"Puzzle Drive"

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Aalborg University Esbjerg 2006/2007

1. Introduction

1.1 A statement of the problem

Computer games are a very popular pastime. Since the creation of the first game in 1958 (Bellis, 2006), computer games have progressed from being simple square blocks on the screen to almost a photorealistic quality. This evolution has given the game developers more freedom to explore areas of gaming that for 48 years ago would have been dismissed as pure fiction.

Educational games have been part of the game genre since the early 70ies. (MobyGames™, 2006) Given that these game haven't the same number of loyal fans as regular game have had, these games have only evolved slowly. The primary followers of this type of game have been teachers this meant have always had tremendous focus on the educational part.

The situation today is that only a few new educational games are created each year. Usually these games are aimed at the 5-7 year old, and the level of difficulty is often lower than the ones in school-related education. This leaves the older, pre-teen school kids (7-16 year old) with either old games, or with only traditional forms of education. The problem with these old games is that they don't fit the today standards within computer games (Dickgrave, 2005). They don't have the nice graphics, the cool sounds and the interesting game play. According to Alan Lenton, a highly regarded game designer, the reason for this lack of evolvement within the educational games used in schools is of a financial matter. He claims in an interview that:

It's difficult and expensive to write a good game. It's difficult and expensive to write good educational software. To try and do both at the same time is a major exercise in the management of complexity. Add to that the tendency of teachers to make copies of commercial software to pass round their cash-strapped schools and you have an understandable reluctance of companies to invest in anything that might be a real 'educational game'. (Lenton, 2005)

So the problem is, how do you create an educational game for school-related education, using simple inexpensive tools, which is still interesting for the student to play. In the same interview, Lenton says that:

Most games that are purported to be educational are boring — boring games and boring 'education'. (Lenton, 2005)

This means, that according to Lenton the educational games are boring because of both their contents and their subjects. So, for an educational game to be interesting, it has to include some kind of motivational elements combined with the educational ones.

How can we improve educational games? Are there any other game genres that have some kind of motivation we can use in educational games? The answer could be puzzle games these games are simple games yet very entertaining to play.

The puzzle game genre was first defined in 1985 with the game Tetris. The fact is that Tetris was far from the first puzzle game. Some of the first puzzle games were games like minesweeper, and card games like such as solitaire, which both was developed before 1985. Tetris however changed everything it was immensely popular, as discussed here: http://en.wikipedia.org/wiki/computer_puzzle_game

Puzzle games were remarkable in the way that they were simple games that focused on the player having fun while doing fairly simple activities. These games ranged from mindless entertainment to difficult engaging puzzles.

I light of this we think it would be interesting to know if it's possible to improve an educational game by adding what we call the motivational elements from puzzle games.

 Our field of interest during this assignment will be educational computer games and computer puzzle games.

1.2 Goal
The final result of this thesis will be a working prototype of a game that includes these motivational elements which should improve the level of interest.

In order for us to do this we will first find out which games are used today within the field of educational games and specify which common factors are present within this type of games. Secondly we will have to define what a puzzle game is, and find different puzzle games within this definition. We will then highlight the motivational elements within these puzzle games to find out what makes them so interesting to play.

Furthermore we will find out if we can combine the elements from both game genres and thereby create some structural guidelines, which should result in an improved educational puzzle game.

Is it possible to create a game that is motivational but educational at the same time, using the elements from both genres? We will evaluate this by doing user tests and interviews in the form of a questioner.

1.3 Definition of terms

We need to define some key terms that we will use in our report in this section we will explain what we mean when we use them.

Game
"A game is a structured or semi-structured activity, usually undertaken for enjoyment. They are usually fun activities that can be educational or purely just for fun." (Wikipedia the free encyclopedia, 2006)
When we use the term Game, we mean a computer game. In a computer game the player interacts with different objects on a screen. The interaction is either done by an input device, such as a keyboard, mouse or a joystick.

Game, Arcade
An arcade game is a game that originally was developed for a coin operated entertainment machine. In this term we also include versions of a given game who later have been converted to home gaming systems.

Interactive
If a computer game is interactive the user has to do something in order for the game to respond. The antonym to interactive can be passive when related to computer interaction.
Among other we use the term to explain how much the player has to interact with a game. If the given game is highly interactive the game requires the player to do a lot of things in order to get a response.

Motivational Elements
We use this term to describe the elements within a game that motivates the player not to stop playing or even play more. (more on this in section 2.2.2)

Multiple step thinking
We use this term to describe how a person can plan ahead. For example in chess good players think several steps ahead.

Prototype	*"An original type, form, or instance serving as a basis or standard for later stages."* (The free Dictionary by Farflex, 2003)
	Our goal is not to create a perfect version of a game that can be published, we create a playable version, but should we want the game to be ready for publication, several things need to be added.
Sub-Genre	Genres are often divided into sub-genres in movies for example a movie can be a drama, and a thriller.
	We use the term to describe that game-genres can be broken down to sub-genres.
User interface	User interface, UI shortened, *"the user interface (of a computer program) refers to the graphical, textual and auditory information the program presents to the user"* (Wikipedia the free encyclopedia, 2006)

1.4 Methodology

In this thesis we will first research the field of educational games, discover what kind of sub-genres there are and what they contain, we will then deduce a set of common elements that they include.

Next we will find out how puzzle games are motivating the player to play them. We will then analyse a number of games according to a set of guidelines and confirm these elements.

After this we will discuss both the aspects of the educational game genre and the motivational elements from puzzle games, and lastly define a common set of constructing elements, including essentials from both genres.

This information we will use to create a game prototype that includes the educational elements from educational games and the motivational elements from puzzle games. We have chosen that this prototype will be a math-based game, because we believe that this particular subject represents an universal language and can be understood by anyone despite their language-

capabilities.

We will then test this prototype on a 6th grade math class in a local school and see if they think we have improved the concept of an educational game.

1.5 Description of chapters

In this chapter we have introduced the thesis. We have described the problems, and how we expect to solve them. We have defined a number of terms used within this paper and described the literature we have used during our research. Finally we have explained our use of methods during the thesis.

Chapter 2 is divided up into 3 sections.

1. Where we define what an educational game is, and find the inner working of this type of game. Afterwards we will investigate games as educational tools and how students can lean by playing this type of game.

2. We start defining what a Puzzle game is, afterwards we will review different opinions on why and what makes puzzle games so motivating to play. We will investigate the area of motivational elements within puzzle games, and then analyze 6 typical representatives of puzzle games in order for us to find the motivational elements within them.

3. Lastly we will sum up the analysis, and afterwards discuss how we can combine the motivational elements of puzzle games with an educational game.

Chapter 3 is about the development of the prototype that includes the results from chapter 2. Chapter 3 is divided into two main sections:

1. The guidelines for developing a game and
2. The actual development.

In chapter 4 we will evaluate the prototype and lastly in chapter 5 we will conclude our findings and on the entire process.

2. Educational- and puzzle games

In this chapter we will first look into educational games, after this we look at puzzle games and lastly discuss our findings.

2.1 Educational games

In this part of our assignment, we want to find out what makes an educational computer game educational, and which elements are the most common features of such a game. These elements will then play an important part in our own prototype. In order for us to do that, we will first consider what an educational game is and how to define it. Furthermore we will investigate the area of educational games, and discuss the different sub-genres included. We will then highlight which common factors, within these sub-genres, we think are the most relevant according to our purpose.

After that, in order for us to gain more knowledge about the educational influence of educational games, and how to create that influence, we will look into some advantages and disadvantages of the use of games as an educational tool and investigate their probable educational effect.

The method that we will use is a case study of educational games, to investigate the different sub-genres of educational games and their common factors, and the educational effects of games.

2.1.1 Definition

In order for us to discuss the different games in the genre of educational games, we are first going to define what we think is an educational game. And with that- which criteria has to be present for a game to be educational. Furthermore we will investigate the field of educational games to find out which sub-genres are present in educational games. According to the glossary, an educational game is:

"*A computer-assisted instruction technique in which skill and chance are combined for practice of previously taught information*" (Bixler, 2001).

This means that any game played on a computer with the ability to enhance the skills and knowledge of a player concerning any kind of familiar subject is seen to be educational. But this practically describes any computer game with an actual subject included, and not every game is

seen to be educational. We therefore have to figure out, what makes an educational game differ from a "normal" one.

Wikipedia states that educational games are:

 "games; board and card games, including video games that are designed to teach people, typically children, about a certain subject, expand concepts, reinforce development, understand an historical event or culture, or assist them in learning a skill as they play (Wikipedia, the free encyclopedia, 2006)".

