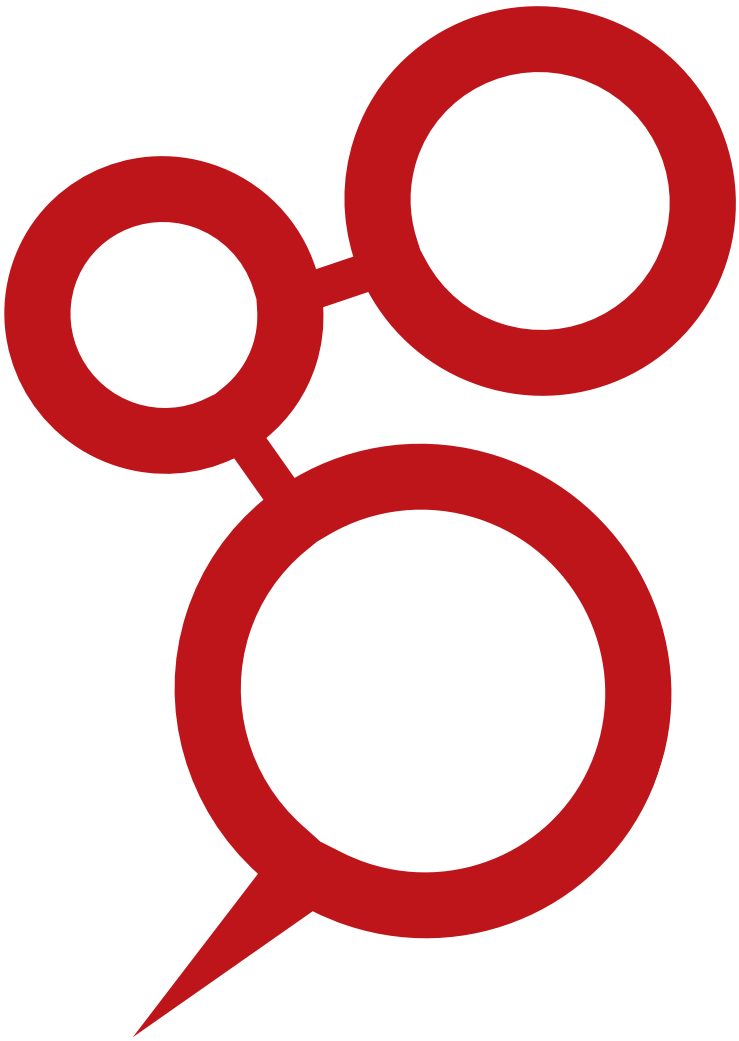

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Going to school in World of Warcraft.
Observations from a trial programme using off-the-shelf computer games as learning tools in secondary education

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The use of commercial, off-the-shelf computer games as teaching tools is an interesting possibility, but one that may alter the teacher's role. Unlike specially adapted, game-like educational software, students' attitudes toward the learning potential of computer games may be very different in the presence or absence of an accompanying teacher. The purpose of this work is to investigate whether commercial, unmodified computer games have potential as a tool for learning enhancement, whether varying properties of game genres have an impact on study results, and how the students perceive the teachers role in a learning environment using computer games. Twenty-one students, all of them participants in a longer-term trial programme in game-based education, were interviewed concerning their perceptions of the learning environment, their preferred game genres, and the outcome of their studies. Our findings show that this form of learning results in significantly increased knowledge. It also appears that accompanying teacher activities are important, especially when successfully linked to in-game activities.

INTRODUCTION

While e-Learning has rapidly risen in popularity, there is still a strong need for research on effective strategies and implementations.[1] A particularly interesting and active area of research concerns the use of computer games as educational tools. The specific advantages of computer games fit very well into key patterns of successful learning. Among others, Gee (2003a) points out that these features may be unrelated to the most obvious and readily appreciated qualities of the medium: "The secret of a videogame as a teaching machine isn't its immersive 3-D graphics, but its underlying architecture. Each level dances around the outer limits of the players abilities, seeking at every point to be hard enough to be just doable." Papert (1998, p. 88) similarly claims: "What is best about the best games is that they draw kids into some very hard learning… The fact is that kids prefer things that are hard, as long as they are also interesting."

It is thus tempting to assume that computer games designed specifically for the purpose would be superior educational tools. Hybrid educational/game software, often referred to as "edutainment", grew out of efforts to fill the game format with traditional, curriculum-oriented material. However, the usefulness of edutainment software has been questioned in many cases. As observed by Kirriemuir (2002): "… when game-oriented entertainment and learning or educational material are combined, the result has often been disappointing; the educational value is debatable or irrelevant, and the gaming and engagement qualities compare poorly to those of pure games…"

So edutainment might not be the best solution. It is therefore interesting to reflect upon the extent to which various commercial game genres can be considered effective tools for game-based learning as a consequence of their intrinsic concepts. It seems reasonable to assume that several openings already exist on a directly instrumental level. For example, in existing construction and strategy games the player can gain insights into subjects such as city planning, elevator algorithms, and the operation of amusement parks. Over the course of the game, the player trains on these tasks and grows skilled in manipulating the simulated systems.

