players want an emotional experience</strong></td>
<td>RG encourages social relationships between players (Zurita &amp; Nussbaum, 2005) by obligating them to negotiate, build common strategies, collaborate and debate among themselves. All of the students were keen on participating in the activity, and enjoyed working closely with their peers. However, gender problems emerged between group members that required intervention by the teacher to resolve.</td>
</tr>
<tr>
<td><strong>Players expect a consistent world where they can interact and understand the actions they can perform and their effects.</strong></td>
<td>RG’s consistent world is made up of five zones that define the avatars’ range of movement and their actions. Both elements have clearly defined effects that the students easily understood.</td>
</tr>
<tr>
<td><strong>Players expect to understand the game worlds bounds.</strong></td>
<td>The students intuitively understood the game rules. However, they associated more power with one of the avatars than the others due to the avatars’ defined abilities, which created problems between group members that were difficult to resolve.</td>
</tr>
</tbody>
</table>
Players expect reasonable solutions to work so that every problem posed by the game can be solved. In RG there are many ways to achieve the game’s objectives depending on the players’ strategies and the agreements they make. In general, students came up with reasonable solutions. Crossing the river was difficult for many since it required coordination and synchronisation among members.

Players expect direction. Instructions regarding objectives and abilities are displayed at the beginning of each level. Information on the game outcome, group energy level and accomplishment of pedagogic objectives is provided continuously. Students continuously monitored the information on their outcomes, which helped them understand what they were doing and achieving.

Players expect to accomplish a task incrementally and be able to understand by means of rewards or checkpoints whether their actions are correct. Some levels turned out to be no more difficult or challenging than the preceding one. Game difficulty depends on the group members’ abilities to master their individual roles, and the complexity of successive pedagogic objectives did not always increase.

Players expect to be immersed. As can be seen in Figure 1, only one student is seated directly in front of the screen. Students seated on either side of the one in the centre were exposed to distractions such as talking with members of other groups.

Players expect some setbacks in order to make the game more fun and challenging. It is not fun if the game is too easy. Striking the right balance between ludic and pedagogical difficulty is a key element not easily achieved. We observed that if an objective was beyond the children’s ability, they lost their concentration.

Players expect a fair chance to solve problems and overcome obstacles. Certain activities required more training to overcome the obstacles they contained, such as crossing the river. Until they mastered these tasks the children expressed some frustration.

Players expect not to have to repeat themselves. The different game levels combine increasingly difficult gaming pedagogical goals. If a mistake is made, the player must return to the previous level. The children found this to be very frustrating.

Players expect not to get hopelessly stuck and have to start over, losing everything already gained. When this occurred more than once in the same level, the children tended to begin arguing and interfering with each other’s roles and play would often deteriorate into an improvised game of killing avatars.

Players expect to participate, not just to watch. They want to be active players in the game. Our observations confirmed that one of the main accomplishments of RG is that all players become protagonists in the game, each through the use of their own mouse.
3.3. Analysis of user efficiency

<table>
<thead>
<tr>
<th>Observed element</th>
<th>Experimental observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time spent understanding the game’s dynamics</td>
<td>According to the session logbook, students found it difficult at first to understand the game’s dynamic because they had no instructor to introduce them to it. However, after a few sessions all students understood the game intuitively.</td>
</tr>
<tr>
<td>Multiple mouse use</td>
<td>Most of the students were able to use the mouse and integrate themselves quickly into their group without problems.</td>
</tr>
<tr>
<td>Ability to move avatar</td>
<td>Although the students understood the system and were able to use the mouse, many of them did not grasp the logic of the avatar movements, clicking repeatedly in a pointless attempt to increase the avatar’s speed. Also, crossing the river was a difficult goal for many and was not always achieved.</td>
</tr>
<tr>
<td>Ability to develop strategies for reaching objectives</td>
<td>Since the groups were formed randomly and changed from session to session, the students had to learn to build strategies with a varying combination of peers. This was not always easy due to their age.</td>
</tr>
</tbody>
</table>