To the question; "what is a computer game?", Wikipedia says that:

 "a computer game is a computer-controlled game where players interact with objects displayed on a screen for the sake of entertainment (Wikipedia, the free encyclopedia, 2006)".

With that we can see, that the main difference between a "normal" computer game and an educational one is the actual purpose of the game play. Both of them has the ability to train and teach the player into getting better at a given subject, but the purpose of a "normal" game is basically entertainment whereas the purpose of an educational game is mainly educational.

So, educational games differentiate from "normal" games basically only in purpose. That is, there is a change from playing the game for social and personal amusement goals to learning and educational goals. Educational games are therefore primary defined through their goal: to educate a student in different skills or concepts that are relevant to real world situations.

Based on these statements, we have chosen to define an educational game as being: **Any game with the ability and purpose of teaching and training the skills of a student concerning any recognizable subject that he or she can use in the real world.**

Through a search on the Internet, we found a list, containing different types within the genre of educational games, which cover a wide area of different educational subjects. We have chosen to use this list to describe and define the field of educational games. The list refers to these types as "educational styles", but because of the fact that they are describing different types of the same computer game-genre with different subjects, we consider them to be sub-genres.

According to www.allgame.com, the following list represents the different sub-genres contained in the genre of educational games. There are probably more sub-genres, but we accept this list to be sufficient for our purpose. Each of these sub-genres can then, when used in educational

context, differentiate in difficulty, subject, layout etc. in order to fit the changing grade levels of students throughout different classes in school:

- Geography	- History	- Interactive Book
- Language	- Math	- Music
- Quiz Games	- Reading	- Science
- Social Interaction	- Spelling	- Sports Instruction
- Test Preparation	- Typing	- Writing

(All Media Guide, LLC., 2006)

2.1.2 Sub-genres

Each of the different sub-genres, mentioned above, has some kind of purpose concerning its ability as a learning tool. Each area has its own unique field of interest, which describes its purpose.

Geography

Games present in this category are often based upon different kinds of information and questions and coursework concerning the locations of- and information about countries, states, continents and cities around the world. Often these games are presented as informative lessons followed by relevant questions (All Media Guide, LLC., 2006).

A good example of a geographical game is the Globetrotter2©, in which the student have to travel through 70 different locations around the globe to advance in the game and become president of the Globetrotter Club. During the trip the student will have to complete different assignments at each location, and answer questions according to these locations, in order to earn travel-money (MobyGames™, 2006).
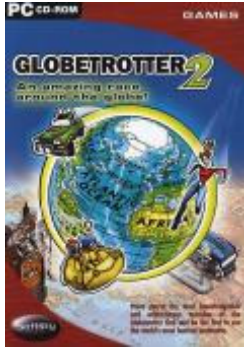
Figure 1 - Globetrotter 2©

History

In this sub-genre, the students of the games can gain knowledge about the past, concerning both specific historically events and different periods of time. The goal is often to inform the student, and to let him or her experience things from the past through images and information. The gained experience is then put to the test, often through a quiz or an adventure-game- presenting historical questions and puzzles from the past- to be solved by the student (All Media Guide, LLC., 2006).

An example of such a game is the "Exploring Ancient Cities©", in which the student is put through a journey back in time to visit four great abandoned cities; Pompeii, Petra in Jordan, Teotihuacán in Mexico and The four great palaces on the isle of Crete. Each location is presented through interactive images, movie-clips and information (All Media Guide, LLC., 2006).
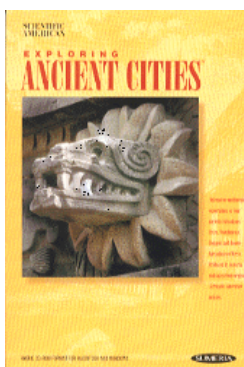
Figure 2 - Exploring Ancient Cities©

Interactive Book

Interactive books can contain all kinds of different subjects, styles and information for the student to gain knowledge from. The main feature with these books is that the student can influence a part of the action on the screen, allowing him or her to interact with the gained information in the book. This gives the student a much wider angle of information through the actual interaction with it. This interaction can both be influencing the story itself but also the elements included in the story (All Media Guide, LLC., 2006).

"Curious George Preschool Learning Games©" is an example of such an interactive book, in which the student can interact with different objects, figures and small games, during the story of a little curious monkey. The goal with this interactive book is to teach the student about shapes, colours, pattern recognition and rhyming (Amazon.com, Inc., 2006).

Figure 3 - Curious George Preschool Learning Games©

Language

Games of this kind presents actions or interactive training intended to advance skills of listening, writing, speaking, and reading, often in a different language (All Media Guide, LLC., 2006).

As an example of such a language-teaching game, we can mention the "Instant Immersion English©", which is a cd-rom-based game presenting different tutorials concerning the training of the ability to perform authentic everyday English language. The game covers a large variety of different situations and conversations in which the student can practice how to master the language (All Media Guide, LLC., 2006).

Figure 4 - Instant Immersion English©

Math

As the name implies, math games are intended to increase the math skills of the student. There are as many different games in this particular sub-genre as there are mathematic subjects. They vary from early calculation-skills and number recognition to complex algebra, data-information and statistics. These games are mostly aimed at different grade levels in school, and tailored to fit different difficulty-levels (All Media Guide, LLC., 2006).

"Fun With Numbers" or as it was originally called "Basic Math", is a good example of a math game, which is designed to help the student with different simple mathematical subjects, such as addition, subtraction and multiplication. The game is build up in a very simple interface, displaying a number of different equations one at the time for the student to solve (All Media Guide, LLC., 2006).

Figure 5 - Fun with Numbers©

Music

The goal of these games is to inform and teach the students about the creation of music. This knowledge is often in form of informative software about how to play an instrument, how to read

music, how to compose or how to organize music, for instance with an orchestra. Games in this category are often specialized in different music-genres and styles (All Media Guide, LLC., 2006).

A good example of a music-game is the "Adventures in Music with the Recorder©", which is a program that can educate children in different aspects concerning music, such as tempo, rhythm and harmony. During the game, the young student will travel around the globe, visiting different countries and leaning new songs (All Media Guide, LLC., 2006).

Quiz Games

Quiz games are designed to challenge the student with questions about a certain subject, which the student should gain knowledge in. These questions can be in the form of multiple choice, fill in the blanks, matching, etc. or a combination of them. The goal with these games is often more visibly educational than entertaining, as the student is challenged into gaining knowledge about a subject for him or her to be able to answer the questions. In other words: the student knows that he or she has to learn in order to be successful (All Media Guide, LLC., 2006).

An example of such a game is the "Bible Quiz©", which is a program that can test the student's knowledge of the Bible and increase that knowledge with new information. There are three different difficulty levels, presenting different questions concerning three different areas: General, Women in the Bible and Wars and Battles (All Media Guide, LLC., 2006).
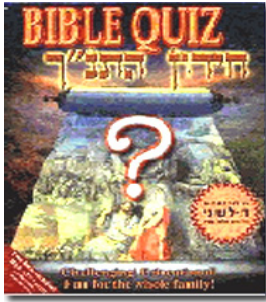
Figure 7 - Bible Quiz©

Reading

Educational games about reading are often using different instructions in relation to subjects such as letter recognition, word detection, phonetics, and verbalization-skills in order for the students to improve their reading and pronouncing abilities. These games are usually aiming at different age groups, determined by difficulty and subjects. These subjects are usually designed to be appealing for the particular age group in a way for the representing students to be more interested in the game (All Media Guide, LLC., 2006).

"Astro Word©" is an example of a reading game, in which the student learns how to read, and how to use different grammatical rules such as compound words, short- and long vowels, suffixes etc. To teach the student these skills, the game is build up like a factory in which the student can "build" words, sort words and write words using the implemented tools (All Media Guide, LLC., 2006).

Figure 8 - Astro Word©

Science

These types of educational games are intended to educate the students about different forms of science like for example astronomy, physics, chemistry or engineering. They are mostly very informative and they often persuade the students to take part of the actions through interaction

with the game and thereby increase their understanding of a given subject (All Media Guide, LLC., 2006).

A good example of a science game would be the "Invention Studio©", which is a game that lets the young students create their own inventions. At the same time, the students can learn about other inventions and the process of inventing. Included there are a number of projects and inventions for the students to investigate and work on (All Media Guide, LLC., 2006).

Figure 9 - Invention Studio©

Social Interaction

Games of this type are often constructed to generate real life situations in which the student has to communicate with an NPC (Non-player character). Often the student is placed in some kind of social environment, where he or she will have the opportunity to answer to questions asked by different NPC´s, in order to strengthen the social skills of the student. This may help the student to respond to questions and to communicate in real life situations (All Media Guide, LLC., 2006).

