Learning can't be fun, can it?

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Abstract:

Inspired by research by Carrie Heeter et al. and the MIT Games-to-Teach project we set up a small scale empirical study on two educational games on Art aimed at primary school children. We found that both boys and girls liked to play these games; that one game scored better on our 'fun-index' and that girls had less mouse skills and lacked certain game skills. This did not, however, affect their test-score, on the contrary, the girls improved more than the boys. To our amazement, we also found that the girls especially anticipated to have learned less from the more entertaining game, which might suggest that even at this early age they think that learning can not be fun.

1 Introduction

Projects like MIT's Games-to-Teach [1] advocate the educational use of computer games. The underlying idea being that children like computer games, that they play regularly and that they learn valuable skills while playing. Video games offer immersive worlds and imaginative stories, so why not use them in education? Part of the Games-to-Teach vision was to develop next-generation educational games, which would appeal to both boys and girls and which would retain the immersive appeal of commercial games but would still be playable in a classroom setting. In a similar vein Carry Heeter et al. [2] compared the fun-elements in eight commercial and four educational games on space exploration to find out how commercial and educational games differ; why commercial games are more appealing and how the fun-element of educational games could be improved on.

In the Netherlands educational games are used in the classroom, but not on a regular basis and seldom as an alternative to normal educational tools. In the past five years the Dutch government has invested millions in the ICT-infrastructure but not in educational software. The latter is left to traditional educational publishers and to independent publishers of educational software [3]. These seem to focus their activities more on the growing group of home-users. Does this imply that fun learning with the help of educational computer games will become the responsibility of the parents, who are ill equipped to judge these games on their educational merits? Or will new research convince the Dutch educational authorities that the use of computer games is a valid and valuable educational asset?

As there is little data about the use of educational games in Dutch schools and, as far as we know, no Dutch data on fun and learning aspects of educational games and, as we were ourselves intrigued to know whether having fun has a positive effect on learning, we set up a small scale qualitative experiment where two groups of primary school children aged nine to eleven played two educational games and were then tested on new information introduced in the games. Because of the children's age, we opted for a small scale qualitative experiment so that we could observe them and record their comments while they were playing the game. We preferred this method to a quantitative approach because we feared that nine to eleven year olds might be more inclined to give desired feedback rather than answer spontaneously.

We furthermore opted for a subject outside the regular Dutch primary school curriculum: Art. This again was premeditative as we feared that children would be biased towards regular school subjects so that their responses would not be as spontaneous. Furthermore it would be easier to asses what they might have learned if the subject was new to them.

We opted for existing educational games because of the educational setting in which the games would be tested. As these are written for classroom use they are more appropriate than commercial games which usually take quite a few hours just to learn the basics [4]. The fact that educational games are easier to install and that school computer equipment rarely meets the technical demands of commercial games, also motivated our choice.

1.1 Learning and Fun

The recent focus on the use of computer games in education [5] might suggest that this is a new phenomenon. However, games have been used in education since the first arrival of a computer in the classroom. One of key factors for using computer games in education is their power to motivate. As the British Educational Communications and Technology Agency (BECTA) puts it:

> A striking feature of games software is its power to motivate. Motivation, or the will to continue the use of the software is the end product of a mixture of psychological effects. [6]

The intrinsic motivation games have and the positive impact they might have on learning has been researched as early as 1980 by Thomas Malone, who found that the key motivating factors are challenge, fantasy and curiosity [7]. Since then more research has been conducted on the educational use of games. Students who participated in Alan Amory et al.'s research in 1999, for instance, reported that logic, memory, visualisation and problem solving were interesting or useful game elements. His study also found that adventure type games were the most useful genre for educational purposes [8].

Pierre-Alexandre Garneau, who was interested in tools to create better games, came up with a list of fourteen elements that are fundamentally entertaining. They are: beauty, immersion, intellectual problem solving, competition, social interaction, comedy, thrill of danger, physical activity, love, creation, power, discovery, advancement and completion, and, application of an ability [9]. Although, as he notes himself, it is virtually impossible for a game to include all features, a combination of features will 'create a richer experience' [10]. Carry Heeter et al. used these fourteen forms of fun plus altruism and learning to find out whether commercial computer games were more fun to play than educational games. They concluded that commercial games are not necessarily more fun to play, but that commercial games contain more elements of fun. The main reason for this seems to be that educational games have a dual purpose to fulfil; they have to be educational as well as entertaining. To be usable in a school setting educational games have to be easy to install, easier to play and shorter than commercial games. Consequently Heeter et al. concluded that the educational games tested:

> Include 30% fewer forms of fun than commercial games. Competition is moderate if present at all; there are no opponents. Learning about the real world, discovery and exploration, solving puzzles, and intellectual problem solving are their dominant forms of fun. Educational games are more grounded in reality, less imaginary and less imaginative [11]

Because of the dual purpose current educational games have, the learning experience in a commercial game is different from that of an educational game. As Heeter et al. put it:

> [Commercial games] define the world of the game, its rules, what can and cannot be done. Thus any learning here has to be about that pre-defined world. Educational games on the other hand always point to something else. Thus there are two levels of learning required. One is learning the game and the other is learning the other stuff that you are playing the game for in the first place [12].

As Heeter et al. have shown, although current educational games differ from commercial games in their educational qualities and the way these are incorporated in the game, educational games do contain certain elements of fun. In our experiment we will use the children's remarks during game-play to rate the games on these forms of fun.

