

BEHAVIOURAL CHANGES IN STUDENTS PARTICIPATING IN AN UPPER SECONDARY EDUCATION PROGRAM USING UNMODIFIED COMPUTER GAMES AS THE PRIMARY TEACHING TOOL

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ABSTRACT

The extensive use of computer games have been suggested to induce behavioural differences in the players as a result of neuroplasticity. Such changes, if present, suggests that computer games may be ideally suited as teaching tools for students having grown up with this technology. Using computer games extensively in the education system would in turn increase the gaming exposure significantly, even further accentuating any such neuroplastically mediated behavioural changes.

To obtain information on possible changes in student behaviour patterns in key areas, an empirical study was conducted. Students participating in a test project extensively using computer games as teaching tools, were interviewed about both games related and other key behaviours.

Results show some changed behaviours in the studied areas, such as decreased television watching habits and a shift from FPS to MMORPG as favourite game genre. While being consistent with computer games being able to induce behavioural changes through neuroplasticity, other factors may also have contributed in the studied case, and more research is needed.

BACKGROUND

The concept of using games as learning tools emerged even before the existence of computer games, most notably with what has been described as *"The modern era of simulation gaming"* (Wolfe and Crookall 1998) including large simulation games such as the RAND corporations logistics simulator for the US Air Force, and the first business simulation being used in college education as early as 1957 (Dickinson and Faria 1997). These and other developments made Duke suggest in

1974 that games may become an entirely new form of communication in education, as noted by Woods: *"He suggested that simulation games might offer a possible answer to the problems of education in an increasingly complex society"* (Woods 2004), in reference to: *"...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"* (Duke, quoted from Woods 2004).

Among the first observed learning effects regarding computer games are those related to reflexes and hand-eye co-ordination. As remarked by Griffiths, these findings are also accompanied by those pointing out particular aspects of games as having important bearing on using them as educational resources: *"Playing computer games (irrespective of genre) produces reductions in reaction times, improved hand-eye co-ordination and raises players self esteem. ... The nature of the challenge also appear to add to a games educational potential"* (Griffiths 2002).

Further research in the area of specific advantages of computer games as educational tools has pointed out several aspects where games fit very well into key patterns of successful learning. As Gee points out, these aspects need not be related to those features that are perhaps most often noted regarding computer games, such as the graphics: *"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"* (Gee 2003a). This positive aspect of something being hard, and the danger of making things too easy, is also discussed by Papert: *"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"* (Papert 1998).

This touches on the Practice Principle, outlined by Gee as one of several principles involved in successful

learning situations: *“Learners gets lots and lots of practice in a context where the practice is not boring”* (Gee 2003b).

Such a high degree of practice, reached because it is implemented through computer games and thus in a way that is not boring, may have even more far-reaching effects than just successful knowledge acquisition, as pointed out by Prensky 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.”* (Prensky 2001b). On the issue of why the extent of this possibly behaviour-changing neuroplasticity has not been obvious in the past, Prensky further expands: *“A key finding of brain plasticity research is that brains do not reorganize casually, easily, or arbitrarily”* (ibid.). Instead, 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 behavioural changes as a consequence of neuroplasticity is in place. As Prensky points out in reference to a learning program 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.).

As a result of the neuroplastic changes discussed above, Prensky argues that *“Today’s students are no longer the people our educational system was designed to teach.”* (Prensky 2001a), 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...”* (ibid.). 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 as *“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 the light of these characteristics, it becomes clear that computer games fit in very well as an educational tool, especially if one also takes into account that many games span across subject boundaries, being able to offer learning in several areas at once. As pointed out in a study by Kirriemuir and McFarlane regarding the roller coaster simulator game *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)”* (Kirriemuir and McFarlane 2003).

The usage of unmodified, commercial, off-the-shelf games is not the only possibility, though. A combination of educational software and computer

games, often referred to as “edutainment” is the result of efforts to explore the game format and fill it with more traditional, school curriculum oriented material. However, the usefulness of such edutainment software has been questioned in many cases, as observed by Kirriemuir: *“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”* (Kirriemuir 2002).