Online games add an interesting dimension to play that increases their potential as learning tools. Player behaviour and progress in this setting can be monitored by game controllers with access to the game servers. If needed, the controllers can also adjust the player's situation—either by manipulating the environment in the game servers, or by adopting an avatar in the game world and communicating with the players directly. In the latter case, even long-term mentoring relationships are possible. Alternatively, teachers could appear in the game through their own accounts to conduct individual or group meetings with students.

There are various types of multiplayer games, including FPS (First Person Shooter) games, strategy games, and MMORPG (Massively Multiplayer Online Role-Playing Games).[2] The latter category has particularly interesting properties from a teaching/learning perspective. MMORPGs are capable of handling many thousands of simultaneous players, who interact with each other and the environment in very large worlds with complex economies and social structures. Game play goes on around the clock, carried out by whichever players are currently connected to the game servers; in effect, each server maintains a *persistent world* that the players can enter and leave at will. The possibility of chatting online with other players is a frequently used feature of these games.

In game genres that possess high natural potential as a learning tool, our hypothesis was that a noticeable learning effect should occur even in commercially sold games not developed for that purpose. To our knowledge, no such study on this scale has ever been conducted before.

Secondary school students in their 10th or 11th year participated in a trial programme using commercial, unmodified computer games as the main teaching tool. They were interviewed on their perceptions of the learning environment, which game genres they used most frequently, and the learning outcome of the project. The next section reviews some aspects of games and learning important to this study. Thereafter we present a description of the trial programme and summarise the students' evaluations. The paper concludes

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with a discussion of the main results. It is clear that the students perceived this form of learning as having great potential, and derived significant knowledge in the subjects studied.

GAMES AND LEARNING IN EARLIER RESEARCH

The first learning effects attributable to computer games were related to reflexes and hand-eye co-ordination. As remarked by Griffiths (2002, p. 47), these findings were accompanied by studies pointing out that games could serve as educational resources: "Research dating back to the early 1980s has consistently shown that playing computer games (irrespective of genre) produces reductions in reaction times, improves hand-eye co-ordination and raises players self esteem. What's more, curiosity, fun and the nature of the challenge also appear to add to a game's educational potential."

The idea to use computer games as learning tools had emerged even before the 1980's, however. Duke (1974) suggested that games might become an entirely new form of communication in education. Woods (2004) echoes this idea, claiming that "…gaming is a future's language, a new form of communication emerging suddenly and with great impact across many lands and in many problem situations."

Gee (2003b, pp. 67, 71, 107) outlines several principles involved in successful learning. The *practice principle* is exemplified by situations where "Learners gets lots and lots of practice in a context where the practice is not boring (i.e., in a virtual world that is compelling to learners on their own terms and where the learners experience ongoing success)." He also cites the *achievement principle* ("For learners of all levels of skill there are intrinsic rewards from the beginning, customized to each learners level, effort, and growing mastery and signalling the learners ongoing achievements"), the *ongoing learning principle* ("The distinction between learner and master is vague, since learners … must, at higher and higher levels, undo their routinized mastery to adapt to new or changed conditions …"), and the *probing principle*: ("Learning is a cycle of probing the world (doing something); reflecting in and on this action and, on the basis, forming a hypothesis; reprobing the world to test this hypothesis; and then accepting or rethinking the hypothesis").

Extensive practice elicited through computer games may have even more far-reaching effects than successful knowledge acquisition. As argued by Prensky (2001b), regarding recent research on neuroplasticity: "… there is no longer any question that stimulation of various kinds actually changes brain structures and affects the way people think, and that these transformations go on throughout life." On the issue of why behaviour-changing neuroplasticity has not been obvious in the past, Prensky expands: "A key finding of brain plasticity research is that brains do not reorganize casually, easily, or arbitrarily." Extensive practice is needed for neuroplastic changes to occur. With the introduction of computer games into society, the type of repeated practice needed to induce such changes is now in place.

As Prensky points out, in reference to a learning programme involving extensive practice: "Several hours a day, five days a week, sharply focused attention – does that remind you of anything? Oh, yes – video games!" (ibid.)

In another publication, Prensky (2001a) argues that "Today's students are no longer the people our educational system was designed to teach." and remarks that "Today's average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games…" Coining the term *digital natives* for the generation having grown up with computer games and other recent information technology, Prensky outlines some of their typical characteristics: "They like to parallel process and multi-task. They prefer their graphics before their text rather than the opposite. They prefer random access (like hypertext). They function best when networked. They thrive on instant gratification and frequent rewards." (ibid.)