An example of such a game is "Disney Girlfriends©", which is a communication-software primary designed for pre-teen girls, in which the participants can interact with each other through different communication-tools such as; e-mail addresses, web pages and chat (All Media Guide, LLC., 2006).
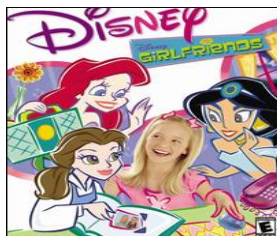
Figure 10 - Disney Girlfriends©

Spelling

Spelling software has the ability to teach the student how to arrange letters in a correct way to form words. This is often in form of a game or a lesson (All Media Guide, LLC., 2006).

"Master Snoopy's Spelling ©" is a spelling game featuring Snoopy from the Peanuts who is ready to help the young students with letter-recognition and spelling. The game lets the young student take the role as Snoopy in different games concerning spelling (All Media Guide, LLC., 2006).
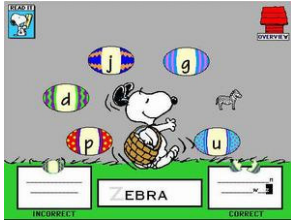

Figure 11 - Master Snoopy's Spelling©

Sports Instruction

These games are teaching the students how to take part in specific sports; the sport education can include subjects such as; fitness-, strategy-, posture-, or coaching instructions etc.

Often these games are mostly theoretical, only telling and showing the student how to do, the student can then choose to bring the achieved skills into real life (All Media Guide, LLC., 2006).

An example of such an instructive media is the "Jack Nicklaus Golf My Way - The Full Swing video©". This isn't exactly a game but more an instructive video featuring different technique-practices and other golf-related elements for the students to learn from. The professional golf-player, Jack Nicklaus, shows the student how to use different techniques such as; the grip, aiming, the backswing and so on with instructions and examples (Internet Shops Inc., 2006).
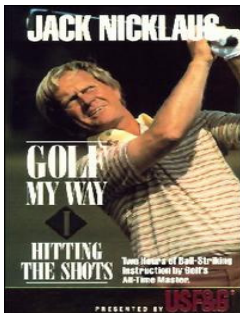
Figure 12 - Golf My Way©

Test Preparation

Test preparation games are intended to help the student prepare for a particular test, often by helping the student to a better understanding of the entire test-experience, beyond the individual subjects of the test (All Media Guide, LLC., 2006).

The "Sybex A+ e-trainer©" is a complete interactive training course, helping the student to learn every angle of the computer service technique A+. The program prepares the student for a test in A+ by generating custom study plans, followed by a practice-test in each subject (All Media Guide, LLC., 2006).
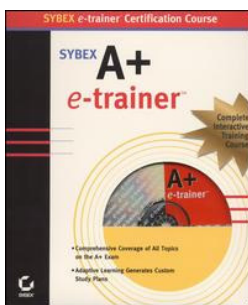
Figure 13 - Sybex A+ e-trainer©

Typing

Games in this category have the goal to teach the student to use a keyboard more efficiently. The idea is to teach the student how to type words and sentences with a keyboard as rapidly and accurate as possible, using all ten fingers (Oekosoft, 2006). A good example of this program is the "Ten finger system trainer" (Berg, 2005). These games are often presenting a wide range of different exercises for the student to choose from (All Media Guide, LLC., 2006).

A good example of a typing game is the "Typing: Quick & Easy©". It first lets the student choose a difficulty-level followed by re-directed practice-lessons. These lessons include directions of correct finger placement, typing- and keypad-instructions and it includes six different typing games for the students to learn from (All Media Guide, LLC., 2006).

Figure 14 - Typing: Quick & Easy©

Writing

Writing Software presents different tools to help the student improve his or her writing-skills. These tools are often a combination of information about writing-procedures and interactive teaching followed by a test intended to advance the writing skills of the student (All Media Guide, LLC., 2006).

"Storybook Weaver Deluxe©" is a great writing program that allows the students to create their own stories with text, pictures and music. The program also features a voice-reader, so that the student can record his or her story for the program to write. The program is build up like a very interactive storyboard with different functions and tools for the student to create his or her stories in (All Media Guide, LLC., 2006).
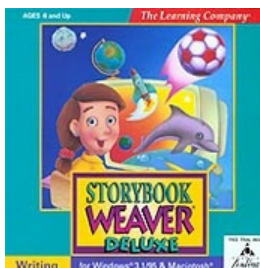
Figure 15 - Storybook Weaver Deluxe©

All of the above sub-genres have a number of elements in common, which describes their capability as an educational game, in the sense that they strengthen the educational value through increased exposure to a game.

To locate and define these elements, we need to investigate how to evaluate an educational game, and with that how to describe what exactly makes an educational game educational. June S. Goyne has defined a list of suitable questions for educators to evaluate educational software:

- Is software consistent with curriculum and learning outcomes?

- Does software offer learner choices and control?
- Does software provide a variety of appropriate media and activities?
- Does the software provide positive formative feedback and achievement measures?
- Is software appropriately challenging?
- Does software have high-quality technical components?
- Does software provide opportunities for practice and review?
- Does software present material in an enjoyable interesting manner?
- Is software interactive?
- Will software allow for social interaction?
- Will software foster learning in an authentic relevant context?
- Will software be accessible to students?

  (Goyne, McDonough, & Padgett, 2000)

According to Goyne, a game that can respond positively to the questions above is seen to be educational. This means, that for a game to be educational, it first of all has to follow a certain kind of subject, which again has to be of an educational manner.

Furthermore the game has to *offer leaner choices and control* within a *variety of appropriate media and activities* and *provide positive formative feedback and achievement measures*. This means that the game has to be interactive and present different suitable actions, according to the educational goal of the game.

The game also has to be *appropriately challenging,* which means that the level of difficulty has to be directed towards the student and the subject of the game. For the game to offer the possibility for *practice and review* it also has to include some instructive guidelines for the student to relate to.

The game also have to contain the suitable *technical components* presented in an *enjoyable interesting manner*, which relates to the fact, that the game has to fit the target group to be functional. Finally the game has to *foster learning in an authentic relevant context*, which means that the subject of the game has to be related real-life activities.

To sum up we can determine, that an educational game has to include the following elements:

- Interaction

- A main subject

- Instructive guidelines

- Difficulty and subject dependent on target group

- Educational goal

- Combined with real-life activities

We will explain and discuss each of the above points in our discussion (section 2.3.1)

2.1.3 Advantages and disadvantages of games used as an educational tool

Apparently a student can actually learn more, simply by using a program (a game) on a computer. But does it really work that way. Can a student learn the same things or gain the same knowledge about certain subjects from a computer game that he or she can learn from actual teaching and reading books?

There are both advantages and disadvantages concerning the use of a computer game as an educational tool. In the following section we will take a closer look at some of these aspects.

Computer games have the capability to add new elements to traditional education forms. They can communicate a special educational experience with the integration of different media such as text, sounds, movies and pictures. This widely spread range of possible impressions gives the student the opportunity for a much differentiated learning and an individual approach to the material (Randel, Morris, Wetzel, & Whitehill, 1992).

One of the features of a computer game is its ability to create a dynamic connection between different angles concerning the same subject, which makes the specific subject seem much more as a connected whole to the student. At the same time, the computer game has the power to generate interactive simulations of different events, giving the student the opportunity to investigate a given problem or a subject from multiple angles. The student can experiment and interact with the information he or she gets from the game, and thereby influence the game into creating new outputs and new possibilities for the student to explore. This interaction gives the student more of an inner understanding of the material, because he or she has his or her hands put deep into the material, the reader has become an active participant (Randel, Morris, Wetzel, & Whitehill, 1992).

On the other hand, a computer game rarely include the same amount of actual information as for example a book, so if the purpose of the media is to communicate many details and information, a book would most often be the superior media compared with a computer game. As mentioned before, computer games are often very specific about only a few aspects of a larger subject matter but in different levels. This is often seen to be a disadvantage, because a student often has to have familiarity with many different aspects concerning the same subject, to achieve the sufficient amount of knowledge to fulfil the examination requirements (Dorn, 1989).

Many adventure games are trying to include a larger amount of aspect concerning a specific subject, in order to enhance the wanted level of knowledge of a certain subject, but this often results in a much lower degree of actual game play. The same effect is often seen in some educational games, which often creates the sensation of an interactive book instead of an actual computer game (Dorn, 1989).