A similar standpoint is taken by Papert, viewing this edutainment “offspring” from games and education software as possessing none of the best features from either “parent”: *“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”* (Papert 1998). More specifically, Kirriemuir and McFarlane points out several reasons for these shortcomings: *“• the games have been too simplistic in comparison to competing video games ... • the tasks are poorly designed and do not support progressive understanding ... • the target audience becomes aware that it is being coerced into ‘learning’, in possibly a patronising manner”* (Kirriemuir and McFarlane 2004). These known issues regarding edutainment suggests that unmodified, commercial off-the-shelf games may be more useful as educational tools.

Another issue central to using computer games as educational tools, is the role of the teacher. Here, Kirriemuir notes various misassumptions about teaching using computer games in the classroom, such as: *“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”* (Kirriemuir 2005). As Kirriemuir points out, is a misassumption, and if realised such learning environments would be very unfortunate indeed. Instead, if treated by the teacher as a beneficial resource, computer games may take the role of tools in the hands of the teacher. Being able to use activities occurring within computer games as starting points for educational activities extending out from the games, is one example of how the teacher may create fruitful learning situations. A key point from a study conducted by the British Educational Communications and Technology Agency, BECTA, is that 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.”* (BECTA 2001).

Relating this to the previously discussed behavioural differences described by Prensky, an educational environment with creative and active teachers utilising unmodified, commercial off-the-shelf games as teaching tools might be ideally suited to meet the needs of today’s students. Such an environment, though, if implemented as the main teaching method used every

day in school and during the majority of the school day, would increase the students exposure to computer games significantly, possibly even further accentuating any behavioural change resulting from neuroplasticity. It is worth noting that such changes, if present, may not necessarily be of a negative nature, but may just as well be beneficial for the individual.

The Studied Test Project

In Botkyrka, Sweden, a test project using computer games as the primary teaching tool for a class of students in upper secondary education was initiated in the fall of 2003. The project first included students in their 10:th year of education, and now in the second year of the project includes students in their 10:th and 11:th year of education in a mixed fashion. This represents the first and second year of the non-compulsory education in the Swedish school system, normally corresponding to students reaching the age of 16 and 17 if continuing directly from the compulsory school system.

The project was set up in such a way that also students lacking sufficient grades in core subjects from the preceding level (year 9, the last year of the compulsory education in the Swedish school system) were qualified to apply. This was seen by the teachers and the local school authorities as an experimental way of reaching students who would otherwise have a low probability of ever undertaking upper secondary education. Also the pedagogical issue of using unmodified off-the-shelf commercial computer games as the main teaching tool was of great interest.

The students were free, up to the limitations of the project budget, to suggest game titles to be used. Although the teachers has the right to refuse any suggested game they feel would be too extreme, this veto right had never been used up to the time of the study. The resulting mix of game titles thus reflects the preferences of the students themselves:

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
Sims	5
Neverwinter nights	5
Sim City 4	3
Matrix	3

Game titles used in the project, ordered by the number of students having played them regularly during their participation in the project.

The teachers main approach to teaching using unmodified computer games involves using in-game activities as starting points for discussions and assignments of various kinds. This method is applied constantly. Both teachers reports that the students seems highly motivated and interested in discussing issues in fields like history, English, or social studies, if the event spawning the discussion/assignment has occurred in one of the computer games. The teachers also frequently requires the students to hand in essays describing their avatars personality, their situation in a game, and similar game related issues, and then uses the received essays in Swedish class.

With kind permission from all involved parties, we were allowed to perform an independent study interviewing the students participating in the project.

RESEARCH QUESTION

As the educational potential of unmodified, commercial off-the-shelf computer games seems high as a result of observed characteristics of students having grown up using this technology, this concept is being debated and tested empirically. As it also has been suggested that extensive playing of computer games may induce behavioural changes due to neuroplasticity, more information in this area is needed.