In light of Prensky's observations and Gees' learning principles, it becomes clear that computer games fit very well as an educational tool. Furthermore, many games cross subject boundaries and thus offer learning in several areas simultaneously. As pointed out by Kirriemuir & McFarlane (2003), regarding the simulator *RollerCoaster Tycoon*: "The game could be used across a number of subject domains, such as physics (motion and velocity), and business and economics (running a theme park)."

The use of commercial, off-the-shelf games is not the only possibility. Game-like software can be and has been specifically developed for teaching purposes, although the benefits of this approach have been questioned. Papert (1998, p. 88) takes the standpoint that edutainment programmes, the offspring of games and education software, lack any redeeming qualities: "Shavian reversals – offspring that keep the bad features of each parent and lose the good ones – are visible in most software products that claim to come from a mating of education and entertainment." More specifically, Kirriemuir & McFarlane (2004) point out several reasons for these shortcomings:

> *"Most edutainment has failed to realise expectations, either because:*
> • *the games have been too simplistic in comparison to competing video games,*
> • *the tasks are poorly designed and do not support progressive understanding, or*
> • *the target audience becomes aware that it is being coerced into 'learning', in possibly a patronising manner."*

The known problems with edutainment make it all the more interesting to determine whether commercial, off-the-shelf games are more useful as educational tools.

Computer games played over the internet are also interesting from a learning/teaching perspective. Such games typically provide methods for the participating players to communicate with each other, either through textual

chat or a combination of text and voice. This form of communication may leave a strong impression on the player. Klastrup (2003, p. 107) describes her impressions after participating in the online role-playing game *EverQuest*: "I also take with me the experience of becoming part of a social network which goes beyond the individual character."

While the narrative (or game content) burden in single-player games rests solely on the game designer, in multiplayer games some of the value is generated by interactions among the participating players. The shift in emphasis can be quite notable; as Klastrup (2001) puts it, "Did anyone notice when the story left?." Even in action games, which support a more modest roster of players and more frequent combat situations, player-to-player communication may be a key feature. As observed by Wright, Borgia & Beridenbach (2002): "The meaning of playing *Counter-Strike* is not merely embodied in the graphics or even the violent game play, but in the social mediations that go on between players through their talk with each other."

With real-time player-to-player communication in place, multiplayer games fulfil the criteria for Networked Virtual Environments as defined by Singhal & Zyda (1999, p. 3):

"1) A shared sense of space,
2) A shared sense of presence,
3) A shared sense of time,
4) A way to communicate, and
5) A way to share."

If the communication also includes sound, multiplayer games can implement some crucial aspects of *rich interaction* as outlined by Manninen (2001), *paralanguage*, the non-verbal audio part of speech (Manninen & Kujanpää, 2002), and *spatial sound effects* that add significantly to realism. As Furness (2001, p. 85) points out: "Humans like parallel input. People make use of a combination of sensory stimuli to help reduce ambiguity. The sound of a letter dropping into a mailbox tells us a lot about how full the mailbox is."

Sometimes, the game requires a combination of external and internal communication. This phenomenon is described by Castronova (2001, p. 30–31) in the context of buying and selling game items for real money: "Earthling A gives Earthling B the money. Then they both create avatars in Norrath and meet at an agreed upon spot." The real-world trading place may be an internet-based auction house, as further noted by Castronova: "On an ordinary weekday (Thursday, September 6, 2001), the total volume of successfully completed auctions (N-112) was about $9,200." (ibid.) The appropriateness of such economic activities is debated, and restricting interactions to in-game communication is generally viewed more positively by the community of players. A majority of participants in a survey by Heide Smith (2003) agree (mostly or totally) with the statement "Communication/chat with other players

is an appealing part of online gaming". 81.4% of participants stated that they judged other players on the basis of dialogue either "often" or "all the time" (those responding "sometimes" to the question are excluded from this figure).

While the communication potential of online gaming is perceived positively by most, it is interesting that the parallel processing required is perceived as a problem by some. As pointed out by Juul (2003), many games employ a 1:1 mapping between player time and event time. In multiplayer games, the event time is shared by all players, so there is no way to go back in time by reloading a saved game state. The players need to simultaneously manage chatting and playing. In a survey by Wiklund (2005a, p. 5), most of the (relatively few) negative comments regarding communication issues related to the flow of game time: "It can stop the game" (boy, grade 4), "When you miss something because you chatted. In games I mean" (boy, grade 7), and "That there is no time to play too" (boy, grade 8). More development in this area might improve the experience of multiplayer games, possibly further increasing their potential as learning tools. In later research, Wiklund (2005b, 2007) demonstrated some positive effects of game playing on key behaviours such as communication and media consumption patterns.