1.2 Games and education in the Netherlands

In 2002 the bureau Intomart polled 765 parents and 536 children aged between eight and eighteen for the Dutch Institute for Classification of Audiovisual Media (NICAM) on the children's use of electronic games [13]. They found that 99% of the children played computer games and that on average they played about an hour and a half per day; 59% play daily, 31% several times per week and only 10% once a week or less. The percentages in figure 1 show that boys play longer than girls [14].
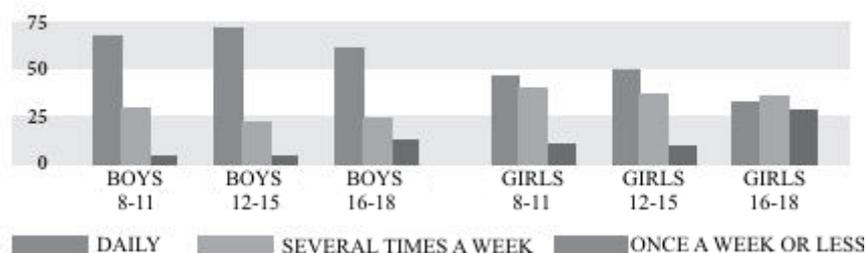

Chart 1 Percentage of children that play daily, several times a week
or once a week or less

Games are played on a PC (95%), game console (43%) or gameboy (38%). When children grow older computer and game equipment moves from the living room to their own bedroom as the 2003 survey by the Dutch Institute for Budget Information (NIBUD) in collaboration with the Jeugdjournaal [15] shows. From the 3954 children they polled, 25% of the eight year olds have a computer in their own room and 31% a game console; by the age of thirteen these numbers have increased to 48% and 40% respectively [16].

Data on the use of computer games in Dutch education are rarer. Even though in 2003 a special games-in-education project was launched [17], data collected by the Dutch government only looks at the use of information and communication technology as a whole and has no separate data on the use of computer games. From these data we learn that primary school children spend about six hours per week on computer assignments in class; these hours are overall used for revision, word-processing and information retrieval. Taking into consideration that the average week has 27.5 class hours, this is almost 25% of class time. When games are used they are mostly educational games on language and arithmetic. Games are, as a rule, not used for regular education but as a reward or as part of extra-curricular revision. Fifty percent of teachers give the children computer assignments as homework, but there are no data on the type of assignments or the hours involved [18].

Although the child–computer ratio in Dutch primary schools is five to one and despite the time already spend on computer assignments, primary school teachers indicate that they are still learning to adapt when it comes to the use of computers as part of the regular curriculum. Furthermore in the Dutch educational system primary school teachers have to make sure that the individual pupils meet certain yearly educational standards. These standards, as a general rule, are based on traditional content and traditional methods. Add to this the fact that there are no overall data available on the use and educational benefits of computer games in the classroom; it is quite understandable that games are not on top of the teachers' list. And as surveys show that most teachers rely on colleagues for information on the use of software in and out of classes, this situation is not likely to change in the near future [19]. So although data shows that Dutch children are avid players, playing computer games as part of the regular curriculum is virtually non existent.

2 Methods

As we wanted to explore both the fun elements in using computer games as well as their possible value as a learning tool, our first objective was to find two suitable educational games on Art. We eventually found *HET LEUKSTE MUSEUM VAN NEDERLAND* ('the most fun museum of the Netherlands') [20] and *ARTUR EN DE GEEST VAN HET MUSEUM* ('Artur and the ghost of the museum')[21]. Both games are targeted at nine to eleven year old primary school children [22]. The main subject of both games is learning about paintings in a museum setting. To determine their suitability, playability and appropriateness we first judged them on general usability criteria. This would also help us determine which forms-of-fun the games incorporated.

2.1 The Games

Of the two games *HET LEUKSTE MUSEUM VAN NEDERLAND* is more of a traditional educational game. The game first presents a short back-story telling the player that a new museum is about to be opened. Unfortunately a tornado has damaged the museum and now all the paintings are jumbled up. The player volunteers to help the distressed museum director to put everything right before the grand opening. Before the game starts, the program asks the player's name and whether (s)he is a girl or boy. The game then continues with a girl or boy avatar. The game can be played directly from CD which makes it also suitable for incidental play. Information is given by a clear young female voice and puzzle-instructions are given by the male voice of the museum director. Information and instructions are given out loud as well as on the screen. Navigation is indicated by on screen direction-arrows which have to be clicked. The museum in the game consists of five galleries corresponding with five famous Dutch museums. There are ten paintings in each gallery. The player can get the usual information about the painting (s)he is looking at (artist, size, subject matter etc.) by clicking on an eye-icon next to the painting.

Figure 1 *Threatened Swan* information screen (texts are not in the original)

By clicking on a puzzle-piece- icon the painting's mini-puzzle game appears:

Figure 2 Here you have to pick the detail that is not in the painting.

These are fairly traditional puzzle games such as jig-saw, sliding puzzle, memory, etc. Most of the picture-puzzle tasks involve close inspection of the painting so that the child is forced to study it carefully. There are also separate games for the paintings per gallery, which are sometimes about more general subjects, for instance putting the name of the painter with the correct painting. Most puzzles are easy to solve and do not need tricky mouse movements. Once the child has solved all the puzzles, the museum is saved. There is a time element involved so that children can compete against each other (or better their own time). Even without installation games can be saved, but all the saved games are put in the same directory so it is advisable to let the children save the game using their own name. Saving the museum (i.e. solving all the puzzles in the game) cannot be done in a single class hour so saving is necessary. For in-class use a network version is available as well as suggestions for teachers.

The second game *ARTUR EN DE GEEST VAN HET MUSEUM* is more of an adventure game about the little mouse Artur who lives with his family in the attic of a museum. One night, when Artur's parents are away, a terrible ghost (Arcimboldo's Winter) escapes from his painting and wreaks havoc in the museum. Using the museum's surveillance cameras Artur has to find the ghost, put the paintings right and finally trap the 'ghost' back in his painting. The game needs to be installed and has lengthy opening and closing titles. It seems that the game is targeted more towards the home market, although suggestions for class use with eleven and twelve year old pupils are included. These, however, address the Belgian educational system. Without reading these suggestions or the booklet or box-cover the game's objectives are not clear. In the game, the player first has to visit the loft to learn about the ghost [23]. Still, if the player decides to look around in the museum the ghost will strike automatically and the player gets involved in the game. Compared to the previous game, information on individual paintings is sparse and a lot less formal. When the player clicks the speaker next to the painting, the voice of grandfather mouse tells something about the content of the painting. More information is given when the print facility is clicked. This prints a sheet where formal information about the painting (e.g. maker, title, date) is only given in the header, followed by the painting's 'story' and narrative information about details [24]. This approach ties in with the mini-tasks which are all about what the painting represents. The loudspeaker's information helps solving each task so that learning is an integral part of game-play. All the information in the game is spoken [25], which makes the game suitable for a younger audience or children who are less proficient in reading. However, most voices are