2.1.4 The effect of educational games

A computer game might be an advantage when it comes to the aspects concerning learn ability of a student, because a game seems to gives the student more opportunities to perceive the material. But does the use of computer games have any educational effect at all, and does the use of computer games result in actual learning, or is it just a minor educational substitute to the reading of books and taking lessons?

It is very difficult to measure the actual educational effect of a computer game, using traditionally measurement-methods and tests, because of the fact that computer games often are very complex and dynamic systems with a great deal of student-interaction. This would result in very different understandings of the games subjects (Dorn, 1989).

The test-participants would most often experience different areas of the same subject and therefore have different approaches to the test. This would make it very difficult to create a test with a line of standard questions. The test-participants wouldn't necessarily know how to answer questions concerning the subject of the game (Dorn, 1989).

Nevertheless, most of the research about the learning effect of educational games shows that these games are as effective as traditionally educationally tools. The students who are using these programs often seem to gain a wide range of knowledge concerning the educational issue of the

game. This knowledge seems to stick to the student for a longer period of time (Egenfeldt-Nielsen, 2003).

Apparently the reason for this "sticky effect" is the fact, that the student interacts with the material in the game, and therefore he or she has a whole other experience working with the material. In most educational games, the student will have the sensation that everything happens continuously and that everything is connected with a certain amount of interaction from the student. This gives the student the possibility to advance through the game with different approaches and thereby create an opportunity to see and understand the material through different angels and with different levels of understanding concerning the subject of the game (Egenfeldt-Nielsen, 2003).

Through this interactive learning, it becomes important for the student to understand the facts in order to see and realize the different perspectives of the material. A good way of describing this procedure of learning is that the student is moving through the "Bloom's Taxonomy". The taxonomy was developed to classify educational goals in a hierarchy (Bloom, 1969).

A group of educators- M. Englehart, E. Furst, W. Hill, D. Krathwohl and Bloom- developed the taxonomy in the period 1948-1956 and it is still used today (Dorn, 1989). Basically the Blooms taxonomy covers the so-called "cognitive area", showing the progress from simple to more intricate thought-processes concerning educational objectives in a hierarchy (McNeil, 2003).

Knowledge → Comprehension → Application → Analysis → Synthesis → Evaluation

In order for us to understand the process of the educational affect a student gains during the use of an educational game, we have described this process with the use of blooms taxonomy, showing the achieved knowledge of a student through time:

Knowledge

When a student has the ability to remember or identify certain information, backgrounds, and values regarding the topic and subject of the educational game, which he or she is playing, and when the student can classify which elements are important concerning the educational purpose

of the game, he or she has reached the first level in Blooms taxonomy called the 'knowledge level' (McNeil, 2003).

Comprehension

When the student reaches the level of 'comprehension', the student will have the skill to explain, summarize and describe the subject about the educational game. The student will furthermore have the ability to interpret the actual purpose of the game and advance details to others concerning that purpose (McNeil, 2003).

Application

At some point during the game play, the student will reach the level of 'application', in which the student will have gained a wide spectre of knowledge in relation to the educational game and its subject. The student can now master most of the principles in the educational game and use them to solve problems in different ways. In best-case scenario, the student should be able to write an instruction on how to play the game (McNeil, 2003).

Analysis

When the student reaches the cognitive level of 'analysis', he or she will have the ability to compare the different elements and subjects of the educational game with other educational games and subjects. The student will also be able to classify the subject of the educational game (McNeil, 2003).

Synthesis

At the level of 'synthesis', the student will be able to use his or her knowledge about the subject of the educational game, and the comparison to other subjects, in order to design and create a new educational game, with the combination of these subjects (McNeil, 2003).

When the student has achieved the ability to critique the effectiveness of the computer game in comparison to the actual subject of it, the student has reached the level of 'evaluation' in Blooms taxonomy (McNeil, 2003).

This process and the Blooms taxonomy will be discussed and evaluated in our discussion- section 2.3.1.

2.2 Puzzle games

During this part of our paper, we want to investigate the field of puzzle games to find out what makes this type of games interesting and almost addicting to play. To do that, we will first define what a puzzle game is, and then consider which motivational elements are present. Then we will point out which elements we think are the most important for our purpose and use them as an analytical guideline. Furthermore we will analyze a list of popular puzzle games, and based on this investigation, we will create a list of features which we argue have to be present within a puzzle game to make it motivational.

These features will then be part of the basic structure for our prototype, in order for us to include these motivational elements into an educational game.

The methods that we will use are a case study of motivational elements in puzzle games, and an analysis of motivational elements within a number of puzzle games.

2.2.1 Definition

What is puzzle games?

Computer puzzle game is a genre of computer games that emphasize puzzle solving. The types of puzzles involved can involve logic, strategy, pattern recognition, sequence solving, word completion or, in some cases, just pure luck. (Wikipedia, 2006)

This implies that puzzle games is a genre where the primary activity is solving puzzles. These puzzles can involve, words, logic, strategy, and sometimes sequence solving.
Puzzle games are usually small games and are inexpensive if not free and given the size they can be found on almost all computer-based platforms, from cell phones to next generation computer

hardware. Puzzles are also used in other computer game genres where they challenge the player. We are interested in the games that are 100% within the puzzle game genre, not the puzzles found in other games.

Subgenres

As it is the case with most computer games, there are subgenres in puzzle games. In the lecture from GDC 1999 given by Scott Kim and Alexey Pajitnov they state that there are 3 basic types of puzzle games: Word, Image, and Logic.

Word puzzles are usually some form of crosswords, but can also be an insert-the-right-word game.

Logic puzzles are games like Mastermind, where the player have to figure what colour combination he or hers opponent has.

Image puzzles are games like the classic jigsaw game where the player has to find the pieces that fit together.

In addition the primary basic types it is possible to combine them, Tetris© is for example a combination of Logic and Image.
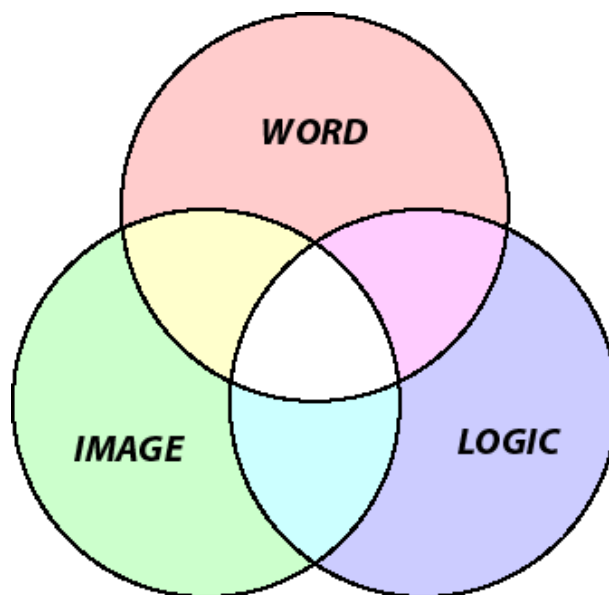
Figure 16 - Basic puzzle games types

For our project we have decided to work with puzzle games within the image and logic types. The primary reason for this is that, as stated before, that we wish to combine motivational elements from puzzle games in a mathematical educational program. For this the image and logic basic type of puzzle games are the most relevant for us and therefore our further investigation will be

focused upon these two basic types. Within these two basic types we find a very wide range of the most popular puzzle games, among them are Tetris©, Lumines© and Sudoku©, just to name a few of them.

2.2.2 Motivation

In addition to knowing the basic type of puzzle game, it is important to know what kind of motivation a given game evokes in the player. All players approach games with different goals, some look for a simple distraction from everyday life, others look for a precise goal e.g. beating a high-score or achieving a higher level than last time the game was played.

It is important for us to know which elements in games are motivating; according to Mahboubeh Asgari, a teachers' assistant at the Simon Fraser University in Vancouver, BC, Canada, there are several motivating elements in computer games. Basically these motivating elements can, when it comes to the game play of a computer game, be divided into two separate areas; the individual motivation and the structural motivation.

The individual motivation

The first area of motivation describes the different personal basics of motivation within the individual, such as the need to be good at something that interests you or the need to be successful within this certain field of interest. This form of motivation is driven by an individual self-perception and is often expressed through several behaviours in the everyday life such as keeping the actions related to specific subjects of interest (Asgari, 2005). When aiming at a certain target group, the common interests and individual motivation-factors for that particular group should be taken under consideration, in order to adjust the product to fulfil the expectations and interests within the target group.