As computer games occur in many different forms and genres, they obviously possess a wide variety of properties with respect to learning. These differences may manifest in visual styles, the game tempo, and the type and intensity of player interaction. The typical feedback mechanism also differs from genre to genre. This independent and very important aspect of the game includes what types of player actions are rewarded with precious objects and/or valuable skills. In effect, feedback mechanisms control what the player has to strive for in order to succeed at the game. On a high level of abstraction, the action, strategy, and role-playing genres make very different choices and thus exhibit different potentials for providing a learning environment.

Nevertheless, it is still important to address the role of the teacher. For instance, Kirriemuir (2005) points out a number of common misassumptions on this subject: "The teacher will be marginalised, and become partially or fully redundant, by the game. The role of the teacher is reduced to an assistant who turns the computers on and off." and "The pupils work individually, boothed, one to a game, in monastic silence. Learning is an isolated and unsocial experience…"

If realised, such learning environments would be unfortunate indeed. But when treated by the teacher as a beneficial resource, computer games can enhance rather than replace his/her teaching. The key point is that games are tools in the hands of the teacher. To take one example, the activities occurring within computer games can serve as starting points for a wider programme of educational activities extending outside the game. In this framework, the teacher can craft fruitful learning situations in a highly creative and active way. As pointed out by the British Educational Communications and Technology Agency (2001, p. 4), a strong teacher focus is essential: "The role of the teacher in structuring and framing the activity of the learner remains crucial

if learning outcomes are to be achieved."

THE BOTKYRKA PROJECT

During the fall of 2003, an experimental teaching programme revolving around computer games was initiated in Botkyrka, a Swedish municipality. The project has followed an upper-level secondary school class for two years, from their 10th year of education through their 11th.[3] Even students lacking sufficient grades in core subjects from the preceding level (year 9, the last year of compulsory education in the Swedish school system) were qualified to apply; the programme is planned to include an extra year to compensate for this complication. The project was seen by teachers and local school authorities as an experimental way of reaching students who would otherwise have a low probability of undertaking upper secondary education. The key features of the project were (a) that computer games should be used as the main teaching tool in the classroom, and (b) the interesting constraint that only commercial, unmodified computer games should be used. At the time of their acceptance, 12 students (57.14%) had achieved all academic requirements of the preceding level (year 9) and thus had graduated in the normal way. The remaining 9 students (42.86%) had not received sufficient grades for one or more of their core subjects (Swedish, English and mathematics). Most parts of the ordinary upper secondary education programme were thus not available to these students.

Subject to the above constraints, the students were free to suggest game titles. Although the teachers reserved the right to veto any game they felt was too extreme, this option had not been used during the period covered by this study. The resulting mix of titles thus accurately reflects the preferred games and genres of the students themselves. Also, no student was forced to play games selected by the majority. As each student was free to play games of their own liking, each student's learning environment was heavily influenced by their favourite game genre.

Game titles used	Number of regular players
World of Warcraft	20
Counter-Strike	18
Battlefield 1942	15
Age of Empires	11
Age of Mythology	11
Star Wars Galaxies	11
Warcraft III	10
Diablo	9
Rise of Nations	9
Morrowind	7
Tibia	7
The Sims	5
Neverwinter Nights	5
SimCity 4	3
The Matrix	3

Games used in the project, ordered by the number of students who played them regularly during their participation in the project.

Within this experimental context, we can immediately identify some relevant research questions.

1) Is the use of commercial, unmodified computer games an adequate way of performing education?

2) How did the students perceive their learning environment, and how did they perceive the teacher's role? The latter question was addressed by comparing the students' perceived knowledge acquisition during the project to their perceptions of the learning potential of computer games alone.

3) Since commercial games have a variety of properties and thus may be more or less suitable as teaching tools, the game genre is expected to be a key factor affecting the learning environment. It is thus natural to ask whether certain games or genres are particularly suited to providing an adequate learning environment.

4) Finally, we ask whether students using commercial, unmodified computer games of their own choosing in the classroom display any notable differences in study results related to their favourite game genres.

With respect to the fourth issue, the subject of English (as a second language) was used as an indicator of achieved results. Other subjects such as mathematics were dislocated over the academic semesters, so their potential learning outcomes are more complicated to measure.

The duration of the project affected our choice of methods, making a participating study unsuitable. On the other end of the scale, questionnaires would have introduced a large amount of uncertainty. Thus, our investigations were carried out through a series of in-depth interviews with the students. These were conducted towards the end of the second year, at a time when it was clear to the teachers what final grades they would give the students that year.