The research issue addressed in this paper is to find out if behavioural changes can be observed in students participating in a test project where unmodified, commercial off-the-shelf computer games are being used as the main teaching tool and thus played extensively. Both behaviours relating to computer games, such as favourite game genres, and other key behaviours such as reading habits and television watching habits are studied.

METHODOLOGY

The empirical contribution of this paper is an evaluation study of an ongoing test project in Botkyrka, Sweden, using commercial, unmodified computer games as the main teaching tool in upper secondary education. The project in question includes students in both their 10:th and 11:th year of education, in a mixed fashion. The interviews were conducted towards the end of the second year of the four year test project, at a time when it was clear to the teachers which grades they would give the students at the upcoming end of that semester. All 21 students in the project participated in the study through in-depth interviews, as well as the two teachers. As all the students in the project were interviewed, rather than just those choosing actively to participate, the risk of results being biased as a result of personality differences was minimised.

The interviews were conducted individually in a separate room, away from the class room, with no

possibilities of anyone else overhearing the conversations. The students retained full anonymity, only being identified by a sequential number untraceable to the specific individual. Each student was informed of this anonymity, and that his or her answers would not be disclosed to anyone else. By taking these measures, the risk of students not daring to answer the questions honestly was reduced as much as possible.

During the interviews, the interviewer followed a fixed form with questions to ensure equal coverage of topics with all students. Only 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 to English for the purpose of appearing in this paper.

RESULTS

All 21 students (males, ages 16-19) in the class participating in the test project were interviewed, revealing that all 21 had played computer games regularly before entering the test project, and as a result of their participation in the program all 21 now also played games regularly in class. 20 of the students (95.24%) stated that they still play computer games regularly in their free time, outside of school.

Clans, Mod-ing, and MMORPG

Out of the 21 students, 13 (61.90%) had been members of a clan, competing in games tournaments of various kinds, before entering the test project. 11 students (52.38%) were currently members of clans formed in school during the project, and 12 students (57.14%) reported currently being members of clans formed in their free time, outside of school and including members other than those in their class.

Before entering the test project, 8 of the students (38.09%) had spent time "mod"-ing (modifying computer games), while 14 (66.67%) had done so in class during the project. 10 students (47.62%) were currently performing this activity in their free time, outside of school.

14 students (66.67%) reported having participated in MMORPG (Massively Multiplayer On-line Role-Playing Games) before entering the test project. As a result of their participation in the project, all 21 students were now active in various MMORPG worlds during class. 17 students (80.95%) currently continued this activity in their free time, outside of school.

Reading and Television Watching Habits

Before entering the test project the students reports having read an average of 6.43 books per year. When divided into the categories of fiction versus

technical/specialist facts-related literature, the students reported having read an average of 5.24 fiction books and an average of 1.19 facts-related books per year.

The corresponding figures at the time of the study, while participating in the test program, were an average of 6.33 books being read per year, out of which 4.57 were fiction books and 1.76 were facts-related books, on average per year.

Before entering the test project, the students reports watching television on average 24.81 hours per week. This can be divided into an average of 4.57 hours per week of watching news and other facts-related programs, and an average of 20.24 hours per week of watching film and other entertainment-related programs.

At the time of the study, while participating in the test project, the corresponding figures were an average of 19.12 hours of watching television per week: 3.83 hours of watching news and other facts-related programs, and 15.29 hours of watching film and other entertainment-related programs, on average per week.

Favourite Game Genres

Before entering the test project, the students regarded their favourite game genre(s) to be as indicated in the following table:

Game genre	No. of students	% of students
First person shooters (FPS)	12	57.14%
Role-playing games (RPG)	2	9.52%
Massively multiplayer on-line role-playing games (MMORPG)	5	23.81%
Strategy games	2	9.52%
Adventure games	3	14.29%
Platform games	1	4.76%
Third person action games	1	4.76%

Favourite game genres before entering the test project. More than one alternative could be indicated.