male and as the game has been adapted by a Belgian company, speech is not always understood by Dutch children because of the pronunciation and typical Belgian sentence structures.
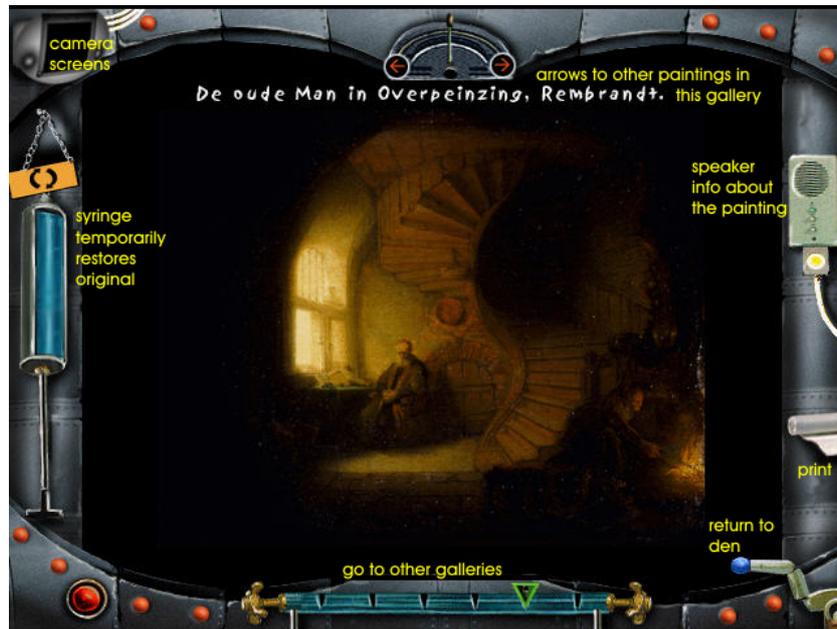

Figure 3 *Philosopher in Meditation* info screen (text not in the original)

When the ghost strikes, a whirlwind obscures the original painting [26]. Now Artur literally dives into the painting and the adventure starts. Artur becomes part of a 'cartoon' version of the painting and can interact with the characters depicted. He is given tasks which lead him to other paintings (with new mini-tasks and mini-games). The mini-games are loosely related to the painting and are either games of dexterity or puzzle-games. Each mini-game yields one or more items to solve either one of the mini-tasks or the original task. Whenever Artur enters a new painting the shadow of the ghost briefly appears. As the ghost has also left a personal message on the answering machine Artur is very much aware that he is battling an opponent, this clearly ads a thrill of danger element to the game. When Artur has solved all the paintings belonging to one gallery he is given a present. With the present he can 'trap' part of ghost back in his picture. Each mini-game solved is also added to Artur's collection of games in his den, so that he (the player) can play them at his own leisure.
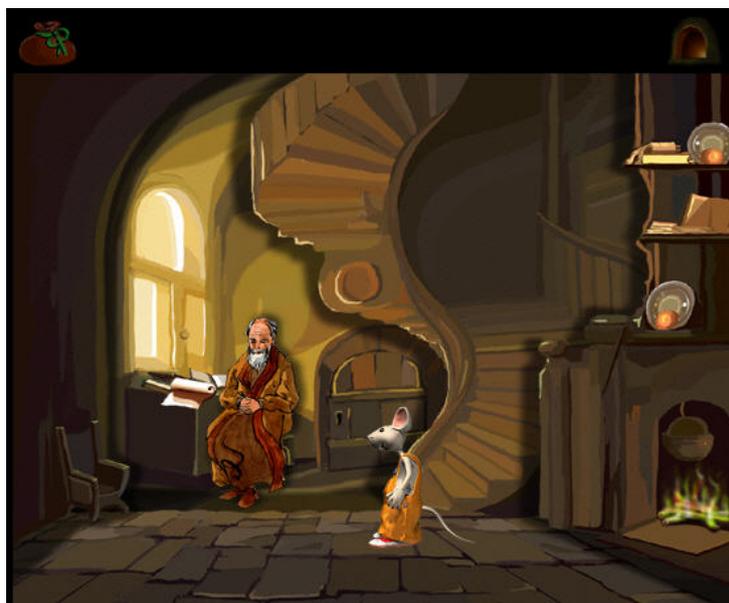

Figure 4 Artur talks with Rembrandt's philosopher

Once you know how the game works, navigation is not difficult. But the arcade-style mini-games are quite tricky and you often have to try a mini-game several times. Some of the puzzle mini-games are also quite difficult. The *ARTUR* game also suffers from technical glitches, which usually means having to leave the game and start again. Saving, however, is automatic (under the player's name), so that no or minimal progress is lost. The game is quite immersive, having solved one gallery you want to go on to see what adventures the other galleries hold and what mini-games you have to play. The player's curiosity is peaked and challenge, fantasy and discovery keep you well absorbed.

Of the two games the *MUSEUM* game conforms more to Heeter et all.'s findings on educational games. There is no opponent; competition is only against the clock. The virtual walk resembles walking through a real museum, so exploration is minimal. Discovery and challenge only comes through the puzzles. But these are very traditional. The back-story only loosely ties in with the game and, although the museum director explains each puzzle, while playing you soon forget about the original incentive. In contrast the *ARTUR* game clearly resembles commercial adventure games for children. In these games we also find arcade like mini-games and mini-puzzle-games. *ARTUR* captures the child's imagination and is very narrative. Exploration is compulsory and the mini-games are sometimes quite challenging. These are typical assets of certain types of commercial games which could prove to be an obstacle for children not familiar with these kinds of games.