All 21 students in the project provided interviews, as well as both teachers. The moderate number of students limits our ability to generalise results,

which should be understood as applying only to participants of the project. As all the participating students were male, gender issues are not addressed in this paper. However, all students in the project were interviewed to minimise the risk of bias due to personality differences. All the students reported having played games frequently prior to entering the programme, and 13 of them (61.9%) already belonged to clans or guilds (organised communities within a game).

The interviews were conducted individually away from the classroom, with no possibility of anyone overhearing the conversations. The students retained full anonymity, identified only by a number untraceable to the specific individual. Each student was informed of this anonymity, and that their answers would not be disclosed to anyone else. By taking these measures, the risk of students not daring to answer questions honestly was reduced as much as possible.

The interviewer followed a fixed series of questions to ensure equal coverage of the research issues by all students. Follow-up questions may differ somewhat among the students, depending on the answers given. The information was entered into a database for processing. Key quotes were translated into English for the purpose of this paper. During their time in the trial programme, the nine students lacking sufficient grades from the previous level were first allowed to study for those grades. At the time of the interviews all nine of these students had successfully passed this stage, so that all students had complete grades for the year 9 core subjects. Regarding the students' grades for year 10 and 11, note that several of the courses given were specific to the programme: digital culture, game development, and web design. As for subjects generally recognised and used in other upper secondary education programmes, 17 students (80.95%) received passing grades in 10th year English, 10 students (47.62%) were about to receive (decisions already made by the teachers) passing grades in 11th year English, and 18 students (85.71%) received passing grades in 10th year social studies.

RESULTS

Students perception of their situation

When questioned about the programme's level of difficulty, 10 students (47.62%) indicated that they found it easy, seven (33.33%) found it of medium difficulty, one (4.76%) found it hard, two (9.52%) gave mixed replies distinguishing easy and hard elements of the programme, and one (4.76%) argued that the difficulty was entirely dependent on how much you asked of yourself.

Seventeen students (80.95%) stated that they acquired new knowledge in the programme, one student (4.76%) felt that no new knowledge had been acquired, and three students (14.29%) stated that they did not know or did not answer at all.

The students also indicated whether they acquired new knowledge in each of five core subjects by participating in the programme:

Subject	Yes	No	Other
Swedish	15 (71%)	5 (24%)	Doubtful: 1 (5%)
English	20 (95%)	0	Knew it already: 1 (5%)
Mathematics*	10 (48%)	11 (52%)	
Social studies	20 (95%)	1 (5%)	
History	14 (67%)	7 (33%)	

*Regarding mathematics, 5 of the students answering "yes" added "a little", "only some" or some similar comment.

When questioned about the knowledge that could have been acquired by playing the computer games alone (without the assistance or efforts of their teachers), the students gave the following replies:

Subject	Yes	No	Other
Swedish	6 (29%)	12 (57%)	Depends on chat language: 3: 1 (14%)
English	21 (100%)	0	
Mathematics*	8 (38%)	11 (52%)	Doubtful: 2 (9%)
Social studies	5 (24%)	12 (57%)	Game-dependent: 4 (19%)
History	10 (48%)	10 (48%)	Game-dependent: 1 (5%)

*Regarding mathematics, 5 of the students answering "yes" added "a little", "only some" or some similar comment.

When discussing their overall impressions of the programme, and how they perceived their situation while taking part in it, all 21 students described the experience in positive terms such as *"very good"*, *"great"* and so on. One student added *"It should be tougher."*.

Teaching methods employed

Interviews with the teachers revealed that their main approach was to use in-game activities as starting points for various discussions and assignments. This method was applied consistently throughout the programme. Both teachers reported that the students seemed highly motivated and interested in discussing history, English, or social studies, particularly if the event spawning the discussion/assignment had occurred in one of the games. Both teachers

state that in their opinion, expanding on in-game events is a key strategy when using off-the-shelf computer games in a learning environment.

The teachers also frequently required the students to hand in essays describing their avatars (personality, their situation in the game), and other game-related issues. These essays were used in Swedish class.

Game genres

The two game genres most often nominated by students as their favourite were First Person Shooters (FPS) and Massively Multiplayer On-line Role-Playing Games (MMORPGs). On entering the programme, 11 students (52.38%) stated that FPS games were their sole favourite. One additional student (4.76%) stated that he preferred FPS games and (offline) Role-Playing Games (RPGs) equally, making FPS games a favoured genre of 12 students (57.14%). At the time of this study two years into the programme, only seven students preferred FPS (33.33%) over other genres. Five of these (23.81% of the total population) regarded FPS games as their sole favourite genre, and two students (9.52%) mentioned other genres as well (RPGs and adventure games respectively). At the beginning of the programme, MMORPGs were the sole favourite genre for three students (14.29%). Two additional students (9.52%) named this genre in conjunction with another genre (strategy and offline RPGs). Thus, MMORPGs were a favourite genre for five students (23.81%). At the time of this study, eight students (38.09%) regarded MMORPGs as their sole favourite genre, and three students (14.29%) named a second genre (strategy games, offline RPGs, and adventure games). Thus, the total number of students favouring MMORPGs was 11 (52.38%).