At the time of the study, while participating in the test project, the preferences regarding game genres had shifted, as indicated in the following table:

Game genre	No. of students	% of students
First person shooters (FPS)	7	33.33%
Role-playing games (RPG)	2	9.52%
Massively multiplayer on-line role-playing games (MMORPG)	11	52.38%
Strategy games	1	4.76%
Adventure games	2	9.52%
Platform games	1	4.76%
Third person action games	2	9.52%

Favourite game genres at the time of the study, while participating in the test project. More than one alternative could be indicated.

DISCUSSION AND CONCLUSIONS

The method of interviewing the entire class in question, as opposed to ask for volunteers, has the advantage of not just reaching a subset of individuals who might differ from the rest in various ways. In studies performed on volunteers that have actively chosen to participate, great care must be taken when interpreting the results. In such cases it is vital taking into account that the participants are more interested in the subject at hand, or at least more active and willing to take part in a study, than other people in general, even in the same age group, etc. This potential problem has been reduced as much as possible by interviewing not just enthusiastic volunteers, but everyone in the class.

Gaming Habits

It is clear from their participation in the test project that all 21 students play computer games regularly in class. As the results show, the school environment of the studied test project is not where this activity was first introduced to any of the students: all 21 reported playing computer games already before entering the project. All but one student (95.24%) also continues to do so in their free time, outside of school. As only one student has stopped playing games in his free time, there is no convincing tendency that the extensive playing of games carried out within the test project is replacing leisure time gaming.

Also regarding the memberships to clans, for game competition purposes, little difference can be noted when comparing this activity before entering the test project with that during the project, at the time of the study. 13 students (61.90%) were members of clans before entering the project, and 12 (57.14%) were members of clans unrelated to school during the project. Interestingly, the one student no longer active as a clan member during his free time, is the same individual who had stopped playing computer games altogether, outside of school. During the interviews, this particular student indicated that other topics had taken over as his main interests, and that he now regarded computer games as “*something I’m supposed to do at school*”. 11 students (52.38%) were members of clans actually formed in school, as a result of the activities in the test project. The small difference in the number of clan members before and during the project (outside of school), 13 versus 12 students, indicates that school time gaming activities involving the formation of clans has little effect on the extent to which students are members to clans formed out of school.

A slightly larger change, and with reversed direction, is observed regarding MOD-ing (modification of games). This not uncommon creative gaming activity had been practised by 8 of the students (38.09%) before entering the test project. During their participation in the project, 14 students (66.66%) had performed mod-ing during

class, as part of school activities, and 10 students (47.62%) now practised mod-ing in their free time, outside of school. Thus the group of students mod-ing during their free time had grown from 8 to 10 students over the time of the project up to the point of the study, a 25% increase. This change seems to indicate that the students leisure time activities in this area has possibly been affected by the corresponding in-class activities, although the causality of this is unclear. Even without the involvement of such causality, though, it can be concluded that the students leisure time mod-ing activities increased during the project. As mod-ing can be seen as a highly creative activity, going far beyond the mere usage of computer games and involving many aspects of design, construction, narration and other creative tasks, this is an interesting tendency.

An increased gaming activity is also observed regarding MMORPG (massively multiplayer on-line role-playing games), being played by 14 of the students (66.67%) before entering the test project, and at the time of the study being played by 17 students (80.95%) in their free time, outside of school. This activity seems particularly popular within the project, being carried out by all 21 students during class. Apart from being popular for entertainment reasons, the teachers involved in the test project has also reported many possibilities of linking occurrences in such games to successful teaching activities extending out from the games: “*When I observed the students gathering [in the online role-playing game World of Warcraft] to decide which one of two dungeons to enter, I was thrilled to see that they performed an ordered 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 discussion with them, going into all sorts of voting taking place in the society, from shareholders of companies to politicians in the Riksdag [the Swedish Parliament]*” (Wiklund and Glimbert 2005). In this case, though, the possible influences by the test project activities on the extent to which the students play on-line games, must be seen in the light of this game genre becoming increasingly more popular in general during the time period in question.