The structural motivation

As we can't interfere with any features which would influence the individual motivation and interests, and thereby improve the experience of a computer game in general, we have chosen to focus our attention towards the second area of motivation (Asgari, 2005). This second area is called the structural motivation, and it describes the motivating features that are often present within the internal structure of a computer game. These features could be:

- Challenge
- Competition

- Interactivity
- Complexity
- Unpredictability

    (Asgari, 2005)

Each of these features represents a motivating tool for the player to enjoy.

To support this theoretical approach, we have consulted a forum for game developers to find out which elements they perceive as being important for motivating the player. We have found a post within the forum where a user have raised a question concerning the structural motivation of a computer game, the forum and discussions can be found at this address: http://forums.gamemaker.nl/lofiversion/index.php/t252633.html

There are several developers who have good answers to the question. The developer "Element Studios" gives this description:

What I do to make a game addicting:
1) Come up with a simple concept.
2) Make the game so there is no way to beat it, it is just endless.
3) Make a highscore table.

People are like, "Whoa! I did good that time! ...I'm gonna beat my old score!" That's how I do it. (www.gamemaker.nl, 2002)

The developer "Severene42" gives this description

Addiction = Progression, Playability, Eye Candy, Addons, and Effects!

1) Progression. You must be able to level up or get to the next level. People like to build on a character with levels stats and attributes.
2) Easy playability. People like to point and click - not use a keyboard. BTW this includes an easy to use inventory and GUI. Make it user friendly to use your characters not a riddle. Make it intuitive to use.
3) Eye Candy - This doesnt mean 3d graphics just GOOD graphics. 2d graphics that are done well or in a perspective are just as good sometimes.
4) Items and Add ons? This is similar to #1 except this is more for new guns and equipment that does new effects and has interesting sounds etc.

5) Effects. Special effects dealing with gravity and physics always goes over well. Sometimes just a NEAT effect of a laser is all thats needed though.

I GUARANTEE if you have these items in your game they will be addictive and played more than once. Compare these items to a game you like to play and see if it doesnt match one or more of these items listed. (www.gamemaker.nl, 2002)

On basis of the previous quotes and the dialogue in the form we can identify some points that according to the users make games motivational.

- Endless / unbeatable games
- Easy to play
- Compelling graphics
- Simple concept
- Interactivity
- Immersive story
- Balanced difficulty
- Community
- Multiplayer

We know that these replies are not written by professional writers or theorists, but given that the forum is a game developer forum we believe that their information is usable. However, looking at the elements from the forum, we can see that they fit perfectly within the structural motivational elements mentioned in the article by Mahboubeh Asgari. We have therefore chosen to use these structural elements in our further analysis.

2.2.3 Analysis of a selection of puzzle games

What is interesting for us to know is how the mentioned elements are implemented into a puzzle game. In order for us to do that we have to select a range of games within the basic type selection we did previously, and analyze them according to what makes them motivational. This analysis should then result in a list of motivational elements for us to use when creating our own game.

In order for us to analyze these puzzle games, we need some guidelines. The game theorist Marc Prensky has defined a list of 12 points which usually are what defines a computer games.

1. Games are a form of _fun_. - gives us <u>enjoyment and pleasure</u>.

2. Games are form of *play*. - gives us <u>intense and passionate involvement</u>.

3. Games have *rules*. - gives us <u>structure</u>**.**

4. Games have *goals*. - gives us <u>motivation</u>**.**

5. Games are *interactive*. - gives us <u>doing</u>**.**

6. Games are *adaptive*. - gives us <u>flow</u>**.**

7. Games have outcomes and *feedback*. - gives us <u>learning</u>.

8. Games have *win states*. - gives us <u>ego gratification</u>.

9. Games have *conflict / competition / challenge / opposition*. - gives us <u>adrenaline</u>.

10. Games have *problem solving*. - gives us <u>creativity</u>.

11. Games have *interaction*. - gives us <u>social groups</u>.

12. Games have *representation and story*. - gives us <u>emotion</u>. (Prensky, 2001)

He claims that no other media than games can deliver these elements. Books and movies come close but they aren't interactive, and are usually experienced alone. This means, that computer games have motivational elements which u can't find anywhere else.

For our purpose, looking into puzzle games, some of the elements are more important than others. Not every game includes all of the above 12 points but according to Prensky they are more or less representing the overall drive in computer games in general.

For the analysis we have modified Prensky's 12 points previous mentioned, in order for us to use them to identify the motivational elements in each game.

1. What makes this game fun?
2. How is the player involved in the game?
3. What are the rules?
4. What are the goals?
5. How does the player interact with the game?
6. How do the game adapt to the player, if at all?
7. How does the game give feedback to the player
8. What are the win-states?
9. What are the conflict / competition / challenge / opposition in the game?
10. What is the problem, and how does the player solve it?
11. Does the interaction in the game result in the formation of social groups?
12. What is the story?

We will not use the above points as 12-point analysis but use them as a guide to reviewing the game. In addition to this we think it would be interesting for us to know, if any, what kind of mathematical subjects the games uses.

The games we have selected are Tetris©, Bejeweled2©, Hexic©, Lumines©, Minesweeper© and Bust-a-Move©. The games have been selected because they are classic, well known representatives of the puzzle game genre.

Minesweeper
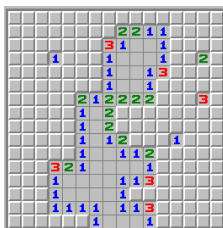
Figure 17 – Minesweeper©, Microsoft windows XP version

In Minesweeper© the player has to identify all the mines in the playing field as fast as possible.

The rules are that when the player presses one of the squares it displays a number this number is the amount of mines in the surrounding squares. If the number is zero (or blank) the adjacent squares are reviled like the above screenshot. Should there be a mine underneath the selected square the game will end.

The challenged is then for the player is to look at the numbers and then calculate in which squares mines are located and which is safe to select. When the player has identified all mines or removed all safe squares he or she will win the game.

In addition to the basic puzzle game there is a high-score, which motivates the player to solve the puzzles faster.

The reason Minesweeper© is a fun game is that it has simple rules but at the same time challenges the player to improve the previous score. The difficulty is done by increasing the number of mines in the game, in fact it sometimes gets so difficult that logic isn't enough to solve the puzzles, and the player will have to guess where the mine is.

There is no story in this game, as it is the case with most puzzle games.
The mathematical subjects or skills that can be related to Minesweeper© are strategy and logic.

We have found the following motivating elements within the game: Easy to play, Simple concept, Interactivity, and there is a high-score so players can compare their scores which enhance the competition.

Tetris
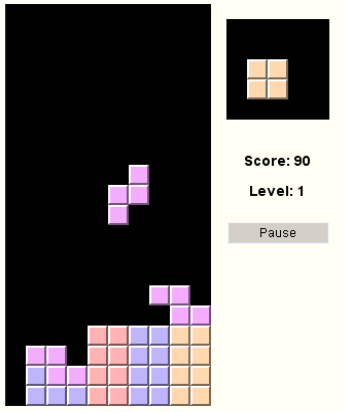
Figure 18 – Tetris©, java Tetris from http://www.percederberg.net/home/java/tetris/tetris.html

In Tetris© the player have a 10 by 20 playing field where he has to drop 1 of 7 different types of bricks. The goal is place the bricks so that they form a continuous horizontal row which will remove them. More points are rewarded if more than one row is removed at the same time. The level, and speed, increases when the player has removed a certain number of rows.

Was makes this game compelling is that it constantly challenges the player, and by its scoring system ensures that it's possible to compare and compete with other players.

Tetris© is based on a math: polyominoes (http://mathworld.wolfram.com/Polyomino.html), but it is neither important nor needed to know for playing the game. The mathematical skills used when playing Tetris© are spatial placement of figures and optimization through strategy, by looking at the next piece.

We have found the following addictive elements within the game: The game is endless and unbeatable, easy to learn and play. It has a very simple game play. There is a scoring system so players can compete on how high a score they get.

Bust-a-Move

Figure 19 - Bust a Move©

This game is a puzzle / arcade game. The game is straightforward, the player have to remove all the coloured in the top of the screen, this need to be done before any of the balls touch the golden line at the bottom. The basic rules are that three balls of same colour need to touch before they are removed, and after a certain number of shoots the target moves down a notch. In addition there is a timer that prevents the player from spending too much time on each shoot.

Unlike Tetris it's possible to win this game. The levels are not created randomly so it is therefore possible to win. However this is usually next to impossible to complete them all, there are therefore a high-score, and a level indicator. These can be used as a comparison with other players.

There aren't that many elements that can be related to mathematics. There are two main areas. 1 Solve the puzzle as fast as possible, usually it's possible to solve them by hitting just a few of the coloured balls. 2. Figuring out the angles in which to hit the sides so that the ball hit the right target. This is very similar to what players do in billiards or snooker.