Game genres and received grades

The following table reports the English as a second language grades received by individual students, sorted by their favoured game genre.

Game genre	Students	No English grades	English A only	English A+B
FPS only at start of programme	11	4 (36%)	4 (36%)	3 (27%)
FPS + other at start of programme	1	0	0	1 (100%)
MMORPG only at start of programme	3	0	1 (33%)	2 (67%)
MMORPG + other at start of programme	2	0	1 (50%)	1 (50%)
FPS only at time of study	5	2 (40%)	3 (60%)	0
FPS + other at time of study	2	0	0	2 (100%)
MMORPG only at time of study	8	1 (12%)	1 (12%)	6 (75%)
MMORPG + other at time of study	3	1 (33%)	1 (33%)	1 (33%)

Number of students having received 0, 1, or 2 grades in English studies, divided by genre preference (MMORPG versus FPS). Data are reported both at the start of the programme and at the time of the interviews.

The average number of years completed in English studies is reported below as a function of the students' favourite game genres (MMORPG or FPS, with or without other genres in conjunction).

Favourite game genre	Students	Average number of completed years of English studies
FPS, at start of programme	12	1.00
MMORPG, at start of programme	5	1.60
FPS, at time of study	7	1.00
MMORPG, at time of study	11	1.45

Average number of years completed in English as a second language, measured as the number of yearly grades received.

DISCUSSION

As the learning potential of computer games and the teacher's role in game-based education are a subject of ongoing debate, more information in these areas is needed. The use of commercial, unmodified games as teaching tools is of special interest, as their edutainment counterparts have been observed to possess deficiencies in this regard. In particular, pure games are observed to be much more engaging and are therefore more likely to be effective.

As we interviewed the entire class as opposed to asking for volunteers, our results have the advantage of not just reaching a biased subset of individuals

from the class. Of course, in any study performed on volunteers great care must be taken when interpreting the results. It is vital to take into account the fact that its participants are more interested in the subject at hand, or at least more active and willing to take part in a study. This potential problem has been reduced as much as possible by interviewing not just enthusiastic volunteers, but everyone in the class.

It is clear that all 21 students in the programme perceive their situation as very positive, as they frequently employ terms such as *"very good"* and *"great"*. This does not mean that they are all 100% happy with their situations. One student, for example, described things as *"fine"* but added *"It should be tougher, though, with higher demands on us"* [in order to pass]. This comment is the single exception, however, to otherwise completely positive replies obtained when discussing the students' overall impressions of the project.

When asked explicitly about the amount of knowledge acquired, the students' replies show a little more variation. While 17 students (80.95%) indicated having acquired new knowledge, three students (14.29%) either didn't answer or stated that they did not know if they had acquired any new knowledge. One student (4.76%) was sure that no new knowledge had been acquired. Not knowing whether or not learning has occurred may be taken as a bad sign, indicating that it probably has not. On the other hand, awareness of learning is not the same thing as learning taking place. As one of the teachers in the programme put it: "Sometimes the students do not realise they have learnt something, just because it has happened through a computer game and not through traditional teaching. When we point it out to them, they say 'Oh, yeah, I know that, it's just like what happened in the game.' ".

Level of difficulty

With respect to the perceived level of difficulty of the programme, still more diversity is shown. The most common view, indicated by 10 students (47.62%), was that the programme was easy. Seven students (33.33%) described the difficulty as *average*, *medium*, *just right* or a similar phrase. One student (4.76%) found the programme hard, while two students (9.52%) pointed out that it contained a mix of activities with different levels of difficulty.

The level of difficulty is a complex concept, as it is closely tied to the reference frames of the individual students; their subjective viewpoints and experiences may produce very different reports. Rather than some illusory notion of absolute difficulty, however, this study is interested in determining the student's perception of his own situation. Variations in perceived difficulty may be dependent on both non-deterministic factors and conscious choices made by the individual. This fact is clearly illustrated by one student, who argued that the perceived level of difficulty depends on how one chooses to live ("It depends on what you demand of yourself"). On a more practical level, two students pointed out that the programme might benefit from dividing the students into two groups advancing at different

paces throughout their studies. Both students felt that the problem stemmed from the group of students who had not passed key subjects at the preceding level, and were slowing the others down: "There should be two groups, one for the unqualified and one for the rest of us" and "It was too easy because of the unqualified, but it's getting better now. If it hadn't, they should be in a separate class". Incidentally, one of the teachers states that two groups of students proceeding at different paces can be handled relatively smoothly in a teaching situation using computer games: "It's easier to go back and forth between a more advanced and a more basic level here, than it is when addressing students in the traditional way as a group in a classroom. I can give the students more individual treatment."