2.2 The experiment

Due to the nature of the actual experiment we decided that each game should at least be played by eight children, four girls and four boys. To make the children feel as much at home as possible we wanted to conduct the experiment in the children's school and not in a controlled environment at the university. This meant that we had to find a school not only willing to let us use school hours for our experiment but also with a suitable place to set up the computer. Fortunately we found Bas Ruiter from the ASVO primary school in Amsterdam willing to have his class participate. As we wanted to make the children feel comfortable in this unusual situation we decided to put the test computer in the hallway next to their classroom, so that they would not be far away from the rest of the class. We also wanted to encourage the children to talk as much as possible about the games; we therefore decided to have them play in pairs [27]. To this purpose we asked them to give the name of another child with which they would want to play. Having a second child present also made it feel less of a test; which could influence the fun categories in a negative way. On test days the children would follow regular classes except when it was their turn at the computer. We soon found that the children really enjoyed playing the games and did not see it as a test at all but as fun time away from the classroom.

The actual experiment consisted of five parts:

- Written questionnaire on the children's experience with computer games
- Written test on paintings taken from the game they would play
- Playing the game (all sessions taped, verbal questions before, during, and after)
- Written questionnaire about the game play and 'test' on the interactive elements (navigation, icons, orientation)
- The same written test on the paintings

The first questionnaire was given some time before the actual playing of the game. In this test we wanted to find out if the children played computer/video games at home; how often they played; game preferences; whether they enjoyed playing; game equipment owned and some questions on affect. We also used it to determine that they did not already know the games in question.

The actual pre-test about the paintings was based on information given in the game. The questions were all open ended. With the *LEUKSTE MUSEUM* most questions were taken from the game. For the picture *The Procuress* by Honthorst the following questions were asked:

What time of day is it, day or night?
What makes you think this?
If you had to tell the painting's story what would it be?
In the painting you can see the young woman better than the old woman or the young man; can you see where the light is coming from?
What is the young woman holding?

For *ARTUR* similar questions were made, mostly based on grandfather mouse's information and information from the mini-tasks. The paintings in each test all belonged to the same gallery so that we could steer the children to this gallery during game-play. In both games we picked a gallery with paintings the children were less likely to know. The written test was taken in class and presided over by their teacher. This pre-test provided us with data for comparison with the post-test. Although the pre-test was held at least two weeks before the actual playing of the game we found that the children did recognize some of the paintings from the test. However, as this was valid for both groups and both games it should effect scoring equally. The post-test, which was exactly the same as the pre-test, was held at least two weeks after playing the game, again in the classroom with their teacher present.

Before playing the game the children were interviewed by Maria on their playing experience; games owned; game preferences; whether or not they visited museums and what kind of game they would design themselves if they were asked to make a game about paintings [28]. While the children were playing they were asked several questions about the game itself. These questions were designed to find out if they liked playing the game and what they found particularly appealing or what aspects they did not like. After playing the game the children were asked if they enjoyed the game; if they thought they had learned anything from playing it; if they could remember and describe a particular painting and if they knew or had recognized any of the paintings [29]. Everything that was said before, during and after the game-play was taped. The children were also observed while playing. The observations and the children's spontaneous comments during gameplay were used to determine the number and amount of fun elements in the games [30]. Having played the games ourselves we excluded physical activity, love, creation, social interaction, intellectual problem solving, power and altruism as they where not present in either or both games or not clearly distinguishable. This left us with Garneau's categories beauty, immersion, advancement and completion, application of an ability, competition, comedy, thrill of danger and discovery and Malone's categories challenge, fantasy and discovery [31]. Because we anticipated problems with *ARTUR* we also added the categories navigation and technical problems. Every comment was assigned to the appropriate category. Comments could be positive (+), neutral (ø) or negative (-). So while playing *ARTUR* a comment like 'This is stupid, he [Artur] is always saying the same dumb things' would be marked as comedy - or a comment like 'His clothes are really funny' would be marked as comedy +. We are aware that marking this way is subjective but we tried to be as meticulous as possible.

3 Findings

Although our aim was to have at least sixteen children play the games equally divided in boys and girls, owing to several causes beyond our control the actual groups consisted of six boys and six girls for the *ARTUR* game and three boys and three girls for the *LEUKSTE MUSEUM* game [32]. As the number of boys and girls in the second group was uneven, one boy and one girl played on their own [33]. So in total eighteen children participated, nine girls and nine boys. Children could not choose which game they wanted to play, game-assignment was random.

3.1 Playing Experience

As with the findings of the Intomart poll we found that game-play was widespread: all of the children taking part in the experiment played computer games. Playing frequency and hours spend, however, differed considerably.
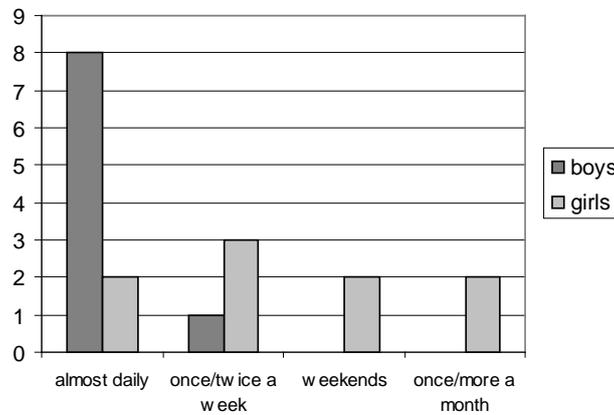

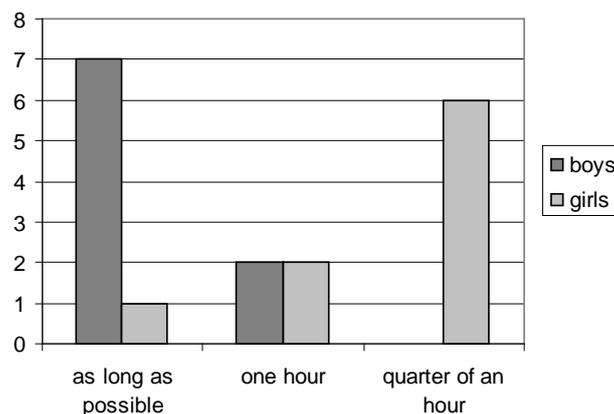Chart 2 How often do you play computer games?

Chart 3 How long do you play per session?