We have found the following addictive elements within the game: Endless / unbeatable, with provision the game has 99 levels which are impossible to go through without losing however the game allows continuing from where the player lost. Easy to play, the game is easy to learn and play. The game has compelling graphics where they use the characters from Bubble Bobble© and all graphics are very cartoon-like. The concept of the game is simple but strong, which draws the player to play even more. Lastly it's highly Interactive which requires the player's constant attention.

Bejeweled2

Figure 20 - Bejeweled 2©

This game was developed by pop cap games in 2001, and has since become one of the classic puzzle games. The play field consists of an 8 by 8 square, filled randomly with 5 different jewels types. The goal for the player is to get as many jewels removed before the time runs out or the player runs out of possible combinations. In order to do this the player has to swap two adjacent gems in order to get a combination of 3, 4, or 5 gems. If 3 gems in a row are formed they are removed and new gems are dropped down from the top. If a row of 4 gems are formed they are removed but a new power gem of the same type as the removed gems are formed, this power gem can be used to explode the surrounding gems. A 5 gem combination removes the row of gems and creates a hyper cube. The hyper cube can then be used to remove all gems on screen of the same type.

When the player advances through the levels the score for 3 row combination is reduced and eventually only cascades of combinations only gives enough points for level advancement. In other words the game rewards the player if he or she thinks ahead and creates cascades of combinations.

As the case with Bust-a-Move© there aren't that many elements that are related to mathematics. We have located a few 1. Multiple step thinking, like what is used in chess. 2. The ability to combine figures in order to solve something.

We have found the following motivational elements in the game: Endless / unbeatable there are level in the game, but there are a next to unlimited number of them. Easy to play and simple concept, the graphics are bright and very compelling, this and a combination of the ease of play often lures the player to play even longer. The game is interactive but it's not possible to move pieces in a wrong way, the game only progresses when something right is done. The game has a balanced difficulty where there in the first levels only usable jewels are dropped.

Hexic

Figure 21 - Hexic HD©

In Hexic the goal is to advance in levels, and can only be won by playing for literally hours. Controls of the game are simple the player rotates groups of adjacent 3 pieces. There are two different types of combinations a 3 piece cluster and a 6 piece flower. It is only possible to rotate the pieces if they fit in one of these combinations.

When the player gets a 3 piece combination the pieces are removed and new pieces fall down from the top. A cluster of 3 star colour pieces removes the surrounding pieces. A grouping of 6 pieces of the same colour in a flower removes all the surrounding pieces and gives a starflower piece. A grouping of 6 starflower pieces removes all the surrounding pieces and gives a black pearl. A cluster of 3 black pearls wins the game.

To add to the difficulty new elements are introduced in new levels. At level 2 stars are added. At level 3 bombs are added. At level 4 new colours are added. In the next levels the pieces dropped are usually of colours the player can't use.

This game requires that the player thinks 3 possibly more steps ahead. If not he or she will only get the basic 3 piece cluster combinations or possibly the 6 piece flower. In addition to the standard Marathon mode, there is a times mode with the same rules as marathon but with a time that counts down if the player takes too long before the next move.

There aren't that many elements that are related to mathematics. We have located a few 1. Multiple step thinking, like what is used in chess. 2. The ability to combine figures in order to solve something.

We have found the following motivational elements in the game: Endless / unbeatable there are levels in the game, but they only go to up to level 5 and this never ends. The game has compelling graphics which help to draw the player into the game. The game is interactive but it's not possible

to move pieces in a wrong way, the game only progresses when something right is done. The game balances the difficult quite well, in the first levels only 4 different colours are present when the player get to the second level stars are introduced, and additional colours appear, in the third level bombs are introduced, in the fourth and fifth level the different colours are dropped les often. This game has some community elements added to it; it has a global high-score and a friend's scoreboard.

Lumines
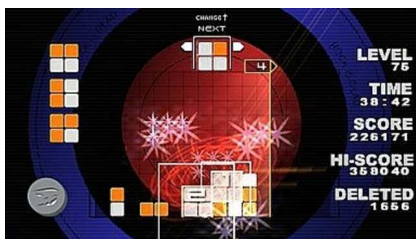
Figure 22 – Lumines©

In 2001 Q entertainment developed the game Lumines© for the Sony PlayStation Portable©. The game was an immediate success. At the superficial level the game looks a bit like Tetris, but after playing it for a few moments this resemblance fades. The objective in Lumines is to remove all the boxes that are presented to the player, a box then consists of 4 squares which each can be in 1 of 2 colours. The player has the choice to which way the box is turned, and where it is dropped. In Lumines the boxes break apart when they hit other boxes which means that the player can place a box half way on top of another box, then the outer most part of the top box is then broken apart and falls until it hits another box or the bottom.

The way to earn points, and remove squares, is to form a box of 4 squares in the same colour. Unlike Tetris© the squares aren't removed right away, they are first removed when the arrow moving from left to right move past the square. This gives the player the possibility to create many boxes in one pass. The game rewards this with bonus points. In addition to full boxes the game allows boxes to overlap (see example underneath) this helps the player to create even more boxes.
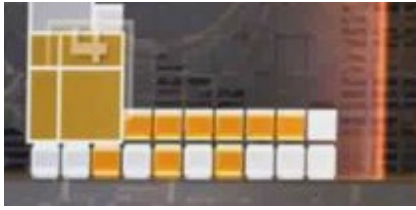
Figure 23 - Lumines, overlapping boxes example

There are 4 main elements that can be changed to vary the difficulty. 1 – The rate the new boxes are dropped. 2 – The speed of the passing arrow. 3 – The time it takes for the boxes to be removed. 4 – The time the game allows the player to think before dropping the box. Together with colours, background, and music this forms a theme. The theme is then changed for each level the player completes. The game rewards forward and fast thinking.

Looking at the game with a mathematical perspective, we see that the game encourage player to think several steps ahead, in the game Tetris© it's possible to see the next piece, in Lumines© it's possible to see the next three pieces. In addition to this there are some elements of geometry but this knowledge isn't important for playing the game.

We have found the following motivational elements in the game: First of all this is unbeatable, there are levels but when the player has completed them all he starts again. The game is easy to learn. The basic concept is as simple as most other puzzle games. Graphics are one of the games strong points, they are crisp and inviting. In addition to the graphics the developers have integrated the music in such a way that graphics, music and sound effects fit perfectly together. There is heavy interaction between player and game, it's possible to move the blocks within the play area. Lastly the game offers a multiplayer either against a human player or a computer controlled player.

2.2.4 Motivational elements in the analyzed games

After these analyses of the selected puzzle games we see some common elements which help create the structural features Mahboubeh Asgari describe in her paper. Underneath is an unordered list of these motivational elements which we have observed in the games analyzed:

Score, easy to play, graphics, music, simple / compelling concept, balanced difficulty, multiplayer. Underneath is a linking between the motivational elements and the structural features.

- Score, multiplayer = **Challenge**

- Score, Balanced difficulty, multiplayer = **Competition**
- Easy to play, = **Interactivity**
- Concept = **Complexity**
- Balanced difficulty = **Unpredictability**

It's obvious that the motivational elements span over a wide range of elements within a game, we have therefore decided to categorize them.

Core of the game

- A easy and understandable concept (if a game is to complex there is a high likelihood that the player will lose interest or possibility drop the game)

- Easy but challenging (if a game like Tetris© started at a to high a difficulty less experienced players may find it too difficult and stop playing. It is the same if the difficulty is too easy, there is then a chance the player will find the game boring and stop playing.)

- The game needs to be interactive (there is some examples of games being more or less an interactive move where the interactivity was reduced to selecting which way to go or duck, Space Ace© was one of these games.)

- Single-/ Multiplayer (there is a huge difference in how the player interacts with a game if he or she has an opponent. Again imagine Tetris© against another player, a new goal will be added to the game, beating the opponent instead of the game)

Content of the game

- Compelling graphics (The graphics need to fit the concept of the game, imagine if Minesweeper had flashing graphics, this would draw the players attention away from the core of the game.)