3.4. Analysis of the collaborative process

<table>
<thead>
<tr>
<th>Collaborative process elements (Zurita, Nussbaum, &amp; Sharples, 2003)</th>
<th>Experimental observation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination: The design of the activity should force participants to perform one task at a time and carry out each group action in a specific sequence.</td>
<td>The game incorporates barriers that have to be overcome in a specific order for the goal to be achieved. The students had difficulties coordinating their actions with their peers. But since the software gave them no choice, in the end they learned to coordinate and were thus able to proceed with the game.</td>
</tr>
<tr>
<td>Organisation: Each participant’s machine should provide all required information for the activity. No additional material should be necessary.</td>
<td>The design of the different levels was always clear and the players’ roles were immediately understood.</td>
</tr>
<tr>
<td>Negotiation: All participants have the same rights and must agree to proceed.</td>
<td>No advance is possible in RG until the group members come to an agreement. Negotiation occurs both in the ludic and the pedagogical aspects. At the beginning students attempted to act on their own, but once they saw their actions did not achieve their goals, they realised they had to negotiate them.</td>
</tr>
</tbody>
</table>
4. Discussion and conclusions

In the light of the usability analysis in Section III – and in particular, the observations in the tables summarising the analyses of user satisfaction, user efficiency and the collaborative process – a number of valuable lessons can be drawn regarding the design of didactic games for children.

(1) Games should include a certain degree of competition between participating groups.

It was clear that not only did the students see the internal group objectives as a challenge, both ludic and pedagogical, they also systematically attempted to finish before their peers in the other groups at each level of the game. As long as it does not affect collaboration, including some amount of competition between groups into the game design helps strengthen the students’ sense of challenge and facilitates the participation of those with a strongly competitive nature.

(2) Game designs should incorporate elements that ensure players will be able to overcome challenges and avoid becoming frustrated.

A significant problem that affected the students’ satisfaction, motivation and expectations was the level of gaming and pedagogical difficulty. To avoid a sense of frustration, the design of each lesson and game level must ensure the degree of difficulty is in line with the students’ abilities and knowledge. Frustration is the enemy of learning, but will occur if the goals are so difficult as to be beyond the players’ reach, or a mistake by a user results in a severe penalty or other negative consequence (such as erasing all previous progress), or the design of the game suffers from inconsistencies.

Given the above, it is essential that an introductory session on the activity be held by the teacher. Also, considerable thought should be given to the complexity of the avatars’ roles and the speed of their movements, which should be fine-tuned to optimise the gaming experience with the intended players’ age level firmly in mind. In this regard it should be recalled that children’s natural impulsiveness leads them to click the mouse constantly, and this will obviously cause problems if not taken into account in the game design.
It is also very important that games offer a range of difficulty levels, starting with activities that are relatively easy in order to build players’ confidence and mastery and give them a sense of success and enjoyment, but not so easy as to be trivial and boring. Also, each level should have enough different activities that players do not get anxious to move on to the next one before they are ready. For children, strategies are initially implicit and only become explicit through practice. Developing social and learning skills is not a trivial exercise, and can only be done through repeated use. The final objective, it must be remembered, is learning and collaboration, not necessarily the acquisition of complex technological aptitudes.

A final consideration on overcoming challenges and avoiding frustration is that the composition of player groups should be changed for each new game session. There are two main reasons for this. First, it was observed that with frequent changes a larger number of students benefit from the support of the stronger players than would be the case otherwise. And second, students who find the activities difficult are given the chance to start over each time and experience an atmosphere of collaboration with different classmates. This helps avoid stigmatisation of the weaker players, which tends to occur with established groups.

(3) Game structures should promote the development of social skills and incorporate the ability to detect the central aspects of collaboration learning.