As charts 2 and 3 show, the boys in our group play more often and considerably longer than the girls. We also found that the boys owned more games than the girls; the majority owned more than ten games whereas the majority of the girls owned about half that amount. Boys were also more reluctant to put a game down and stated that they often played out of boredom. Both boys and girls play on pc, console and gameboy with a preference for pc-play in both groups. This is directly linked to their preferred games which were strategy games (these games were mentioned by nine children, both boys and girls), sport related and racing games (seven children, majority boys) and The Sims (seven children, majority girls). The Sims thus ranked the list of most mentioned game-titles, followed by Roller Coaster Tycoon which was mentioned four times [34].

All children interviewed visit museums; most of them only occasionally and only half of them enjoying the experience. When asked about their favourite museum, the Amsterdam science museum NEMO came on top. As this is a hands-on museum for children this came as no surprise. When asked how they themselves envisioned a game about museums and works of art, most of them stated that they would make a game about walking through a museum having to find certain paintings in a puzzle environment, learning about the paintings and being quizzed afterwards. Some also mentioned building their own museum or making their own painting. Most children included action, comedy, danger, mystery and mini-games in the description.

3.2   Enjoyment and fun categories

When asked if they had enjoyed participating in the experiment all children were positive. Most of them said they would like to play these kinds of games in school and most of them also wanted to finish playing 'their' game at home. The elements they liked best in *ARTUR* were the mini-tasks and mini-games which involved helping Artur and the people in the paintings [35]. Looking for clues and watching the on-screen action were also mentioned frequently. In the *MUSEUM* game solving the puzzles was by far the most favourite element. The elements they liked the least in *ARTUR* were that exploration was not straightforward, making them feel disorientated, and the Belgian accents. In the *MUSEUM* game the children mentioned the way in which the information was presented (figure 2) which they found unimaginative and boring. Both terms were also used for other elements in the game, for instance for the graphics and the sound/music. On the whole it can be said that they found the *ARTUR* game more challenging and imaginative but that it was also more difficult to play. The *MUSEUM* game, on the other hand, was much easier to play (some said too easy) but lacked in imagination vis-à-vis gameplay and visualisation.

It is therefore not surprising that in the children's comments, the *ARTUR* game scored more often on the plus-side in the categories curiosity, challenge, fantasy, discovery, thrill of danger and comedy. Of the 287 remarks 91% were positive and only 9% negative. The *MUSEUM* game also elicited more positive comments, but only 65% of 75 comments made. Also remarkable was the fact that the number of comments made per child was considerably higher for the *ARTUR* game averaging 23.4 (boys 26.3; girls 20.5) compared to the *MUSEUM* game with only 12.5 comments per child (boys 12; girls 13).
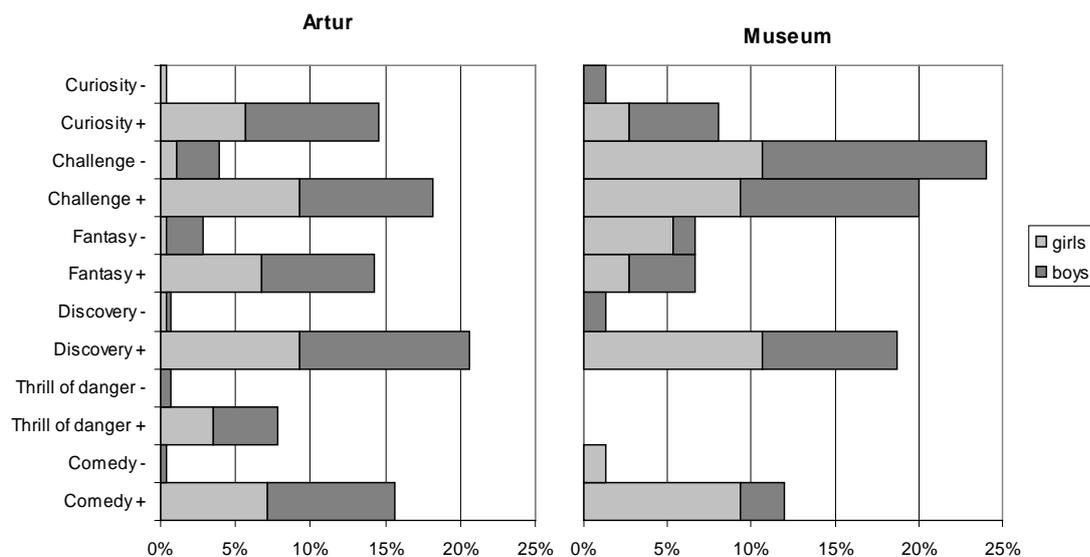

Chart 4 Percentage of remarks per category

In chart 4 the percentage of remarks per category is given. The clear difference between positive and negative remarks for the *ARTUR* game is immediately noticeable, as is the distribution of positive and negative comments in the challenge category in the *MUSEUM* game. The latter seems odd, however, the positive comments relate to the puzzles and the negative comments either to a few of the more tricky puzzles or to the game as a whole. Since these numbers represent less children and less remarks one should not compare the percentages between the two games but look at the distribution for each game separately. These show hat the *ARTUR* game scores almost equally in all categories, with the exception of thrill of danger (they were clearly not impressed by the ghost), whereas the *MUSEUM* game's scoring is more disparate [36].

The other four categories: beauty, immersion, advancement and completion and application of an ability, were addressed independently as we considered these to be more general.