- Compelling music (imagine Minesweeper© with thrashing death metal, this would again remove the players attention)

- Compelling sound effects (this is more or less like the graphics and music, the sound effects need to be like what the player expects, it would be wrong if a mine blows and a sound of a duck quacking was played)

- All of the above needs to be in harmony (e.g. realistic graphics and cartoon music usually doesn't fit together)

Scoring

- There should be some form of score (within the game)

- There should be a high-score (after the game has finished)

- Global high-score (this would increase the difficulty and would encourage the player to play even more, this is for example done in puzzle games on Xbox 360©, it's possible to see the high-score of one's friends but also a global high-score)

- Lives (this can be used as to make a game easier or harder, e.g. a game with only a single life the player would spend more time on his or hers next move in order to avoid not to start all over again)

These features will be described in depth our discussion section 2.3.2

2.3 Discussion

2.3.1 Educational games

Throughout the theoretical research on educational games, we have found a number of features, which we think need to be present in an educational game for the game to assist the learning experience the student have when playing the game. These features are:

- Interaction
- A main subject
- Instructive guidelines
- Difficulty and subject dependent on target group
- Educational goal
- Combined with real-life activities

Interaction

The games included in the game-genres mentioned in section 2.1.2 are interactive (like almost every computer game), which according to Wikipedia means: "*a kind of action that occurs as two or more objects have an effect upon one another. The idea of a two-way effect is essential in the concept of interaction, as opposed to a one-way causal effect. Combinations of many simple interactions can lead to surprising emergent phenomena* (Wikipedia the free encyclopedia, 2006)".

This means that the student can influence different parts of the game to receive some kind of feedback, which is important for the student to achieve the expected/unexpected reactions during the game play. It also becomes important for the student to learn which actions are good/correct or bad/incorrect according to the gain of educational effect. The human interaction can include

features such as; moving- and removing different items, moving characters, handle different tools etc.

A main subject

Every educational game has some kind of main subject, which often describes either the goal of the game and/or the interactive game play. For instance the game-example included in the sub-genre "science" called "Invention Studio" has a main subject; "inventions". The student has to invent different things during the game play, which describes both the goal and the game play- to invent things. Another example could be the "Bible quiz" from the genre "Quiz games", where the main subject is the Bible. A main Subject in a game is important, because it gives the game some kind of identity and it helps the player of the game to keep focus.

Instructive guidelines

When playing an educational game, it is important that the student know what to do to succeed and how to avoid failures, in order to keep focus on the educational rules of the game. It is important that the game includes some obvious guidelines for the student to follow, both before and during game play. Every sub-genre mentioned in section 2.1.2 (Sub-genres) seems to have such features included in the games it represents. The instructive part of the educational games is often visible through different features, both through expressive contends, like for example in-game hints in form of indicators reacting upon right- and wrong answering and directly described procedures such as an introducing description of the game and the rules.

Difficulty and subject dependent on target group

Most of the educational games are strictly directed towards a specific target-group, often within a narrow range of age for the game to be as effective as possible. The reason for this is probably that the educational effect often is dependent on a certain kind of difficulty level, and that this level has to be adopted into the educational game, to meet the abilities and expectations by the student. Often this dependency is visible through both the level of difficulty and also through the specific subject of the game, as the subject has to reflect something that the student can rely to and even catch some interest in.

Educational goal

One of the most important factors of an educational game is of course that the game is educational. This factor is most often realized with the implementation of a certain educational goal in the game, like for example that the student shall gain knowledge about a certain area or

get better at a topic within a school related subject. Examples of such educational implementations are present in every educational game; learn how to write, how to do math, how to socialize etc. while playing the games within the specific genres.

Can be useful with real-life activities

To explain what exactly we mean with the term "real-life activities" we have chosen again to use Wikipedia's definition. It says: "*real-life" is "a term with multiple meanings. It is most often used to mean life outside of an environment that is generally seen as fiction or fantasy, such as something on the Internet, virtual reality, a dream, a novel, a movie, a hallucination, or a delusion"* (Wikipedia, the free encyclopedia, 2006). This means, that a game with useful elements to real life activities is teaching the student things in a game, which he or she can use in different situations in their everyday lives, in "the real world" so to speak.

Through the interaction with games, which contain the above features, it seems that the student can improve his or her knowledge about different subjects like science, writing, math, spelling and so on. The student will, through interaction with these games have the possibility to get improved knowledge about different subjects, aimed directly at the student in both interest and level of difficulty, and with that get challenged into learning about them. The student can furthermore even learn how to improve skills in relation to real-life-situations such as social interactions or school-related subjects.

According to the taxonomy of Bloom, a student can gain different levels of knowledge about the subject of an educational game. The more the student plays the game, the more he or she will know about its topic. Eventually, the student will reach the ability to critique the game and maybe even create a better one. This makes the educational game work as a tool, which constructs a course of events, in which knowledge becomes very important for the student to be able to act and continue. This makes the educational process more ambitious and coherent.

This shows us, that a game actually can have a great amount of educational effect, and function as an effective educational tool, creating a need for more knowledge. But it also shows that it is still important for the student to at least have some basic knowledge concerning the educational subject of the game. Furthermore, the amount of knowledge gained through the game might be insufficient to proceed to the higher levels in the taxonomy. Therefore the game should deliberate be coupled with other kinds of education (like for example reading books about the topic), for the student to be able to enhance during the game and thereby gain further knowledge.

In the analysis we have found several elements that make these types of games motivational. As stated in our goal we want to improve an educational game by adding elements that motivates the student to play more and with that, according to Blooms taxonomy, learn more.

We believe that these elements are to be found in the computer game genre of puzzle games. These elements we refer to as motivational elements, and are an intricate part of each puzzle game. After the analysis we have confirmed a number of elements. These elements are:

Core of the game

- An easy and understandable concept

- Easy but challenging

- The game needs to be interactive

- Single-/ Multiplayer

Content of the game

- Compelling graphics

- Compelling music

- Compelling sound effects

- All of the above needs to be in harmony

Scoring

- There should be some form of scoring

- There should be a high-score

- Global high-score

- Lives

Core of the game

First of all the most important part of a game in general is the core, because this represents the very essence of the game. It describes the functionality of the game and with that, the rules, the subject and objectives which specifies the game in genre, problem, goal and content. The core describes the fundamentals of the game.

We have found out, that there are some very important aspects concerning the core of a puzzle game, for the player to experience an easy approach. The puzzle game has to include a very easy concept, because when playing a puzzle game, the player doesn't expect much explanation about the game. The puzzle game should also be very easy to handle, but at the same time provide a

certain amount of challenge for the player to keep his or her interest. If the player would first have to learn a lot about the functionality and objectivity of the game, or if the game would be too easy to complete, he or she would most likely lose interest before even playing the game.

Interactivity is a fundamental part of the game, without this, the game would be a movie. Even games with very simple interaction give the player the sensation of controlling the events happening on the screen. This sensation represents a big part of the whole experience and it often leaves the player with the impression of being a part of the game.

There are two different ways of perceiving the challenge in a computer game; in a single- and in a multiplayer environment. Both of these environments have their unique way of challenging the player, giving different kinds of motivations. In a single player environment, the player has the sensation of playing with a single goal- to beat the game by getting a better high-score, a better time etc. In a multiplayer environment, the player is facing challengers with the same possibilities as him- or herself. This gives the player an additional goal- to beat the opponent, which results in a whole different player-motivation

Content of the game

For a computer game to be appealing in relation to the combination of a number of factors such as; a certain target group, a specific subject, the goal etc. It is important to create the proper appearance for the game. When working with appearance we mean the graphics, the music and sound effects. It is important that these elements are en harmony, if not the player is likely to be confused and possibly stop playing the game.

Scoring

Scoring is one of the elements all the analyzed games had. The score can also be interpreted as a goal e.g. the player has to beat the game, and get the highest score possible. Given that puzzle game usually are endless the player use the high-score as a benchmark to beat each time he or she plays the game. In fact one could argue that the score is the strongest motivation for the player to keep playing the game.

There are several ways of displaying the scores. In a typical puzzle game the current score is displayed on the screen at all times, but if one would add the current high-score the player may interpret this as a goal to beat. An extension to the high-score can be to use a global high-score,

potentially this would let the player compete with players around the world, and this would make the game more challenging and strengthen the motivation.

2.3.3 Combining the genres

As mentioned earlier in this report, we want to create an educational game with the motivational features of a puzzle game. The expected result of this fusion is a game with an enhanced experience for the student to enjoy while playing the game. This enhanced experience should then result in a greater level of interest and with that, a possible greater educational effect.

As described earlier, Blooms taxonomy states, that when a student plays a game for a longer period of time, he or she opens the possibility to increase his or her field of knowledge about a certain subject. So if the student wants to proceed through the different levels of awareness, he or she will have to maintain an interest in relation to the subject.

But if this interest is increased, it will result in a need for more information for the student to learn more and thereby proceed to the higher levels in the taxonomy.

In relation to an educational game, this means that a student eventually will face the fact, that to proceed through the different difficulty levels of a subject within the game, he or she will need to increase his or her level of understanding about the specific subject, which eventually will result in the need for learning more, and thereby raise the educational level.