The collaborative activities revealed behavioural problems and gender differences in attitudes toward collaboration and supporting other students.

The structure of the game was such that the students were forced to collaborate. None of them were ignored or left out; on the contrary, all group members were included in the activities and had a specific function to carry out. This led to behavioural and gender conflicts that in a design which does not force collaboration would likely have gone unnoticed. The teacher in our experiment registered the existence of these conflicts in her logbook, also commenting how she intervened to solve them and her discussions of them with the students. It was noted that when a group leader was female she tended to support her peers whereas a male leader would sometimes pressure and give orders to female or weaker peers. Also, given their young age, many of the male children displayed a high level of impulsiveness that clashed with the obligation to collaborate.

Given these findings, it is absolutely essential that gender conflicts and impulsiveness be taken into account in order to ensure an activity will lead to collaborative skill learning and social development. In particular, games must be designed in such a way as to prevent group members from ignoring their peers or trying to give them orders.

(4) Young children learn the rules of a game intuitively, and every element of the game has some impact on them.

Game designs must take this factor into account when considering such details as colours, images and object speeds, all of which may affect the learning process. Any element that unintentionally stands out, such as an avatar that is larger or more brightly coloured or faster, can have a negative impact in that the students will associate it with greater or lesser power or capabilities. This will tend to interfere
with the proper functioning of the game, hinder the collaborative process and compromise the sense of equality and fairness that should be paramount.

Similarly, with SDG implementations the physical distribution of the players in front of the monitor means that whoever is seated in the centre has a broader view of the screen. The children should therefore be rotated through the different positions so that those seated at the sides are not disadvantaged.

Finally, a key aspect of the SDG activity was that each child identified with their avatar through their individual mouse. This created a sense of ownership that facilitated a constant and active involvement.

(5) Children need constant feedback to maintain their motivation and reinforce their sense of mastery of the game and clarity regarding the progress of the activity.

Games must be designed to constantly provide positive feedback to the players, and particularly to celebrate collective achievements. The emotional experience and clarity regarding how to move forward and in what direction are fundamental elements in the learning process.

(6) Collaborative games must:

(1) Force coordination between peers, which is ensured by assigning each child a clear role in the game.

(2) Provide a negotiation space so that agreement between the children can be achieved. Agreement must be built through peer interaction.

Role Game proved to be a satisfying experience for the students who participated in the study, keeping them motivated throughout the experiment. The children enjoyed playing the collaborative game and found the objectives to be an interesting challenge. Furthermore, the activity fulfilled their expectations. They collaborated well in carrying out the tasks, and their random assignment to different groups resulted in successful working relationships.

The console multiplayer video game is a powerful instrument that can be used to advantage in the classroom. Though not designed as a learning tool, our experiment showed that for kindergarten students, these multiplayer games are both effective and attractive as pedagogical devices. Despite the fact these games are generally considered to produce a strictly competitive environment, we found that these attributes carried over well to collaborative activities, helping maintain students’ motivation even though they were required to collaborate with each other rather than compete.

Furthermore, console video games with a high-level application-building environment that teachers can use to specify educational activities offer the necessary flexibility to intermix gaming and pedagogical objectives and afford new ways to align learning software with school curricula. From this perspective, the games create a socio-technical environment that can support meta-design and social creativity in educational settings (Fischer, 2007). Our findings thus confirm the view of McFarlane et al. (2002) that games “provide a forum in which learning arises as a result of tasks stimulated by the content of the games, knowledge is developed through the content of the game and skills are developed as a result of playing the game”.

Finally, on the basis of what has been learned in this experiment, the authors are currently pursuing further lines of research into educational video games. Three of these
appear to be the most promising: quantitative studies of student learning, the use of Role Game with older students and applications of the game to the development of cognitive skills such as attention and memory.

Acknowledgements
This work was partially supported by Microsoft Research and Microsoft Partners in Learning.

References