Perceived knowledge acquisition by subject

English and social studies stand out as subject in which the students consistently perceived acquired knowledge. In the former case this is hardly surprising, given the large amount of communication (textual or in some cases voice) that takes place between players, or between players and NPCs (Non Player Characters) in many modern games. Since geographical distances are unimportant when using the computer-mediated communication capabilities of online games, players frequently encounter people from other countries. As a result, chatting in English is extremely common. Local servers using languages other than English exist, but in practice receive much less traffic than the English servers. Thus, it is easy to see how students with other native languages can quickly improve their English through online computer games.

Twenty students (95.24%) stated that they increased their knowledge of English by being in the programme. The only student who replied that he did not increase his knowledge happened to speak English fluently already. "It's good that I practice it here, though," he added, "so that I do not forget it." The figures regarding social studies are similar, with 20 students (95.24%) indicating increased knowledge. In this subject, the remaining student simply does not feel any increased knowledge.

In the case of social studies, more of the acquired knowledge seems to come from teacher activities related to the computer games being played. Often, events in the games give rise to classroom discussions, serving as a source of inspiration for interesting cases. In this context, learning is clearly a positive side effect that would not have occurred without active work by the teachers. As one of the teachers puts it: "When I observed the students gathering [in the online role-playing game *World of Warcraft*] to decide which of two dungeons to enter, I was thrilled to see that they performed an orderly voting procedure, standing up or sitting down to indicate if they were in favour or opposed to the suggested alternatives. This led me to have several very fruitful discussions with them, going into all sorts of voting taking place in society, from shareholders of companies to politicians in the Swedish Parliament.". Regarding the subject of Swedish, 15 students

(71.43%) reported that they increased their knowledge by being part of the programme. Five students (23.81%) perceived no increase, and one student (4.76%) expressed doubt. Two of the students who replied "yes", chose to qualify their response, saying "But that's from the teachers" and "Not from the games, but when the teachers ask us to write things." The latter student refers to side activities such as writing essays about game-related events and concepts.

Figure 1. A meeting in the night. Game genre and atmosphere can greatly influence the type of communication taking place, both between players and between player and environment. Quest texts in World of Warcraft (above) are of a verbose nature, and cooperating players have been observed to make decisions through an in-game voting procedure. (Published with permission from Blizzard Entertainment Inc.).

One student playing the *Age of Empires* strategy game remarked "When you ask the teacher what some tricky medieval English word means, he tells you the Swedish word for that. Then you do not know what that means, either. Then he explains it, and you know a new Swedish word too."

In mathematics,11 students (52.38%) reported having increased their knowledge by participating in the programme while 10 students (47.62%) felt they had not. Among the students replying *"yes"*, five added *"a little"* or other comments to that effect. Two students pointed out that a lot more mathematics was used in constructing the games than in playing them. Game construction was a topic just beginning to be studied by the group, and these students pointed out that more mathematics was likely to be learned as a result. However, when reporting on the programme so far, it seems clear that the majority of students felt they learnt very little new material in this subject.

Regarding history, 14 students (66.67%) reported increased knowledge and seven students (33.33%) felt otherwise. Several comments indicated that the level of historical knowledge is highly game-dependent. Some games are purely fictional, while others strive to be more or less historically accurate. Some students felt they had learnt history from strategy games set during the stone age, medieval times, or world war II (from the first-person action game *Battlefield 1942*). Those students who happened to focus on purely fictional games naturally felt that they had learnt little to no history. As one student put it, "Just some from what the teacher said when we were not playing."

Learning from games or from teachers using games

The above results describe perceived levels of knowledge acquired through participating in both games and game-induced teacher activities. When this is compared with the students' views on what they could learn by playing the games alone, an interesting pattern appears. With the exception of English, which has a very high potential in both cases, all other subjects are perceived to have a lower potential for learning without teachers present. The difference ranges from slight to significant, as measured by the number of positive responses summarized below:

Subject	Game + teacher	Game only
English	20 (95%)	21 (100%)
Mathematics	10 (48%)	8 (38%)
History	14 (68%)	10 (48%)
Swedish	15 (71%)	6 (29%)
Social studies	20 (95%)	5 (24%)

Number of students in the study who state that learning from the games alone is possible, compared to those who believe that the programme's mixture of games and teacher activities promotes learning.