Reading and Television Watching Habits

To further investigate any behavioural changes from before entering the test project and up to the time of the study, the students reading habits were examined. Here, the students reported having read an average of 6.43 books per year before entering the test project. The equivalent figure at the time of the study, while the students participated in the study, playing computer games extensively in class, was still almost as the same: 6.33 books per year on average. At first glance, this seems to indicate that the students extensive playing of computer games in the school had no effect on the students reading habits.

Some changes were observed, though, when the books in question were divided into fiction and technical/facts-related literature. The average number fiction books read by the students before entering the test project was 5.24, a figure that had dropped to 4.57 fiction books read per year on average while the students participated in the project, at the time of the study. This decrease in the reading habits of fictional literature, was matched by an increase in the reading habits of technical/facts-related literature. Before entering the test project, the students read an average of 1.19 technical/facts-related books per year on average, while at the time of the study, when participating in the test project, the students read 1.76 technical/facts-related books per year on average.

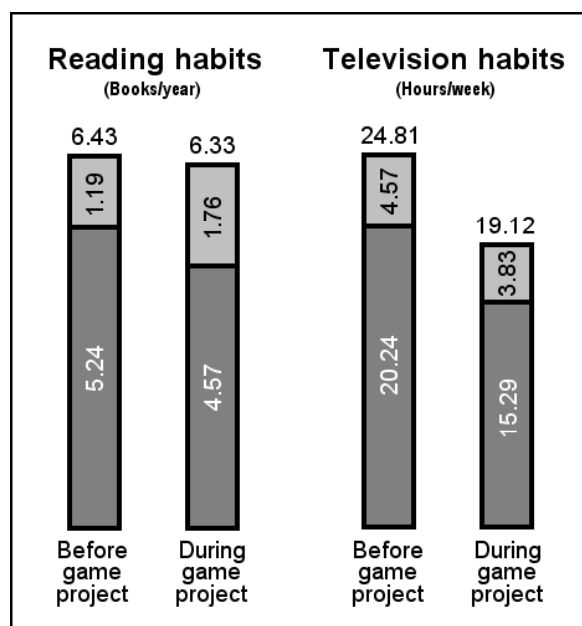
As always when discussing behavioural changes that has occurred over time, it is not possible to completely rule out the possibility that the observed changes are simply the result of the test subjects growing older. There are, however, in this case no particular factors, such as statements explicitly made by the students regarding changes in taste as a result of now being older, and similar, that would more strongly point in that direction. It is clear, in any case, that the students on average read less fictional literature, and more technical/facts-related literature, while participating in the test project than before entering it.

Relating to reading habits, an interesting point was made by one of the students when discussing his reading habits: "Well, I read quite a bit, but you mean books, right? I don't read so many books. I read on my computer. You know, 'Adrenaline Vault' [web site with news and reviews about computer games] and stuff like that." Clearly, when discussing reading habits, issues such as if reading texts on internet web sites should be considered equal to reading books, should be defined. In this study, only reading habits regarding printed books are examined.

Regarding television watching habits, the students reported having watched an average of 24.81 hours of television per week before entering the test project. This figure had dropped to an average of 19.12 hours per week of watching television at the time of the study. This decrease is fairly evenly dispersed between entertainment-oriented and news/facts-oriented television programs. Before entering the test project, the students watched 20.24 hours of entertainment programs and 4.57 hours of news and facts-related programs on average per week. This was down to 15.29 hours of entertainment and 3.83 hours of news and facts-related television programs on average per week at the time of the study. The tendency in the case of television watching habits is clear, the students on average watched less television, both entertainment and news/facts programs while participating in the test project than before entering it.