Here we found that Artur scored better in the categories immersion and beauty but less in the category advancement & completion. Both games scored equally well on application of an ability:
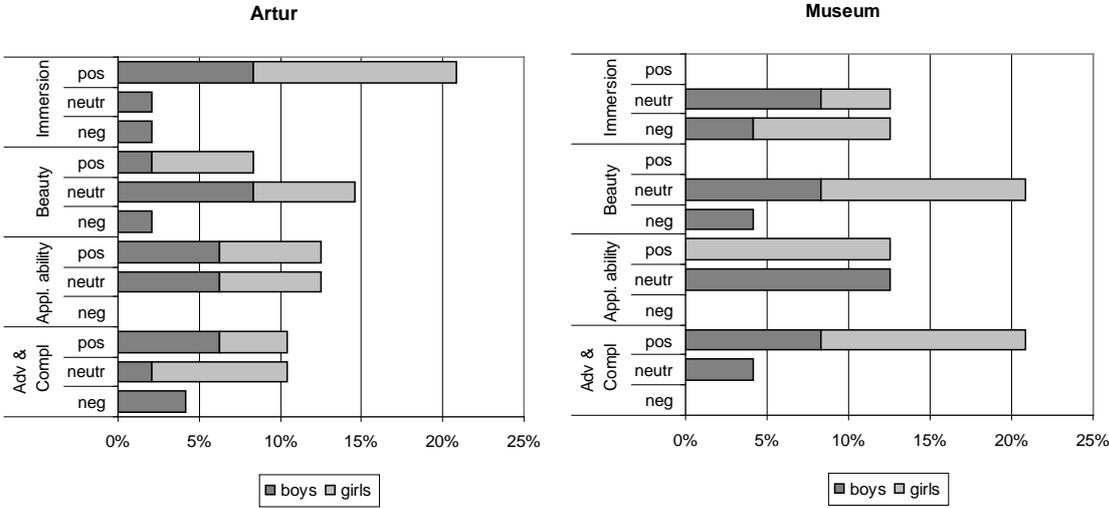

Chart 5 Percentages general categories

It is interesting to see that with the ARTUR game all the girls' remarks in the immersion category were positive and on beauty they were also more positive than the boys. In the category advancement and completion girls were more negative. In contrast, in the MUSEUM group the girls were all positive about their achievements, both regarding application of an ability and advancement and completion.

Both sets of data confirm the answers given in the written questionnaire. The ARTUR game is more appealing visually and in gameplay. However the children who played this game did not think that they had accomplished as much as the children playing the MUSEUM game. This is also shown in their responses to our direct question when we asked them whether or not they thought they had learned anything from playing the game:

	yes, a lot		yes, some		perhaps		no, not much		no, nothing	
	b	g	b	g	b	g	b	g	b	g
ARTUR	1	0	1	0	2	1	2	4	0	1
MUSEUM	1	2	2	0	0	0	0	1	0	0

Table 1 Children's own assessment of knowledge acquired

We asked this question immediately after the game-play session, when the post-test was still two weeks away. As table 1 shows on the whole the children who played the MUSEUM game were a lot more confident about the knowledge they had gained than the ARTUR group. Interestingly two girls in the MUSEUM group said that they had learned a lot from playing the game, whereas in the ARTUR group most girls felt that they hadn't learned that much.

3.3 Navigation and technical problems

Navigation has to do with orientation as well as with hand-eye coordination (mouse skills). So any comments made in either group were summed up and added to the categories navigation+ and navigation- for both games. Chart 6 shows the results:
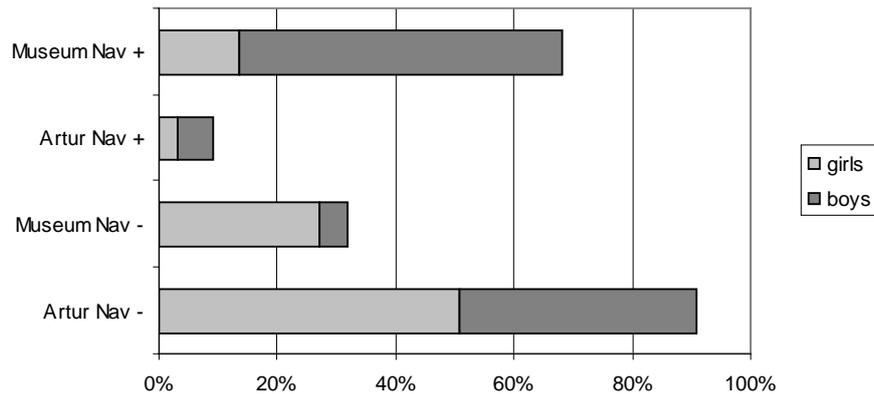
Chart 6 Positive and negative comments on navigation in percentages

It is obvious that *ARTUR* scored quite badly in this category, where girls were slightly more negative (51% of 65 remarks) than boys (40%). While they were playing we noticed that the girls in the *ARTUR* group asked more questions about navigation and required more encouraging feedback. In the *MUSEUM* group 69% of the 22 remarks made by the children were positive. What is interesting to note is that the difference between the boys and the girls are more prominent here. The girls made markedly more negative remarks and the boys markedly more positive remarks. So even though navigation in the *MUSEUM* game is a lot easier, the girls still seemed to have more problems than the boys.

We also asked written questions on orientation and on the transparency of the icons. Here again the *ARTUR* game proved to be more difficult for the girls. Although both 17% of boys and girls said that they got disorientated while playing the game, only 17% of the girls were completely certain of where they were and what was to be done, as opposed to 67% of the boys. From the written questions it became clear that girls were less adventurous at clicking and therefore didn't notice the function of certain screen elements. On these questions the boys did markedly better. Compared to *ARTUR* the *MUSEUM* game was crystal clear; everyone knew where they where and what was expected of them and in the questionnaire the girls even did slightly better than the boys. Only on some of the more obscure icons both boys and girls failed to give the correct answer.

As we encountered a few technical problems while playing the *ARTUR* game ourselves we introduced this as a separate category. Technical problems hinder navigation or make it completely impossible which in turn will have an impact on pleasure. Unexpectedly children playing the *MUSEUM* game also made remarks about technical issues. All in all 23 remarks were made in the *MUSEUM* group i.e. 3.8 comments per child. In the *ARTUR* group 38 remarks were made i.e. 3.2 comments per child. Because of the marginal difference between the two, we surmise that the technical problems encountered will influence the post-test equally for both games.