When making this comparison, however, the reader should be keenly aware of one difference between the two questions: the students' "game + teacher" responses are based on their actual experiences, while the "games only" question refers to a hypothetical situation. The students may not have ever tried to learn a subject in this way. (This fact accounts for the anomalous results of English, as the one student already fluent in this subject still deemed learning from the game alone possible.)

Both mathematics and history are perceived by the students as having somewhat lower potential for learning through playing games alone, in comparison with benefiting from teacher activities linked to the games.

Swedish and social studies were perceived as presenting much less potential through games alone.

Even though no subject is without its supporters, in four subjects out of five the learning potential is clearly perceived as higher when the gaming experience is combined with classroom activities linked to and inspired by in-game activities. In a project using computer games as a teaching aid, the teacher's efforts are therefore vital. Rather than decreasing the number of teachers, computer games appear to be an effective tool for increasing motivation and enriching the learning experience. Teachers can use their students' in-game activities as jumping-off points for the exploration of a knowledge landscape extending beyond the games.

The game genre factor

Since each student created an individual learning environment, in the sense that they were allowed to play games of their own choosing, the participants most often played games belonging to their favourite genre. This section asks whether any differences can be observed between students favouring (and thus using) games of different genres. With respect to communication between player and game environment, genre and atmosphere can greatly influence the types of English texts encountered. For example, quest texts in the MMORPG *World of Warcraft* are fairly verbose, an uncommon trait in FPS (First Person Shooter) games. Accordingly, survey data related to the study of English are subdivided by the students' two most favoured game genres: MMORPG and FPS. During the interviews, three students made spontaneous comments directly related to the question of different game genres and their suitability for learning. Two were quite specific: "You can learn things from some games, like English and about history and stuff. From WoW [*World of Warcraft*] and games like that, I mean. And medieval strategy games. But not from the shooters, you don't learn anything there." and "They shouldn't allow CS [the FPS game *Counter-Strike*] and games like that in school, only online games. Because there you have to think more." The third comment was more vague, but still attached some importance to genre in achieving learning: "I don't think it matters what kind of game it is, I've learnt things from all games! Well, no, perhaps not from all games, not from really stupid games, those that are just reflexes. But from all others." It seems clear that at least one game genre, possibly FPS games, is unsuitable as a learning tool in this student's opinion.

The number of yearly English grades awarded is used as a measure of the number of completed years spent studying this language. The average value of this figure among students favouring FPS games (alone or in conjunction with other genres) at the start of the programme is 1.00. Among students preferring MMORPGs (alone or in conjunction with other genres) at the start of the programme, the average is 1.6 completed years of English studies. At the time the interviews were conducted, the students now favouring FPS games remain at 1.00 years of completed English studies, while the now MMORPG-favouring students have completed 1.45 years of English studies on average. Note that some of the students have changed their preference over the course of the programme; the MMORPG group, for example, has grown. Although the average level of English achievement changes over time among students favouring MMORPGs, the average number of years completed by students favouring FPS games is lower in both cases.

It is worth noting that this difference, although interesting enough in itself, has at least two possible explanations. On the one hand, students favouring MMORPGs may be more motivated to study than students favouring FPS games. On the other hand, it is also possible that students who play more MMORPGs are receiving more training in and exposure to English, and as a consequence are more motivated to continue their formal study of English. Each of the two possibilities has interesting implications, whether regarding game preferences as indicators or the quality of various games as teaching/training tools. Neither hypothesis has yet been proven or falsified.

CONCLUDING REMARKS

The results described in this paper indicate that commercial, unmodified games can be effective as learning tools in the classroom. The studied environment included significant teacher efforts (although these revolve around in-game experiences), and the students themselves perceive game play to have less learning potential if not accompanied by a teacher. Thus, more research on the teacher's role in computer game-based education would add valuable information.

Teaching methodologies focussing on in-game activities/events appear to have been effective, and are therefore worth investigating further. The results of this study also indicate that the learning potential of a game may depend on its genre. The average number of completed years in English studies among students preferring MMORPGs was significantly higher than that among students preferring FPS games, so the learning potential inherent in different game genres should also be a topic for more research.

An observandum here is whether the observed differences regarding game genres and study results arise from the fact that students exposed to certain genres receive specific training through the games as learning tools, or from the fact that more academically inclined students tend to choose certain genres. More research is required to investigate this.

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[1] An overview of current trends in learning processes and methods is provided in Kahiigi, Ekenberg, Danielson & Hansson (2007).

[2] These labels should not be interpreted too strictly. In the absence of formally defined genres, a spontaneously developed model is commonly used to classify computer games. The boundaries between genres are not always clearly defined, and overlap is possible. Thus, a given game will often be described using a combination of generally accepted types.

[3] These are the first and second years of non-compulsory education in the Swedish school system. Students continuing directly from the compulsory school system will be 16 and 17 years old.

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