Also in the case of television watching habits, one student raised a point somewhat similar to that discussed regarding reading habits. This student, having just reported watching television 24 hours per week, added: "But that's on my PC. I have a TV-card in my PC. Does that count?". This, indeed, illustrates an interesting trend in television watching habits. However, this issue goes beyond the scope of this paper, and in this study, therefore, watching television programs on the computer screen is considered equal to watching it on a television set.

The changes in reading and television watching habits before entering and during participation of the test program is summarised in the following figure:



Changes in reading and television watching habits before and during participation in the test project using computer games as teaching tools. Legend: dark grey = fiction literature and entertainment television programs, light grey = technical/facts-related literature and news/facts-related television programs.

Favourite Game Genres

Also in terms of which computer game genres the students regarded as their favourites, some changes were observed. Although some game genres with relatively few supporters, such as role-playing games (the single user, off-line form) (2 students) and platform games (1 student) retained the same number of supporters at the time of the study as before entering the test program, other genres showed a varying number of supporters.

Slight changes were seen in the number of students who regarded strategy games their favourite genre (down 1 student from 2 students before entering the project to 1 student at the time of the study), adventure games (down 1 student from 3 students before entering the project to 2 students at the time of the study), and third

person action games (up 1 student from 1 student before entering the project to 2 students at the time of the study).

The most significant changes in terms of favourite genres were seen regarding first person shooters, FPS, and massively multiplayer on-line role-playing games, MMORPG. Here, the number of FPS games supporters dropped from 12 students before entering the test project, to 7 students while participating in the test project, at the time of the study. During the same time period, the number of MMORPG supporters increased from 5 to 11 students. These two shifts results in MMORPG replacing FPS:s as the most popular game genre in the studied group of students. Having been advocated by 57.14% of the students before entering the test project, FPS games were at the time of the study the favourite game genre of only 33.33% of the students. Contrary, MMORPG, having been the favourite game genre of 23.81% of the students before entering the test project, were at the time of the study the favourite game genre of 52.38% of the students.

The observed shift from FPS games to MMORPG is significant and interesting, not the least because massively multiplayer on-line role-playing games seems to possess many interesting properties as teaching tools, as discussed earlier in the gaming habits section. The observed change, though, may have several causes. One such cause may be that the consistently high exposure to computer gaming every day in school, may over time have triggered some students to long for games with more depth and nuances than is commonly seen in FPS games. As MMORPG offer in-game activities along more dimensions (complex character design and improvement, trade, the manufacturing of goods, diplomacy, ability to take on different social roles, and taking both practical and magical skills into account, as well as combat), a shift towards this type of game would be logical for those having grown tired of the more straight-forward design of most FPS games. While it seems likely that this is at least partly the cause in this case, other factors may also have influenced the observed shift among the interviewed students, most notably the release of the World of Warcraft game during the time period in question, making MMORPG gaming coming more into focus in general at the time of the study.

The behavioural patterns reported by the students in this study indicates interesting changes in mainly two areas: while participating in the test project, and thus playing computer games extensively in school each day, the students in the study watched less television than they did before entering the test project, and more students had come to favour the MMORPG type of games, replacing FPS games as the most popular game genre. These observed changes seem consistent with the views expressed by Prensky in (Prensky 2001a) and (Prensky 2001b) regarding extensive gameplay leading to

information processing changes due to neuroplasticity, although other factors may also contribute in this case. In other areas, behaviours not changing significantly includes reading habits, where the overall volume is virtually unchanged and the subcategory of non-fiction is actually increasing. This indicates that the notion of computer game players being preoccupied to the point where the games have replaced all other activities and sources of information is a misassumption.

FUTURE RESEARCH

To further investigate the area of frequent playing of computer games, and either confirm or disconfirm the possible influences of this on player behaviour, more studies in this field is needed. One quantifiable factor of interest would be the number of hours spent gaming per week, in correlation to observed behavioural changes over time. Since in the present study, other factors possibly contributing to the observed behavioural changes have been identified, studies in a more controlled environment where outside factors can be eliminated as much as possible would be especially useful.

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