3.4 Results of the tests

In the pre- and post-test the children were quizzed on their knowledge of six paintings in the *ARTUR* group and seven paintings in the *MUSEUM* group. The Artur-test consisted of eighteen (sub-)questions and the museum test of seventeen (sub-)questions. We scored the tests as follows: a completely correct answer was awarded two points, a partially correct answer one point and zero points were given for an incorrect answer [37]. This gave us a maximum score of 36 for the *ARTUR* test and 34 for the *MUSEUM* test. When we marked the pre-test the difference between the girls and the boys in the *MUSEUM* group was marginal; the girls' average being nine points and the boys' ten [38]. For the *ARTUR* group we expected similar results but we found that the boys scored an average of twelve points whereas the girls only managed an average of seven-and-a-halve. We wondered why this was so. As far as we

could tell the only marked difference between the paintings in both tests was that the *ARTUR* paintings were more figurative and lyrical, but this usually means that girls have an advantage. Perhaps the paintings' subject matter appealed more to boys or perhaps the girls were too uncertain to give an answer at all? As this was the pre-test we could not ask the girls themselves, because that would have biased the outcome of the post-test so we left it at that for the moment.

That children have a lively imagination is well known and because most of the questions were open-ended, describing what they saw, we received some very colourful answers. For the picture *The Procuress* by Honthorst (see § 2.2) our Amsterdam children thought that the painting was about:

- Drug trafficking where the young woman is holding a bag of drugs.
- The young woman is telling a joke and she is holding a large pan so that she can hit the man over the head when he doesn't think her joke is funny.
- Trading meat, with the young woman holding a large ham.

On the appearance of the ghost in the *ARTUR* game the following conversation ensued:

(c):   'He looks a bit like Einstein.'
(m):   'Einstein? No, Einstein wasn't an evil person.'
(c):   'He was… he also came with a jolt like that and then he was alive'.
(m):   'Einstein? Oh, you mean Frankenstein.

Having seen the results of the pre-test we were very interested in the results of the post-test. In the *MUSEUM* group the boys bettered their average by three points now scoring thirteen. The girls in this group did better; their average went up by six points to fifteen. But the results in the *ARTUR* group were even more astounding. The boys in the group gained four points, now scoring an average of sixteen points. The girls, however, improved their average by seven-and-a-halve points, now getting fifteen points. One girl even improved her score by ten points and another by nine. According to these findings it would seem that the girls in both groups gained more by playing the games than the boys.

Still, we should not jump to conclusions. Looking at the individual answers we saw that some of the boys had scored less on particular questions because they answered them less carefully the second time around. So the boys' achievement for both games could have been better than data suggests. However, this does not diminish the girls' achievement. We can only speculate why they did so well in the post-test compared to the pre-test. We do not think that playing the games should get all the credit. Rather we think that the girls probably paid more attention to what was being said about the paintings when they were playing, perhaps triggered by the pre-test. Or they were now more confident. Or the boys got more carried away while playing and forgot about the test. The boys' familiarity with adventure type games could also mean that they clicked more intuitively and faster, missing valuable information. However, this does not explain why the girls in the *ARTUR* test did not think that they had learned much by playing the game (see table 1).

4   Conclusions

Ninety-nine percent of Dutch children aged eight to twelve like to play computer games. The use of computer games as regular teaching tools in the Dutch classroom, however, is virtually non existent, despite the increasing amount of time pupils spend using ICT. Teachers are reluctant to use games because they feel that their use of ICT in the classroom is still in an adaptation phase. Furthermore they feel that there is a limited amount of data available on the actual educational use and benefits of computer games. Finally the present system of educational standards relies mostly on conventional teaching materials, where computers play a supportive part as a writing, information retrieval or communication tool. Yet, it is well known that computer games are intrinsically motivating, which makes them

valuable as a teaching tool as well. However, most recent studies on the use of computer games in the curriculum focus on the benefits of the use of commercial games because these are the games that children like to play. Still, as Heeter et al. have shown, using certain key aspects of commercial games, educational games can be made more appealing.

To explore a possible connection between the intrinsically motivating fun-elements of computer games and their educational content, we set up a small scale qualitative experiment where eighteen children played two educational computer games. The first game *HET LEUKSTE MUSEUM VAN NEDERLAND* is a traditional educational game that complies with the findings of Heeter et al.. The game-play of the second game *ARTUR EN DE GEEST VAN HET MUSEUM,* although also educational, is clearly based on commercial games in the adventure type category. It was therefore not surprising that in the remarks the children made while playing, this game scored markedly better on the fun-categories curiosity, challenge, fantasy, discovery, thrill of danger and comedy. *ARTUR* also did better in the categories beauty and immersion. This was confirmed by the children's answers to written and verbal questions.

The *ARTUR* game resembles a traditional adventure type of game with arcade like mini-puzzles. We found that this made orientation and navigation difficult, especially for the girls. The boys were more confident about what was expected of them. This could be explained by the fact that the exploration orientated type of game-play presented by the *ARTUR* game is similar to the type of game-play the boys prefer. They are more used to search for clues and hidden treasure and are therefore more likely to explore all the items on a screen to see what happens. Playing more often and longer than the girls also means that they are more dexterous using a mouse. One would assume that with a game like *ARTUR* this would put them at an advantage. Perhaps as a consequence the boys were more confident about what they had learned from the game than the girls. In the *MUSEUM* game the girls were more confident about their achievements both in their remarks as well as when asked directly.

The children's intuition was, however, not corroborated by our test-data. Here we found that in both game-groups the boys as well as the girls had learned new information. We furthermore found that despite the fact that the girls lacked certain mouse-skills and despite the fact that they were more thrown by *ARTUR*'s exploratory navigation and unfamiliar game-skills, they did extremely well in the post-test. Moreover we found that the girls in the *MUSEUM* game group also did better in their post-test compared to the boys. That the boys achieved less with both games can be partly explained by the way they approached the post-test. This still leaves the question unanswered why the girls in most cases improved so much. As we were focussing on fun-elements and learning we had not anticipated this outcome and therefore had not provided questions to explore this seeming discrepancy.

4.1 Recommendations

Although our own and other surveys have shown that Dutch girls play less long and less frequently than boys and that the girls' game preferences mean that they lack certain game- and mouse-skills, the girls did learn new information from playing the adventure type game. Why this is so, we do not know. We would like to test both games with a larger group of children to see if our findings still hold true. This would also give us an opportunity to find out why the girls' pre-test scores in the *ARTUR* group were so low. Was this just a fluke or were the paintings or the questions somehow biased towards girls? (And if so, why didn't the *MUSEUM* test show similar results?) And why does it seem that the girls have learned more than the boys? Are the girls trigged by the pre-test or do they benefit more from the way they learn in the games? And if they did have comparable mouse and game skills to the boys would this imply that their score would even be higher? Only testing with one or more control groups can help answer these questions. As we can not answer them at present, it is too early to say that the type of game used for educational purposes does not matter. To this purpose surveys on computer games should also include questions on types of games and gender preferences. And data on the use of ICT in the classroom should also include figures on the use of (educational) computer games. This will help to ensure that fun elements and

game elements in educational games in future will reflect the preferences of both boys and girls. That children merit from playing games has been shown by this and other experiments. So teaching authorities should be less reluctant to incorporate games in the curriculum. That educational games do not have to be lacklustre but can be as entertaining as commercial games is shown by *ARTUR EN DE GEEST VAN HET MUSEUM*. If there were more educational games like *ARTUR* both teachers and children would see that learning can be fun!

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[16] NIBUD. Rapport 'Kinderen en Geld Enquête'. Utrecht: 2003, p. 7. http://www.nibud.nl/docs/rappjj.pdf, 21/06/2006.

[17] Gaming: a collaborative project by SURFnet and Kennisnet.

[18] see the reports mentioned in note 3 and BEEKSMA Jetske; VAN DER HULST, Arno. Games – meer dan spelen; ICT verkenningen voor het onderwijs. Zoetermeer: 2005.

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[20] KUNST & KIDS. *HET LEUKSTE MUSEUM VAN NEDERLAND* Hilversum: 2002. The literal translation given in the text is 'the most fun museum of the Netherlands' but in the game itself the museum director talks about 'the most beautiful museum of the world'. The game was made in collaboration with the Dutch museums Rijksmuseum, Mauritshuis, Boijmans van Beuningen, Van Gogh and Centraal Museum which each picked ten famous paintings from their own collections to incorporate in the game. Kunst & Kids is a small independent developer. They make games as a passion not as a serious commercial enterprise.

[21] LANNOO. *ARTUR EN DE GEEST VAN HET MUSEUM*. Warnsveld: 2001. This game was originally conceived by the French Réunion des Musées Nationaux which is reflected in the choice of paintings which are famous works of art found in the collection of French Museums. Computer games and educational games have a higher status in France than in the Netherlands. Therefore there are more serious developers available and budgets are larger.

[22] *ARTUR* is recommended for seven to twelve year olds, but as we found in the experiment children have to be a certain age to be able to play the game on their own without a parent or teacher there to help them.

[23] In the experiment all the children in the *ARTUR* group where therefore instructed to visit the loft first.

[24] This is not very practical in a class setting. It would be advisable to have all the information in a binder so that the children could look it up in there. Or it should be possible to read the information in a separate window on screen, with printing optional.

[25] Except, of course, when the print function is used.

[26] By using the syringe to the left the original painting can be temporarily restored

[27] On the benefits of playing in pairs in usability research with young children see CHAMBERLIN Barbara. Creating Entertaining Games with Educational Content: Case Studies of User Experiences with the Children's Website, The Food Detectives Fight BAC!® Dissertation. Charlotsville: 2003. http://www.cahe.nmsu.edu/bchamberlin/publications.html 14/06/2006. After our experiment new research found that paring children does not necessarily facilitate natural thinking aloud but rather evokes talking aloud. See ALS Benedikte Skibsted; JENSEN Janne Jul; SKOV Mikael B. Exploring Verbalization and Collaboration of Constructive Interaction with Children. In: Conference Human-Computer Interaction - INTERACT 2005 proceedings, pp. 443-456. Rome: 2005.

[28] We repeated some of the questions from the preliminary questionnaire to avoid any misunderstandings the questionnaire might have posed. The kind of game they would like to design themselves would give us further information on their own game capabilities and preferences. We also thought that it would give them a smooth transition to the actual playing of the game.

[29] Because we asked them where they had seen a painting, we learned that quite a few of them remembered the paintings from the pre-test.

[30] As a more 'objective' way to determine which game was more fun to play, as opposed to the direct questions where they again might give preferred answers.

[31] We felt that Malone's categories were so basic that they had to be included. Heeter et al.'s category 'learning' would be tested separately.

[32] At the time of the experiment three to five subjects were considered sufficient for usability testing (see amongst others NIELSEN Jakob. Usability Engineering. San Fransisco: 1993). Research since suggests that for usability testing with children different rules apply. See BARENDREGT Wolmet; BEKKER Mathilde M. Extended guidelines for usability (and fun) testing with children. http://sigchi.nt4all.nl/documents/Barendregt%20&%20Bekker%20-%20testing%20with%20children.pdf 14/06/2006.

[33] Contrary to our expectations they were very talkative. For the fun-orientated categories (see 3.2) the *MUSEUM* game yielded 75 comments which averages to 12.5 comments per child. The boy playing on his own contributed 13 comments and the girl 11).

[34] The difference in game preferences between boys and girls are also shown by the Waag Society where similar aged girls preferred action/adventure style games and the boys race/sports games (WAAG SOCIETY. Demi Dubbel's teletijdmachine: onderzoeksrapport. Amsterdam: 2002). In the BBC report on game play in the UK the vast majority of six to ten year old girls preferred to play puzzle games whereas the boys in that age category mostly liked to play action adventure games and racing games. In the eleven to fifteen year olds category, game preferences were the same (BBC. Gamers in the UK: Digital play digital lifestyles. 2005)

[35] From their comments it is not clear whether they see this as acts of altruism or just as acts triggering the sub-tasks and mini-games. The children in the *MUSEUM* group did not mention that they wanted to help the distressed museum director.

[36] In the museum graph you will notice a gap in the thrill of danger category, this is because no comments were made at all in this category by the six children in the museum group.

[37] Or when they had left the answer blank.

[38] We were not concerned about the relatively low scores, especially since it was a pre-test about paintings the children did (hopefully) not know. Even with the post-test the actual scoring did not matter. It was only there to see if playing the games made a difference at all.

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