To create this game we have found what we believe are the fundamental elements within both game-genres, on the one side we have the basic elements in an educational game, and on the other side we have the elements, which make a puzzle game motivating:

Educational games	*Puzzle games*
Interaction	**Core of the game**
A main subject	An easy and understandable concept
Challenge	Easy but challenging
Difficulty and subject dependent on target group	The game needs to be interactive
Educational goal	Single-/ Multiplayer
Combined with real-life activities	**Game Appearance**
	Compelling graphics
	Compelling music
	Compelling sound effects

All of the above needs to be in harmony

Scoring

There should be some form of scoring

There should be a high-score

Global high-score

Lives

An educational puzzle game

To increase the motivation in an educational game and thereby improve the level of interest, we will have to create a basic fundament, which includes features from both lists. We will therefore establish a new list of features, which includes both the educational- and the motivational elements. This list will then represent the basic contents for the internal structure of our game:

Core of the game

- A main Subject (Easy and understandable and directed towards a specific target group)

- Educational goal (Reflected in the subject and game play)

- Combined with real-life activities (The contend and subject shall reflect a real-life activity)

- Interactivity (The game shall include main player-controls)

Game appearance

- Compelling graphics (Reflecting the game subject and directed towards the target group)

- Compelling music (Setting the mood of the game)

- Compelling sound effects (Underscoring the actions)

- All of the above needs to be in harmony (Creating an atmosphere as a whole)

Scoring

- *Difficulty* (Challenging game play- dependent on target group, but easily seen through)

- *Score* (An important element for the student to keep track of his or her progress in the game)

- *High-score* (For the student to have a goal to beat within the game)

- *Global high-score* (A goal to beat other students on a global level)

- Lives (A strong motivation feature to insure correct answers)

- *Single-/ Multiplayer* (The game should leave both possibilities as each of them includes their unique motivational effects)

3. Creating a prototype Game

In the previous section we discussed a number of motivational elements that are used in puzzle games, and we discussed the elements included in an educational game. As stated in the beginning of this report, our goal is to see if it is possible to combine these elements with each other and thereby create an educational puzzle game.

In this section, we will design and create a prototype including the elements we enlightened during the past section. The prototype will be created with elements from both genres: Puzzle- and educational games, which will result in a game that could be described as an educational puzzle game.

We will describe the process of the game development from the design face to the evaluation of our prototype.

3.1 Guidelines for developing a game

When creating a game, it is important to follow a set of guidelines for the game to include every important aspect, and for the developer to control the procedures in every phase of the process.

Scott Kim have created some guidelines to follow when developing puzzle games, and given that our game is going to be an educational game fused with some of the motivational elements we have found in puzzle games, we think that Scott Kim's guidelines will be a useful tool for our purpose. (Andrew Rollings, 2003)

1. Find inspiration
2. Simplify
3. Create a construction set
4. Define the rules
5. Construct the puzzle
6. Test
7. Devise a sequence
8. Pay attention to presentation
   (Andrew Rollings, 2003)

Even though these guidelines are interesting for us, we have modified them to reflect on our goal- to test whether it is possible to combine the elements of a puzzle game with those of an educational game to enhance the motivational aspects within the educational game. For that

purpose we need to include the last two steps within the remaining six, because they describe aspects which we think, in relation to our project, are important through the whole process.

The first four steps are relating to the process of specifying the set of rules of the game, while the last four steps are describing the actual construction of the game:

1. Find inspiration

The first step of developing a game is to find some inspiration to build on. This inspiration can be found in all sorts of places, not only within the field of games, but also in other aspects of our surroundings. It could be from watching a movie or listening to music, or even through our everyday actions. This step is important for the development of the idea, subject and contents within the game (Andrew Rollings, 2003).

2. Simplify

When the inspirational step has lead to an idea, this idea has to be simplified. The simplification of a game includes the elimination of all non-important aspects concerning the game to clarify its fundamental elements. To do that we first have to describe the very essential parts of the game and concentrate the development towards these essentials, then we will remove the irrelevant details and standardize the important elements, for the game to be consistent and evident. Finally we will specify the fitting controls (Andrew Rollings, 2003).

3. Create a construction set

For us to be able to figure out, whether the concept works, we have to examine the functionality according to the subject and contend of the game. For us to do that, we will create some graphical prototypes in flash, describing the different elements contained in the game and redefine these elements to fit the game concept. With the combination of these elements we will build a construction set for us to follow during the further development. This construction set will also be based upon a chosen target group, which we will specify upon the basis of our idea, concept and subject (Andrew Rollings, 2003).

4. Define the rules

With our construction set in hand, we can move on to one of the most important things when creating a puzzle game- creating the rules. According to Scott Kim, the rules of most puzzle games can be divided into 4 main areas, which we will define during the development of our game. The 4 areas are:

- The board (how is the stage of the game build up? which boundaries are there? etc.)
- The pieces (which pieces are included? how do they look? which function do they have? etc.)
- The moves (How does the student control the game and with which effects?)
- The goal or victory condition (How do the student win the game)

Furthermore the rules of the game can include factors such as punishment (loss of lives) and scoring etc (Andrew Rollings, 2003).

5. Construct the puzzle

This step describes the construction of the puzzle-part of the game, which means how the player moves from a problem to a solution. In this section we will describe the actual game play within the game to clarify what it exactly is, that the student has to do to complete the game. The description of this will include which options the student will face, how he or she can fail or succeed through different choices and the purpose of it (Andrew Rollings, 2003).

6. Test

After we have completed the development of our prototype, we will have to test it on our target group. This test should show us some vital things according to our game and the idea of it. Is the game too difficult/too easy? Is it appealing to the target group? are there any errors in the rules? How can we improve the game? etc (Andrew Rollings, 2003).

Furthermore it will give us the possibility to estimate whether we have succeeded according to our goal or not, which will be one of the essential elements in our conclusion.

7. Devise a sequence

During the development of our educational puzzle game, we will have to create some kind of puzzle sequence to control the difficulty level. It is very important, that the student gets challenged during the game, but at the same time he or she should be able to manage the game or they will lose interest. It is also important to think about linearity, because if the game moves directly from easy to difficult, it would also create the possibility of an exhausting and hopeless game play (Andrew Rollings, 2003).

8. Pay attention to presentation

The last step simply describes that it is important for the game to have the proper appearance for the student to enjoy, which means that the game shall include an harmonic selection of elements

such as graphics, sounds, music, animations etc. During the development of our game we will therefore need to be aware of this harmony (Andrew Rollings, 2003).

During the development of our prototype game, we will take the above 8 steps into consideration according to each part of the development process, from idea to the final prototype. They will be used as a guideline for our considerations according the idea, subject for our game, the process of development and the testing of our prototype.

First we will describe and design our game according to the mentioned guidelines in step 1-4 and 7.Then we will use the guidelines in step 5-6 to guide us through the process of development and finally use the final step (8) when testing our prototype.

3.2 Development process

In this section of our paper, we will describe the development process of our prototype. Considering the above mentioned guidelines, we have divided the process into 4 main areas, which the development of our prototype will be based upon:

Designing the prototype – Tools of development – Developing the prototype – Testing the prototype

Designing the prototype – This area will cover the idea and how we will add both the motivational- and the educational elements into our game. We will reflect on the presentation of our game, which graphics and audio we will use and the functionality of the game in general. During this part of the process, we will also consider and describe how we implement the rules of the game, including the level of difficulty, the scoring- and punishment features. This should then result in some general key-features for our concept.

Tools of development – In this area we will describe which software we will use when creating our prototype and why, this software will be considered upon its use and the results we want, both according to the construction set and the prototype.

Developing the prototype – this area will include a description of how we created the prototype, based on the design-area. In this part we will reflect on the rules of the game and the puzzle sequence including the levels of difficulty.

Testing the prototype – This area will be placed in the chapter 4, and it will include a description of the user-test of our prototype and the results of the test.

3.2.1 Designing the prototype

When discussing the idea for our prototype, we wanted our game to be directed towards a specific target group with the necessary skills and knowledge to fit our purpose. Because we wanted to create an improved educational math game, this group should also be familiar with existing math games. Based on our contact with a local school, we found a class of 6th grade students which we thought would be perfect for our purpose. The students there are about the same age, and with the same level of educational skills, which made them a very specific target group. Furthermore, the students were actually using educational games during their daily education in math.

We therefore decided to use them as a target group and that our educational subject could be based upon what they already knew. After contacting their teacher we were allowed to use the students as test-subjects, so we began to create our idea.

Core of the game

The main inspiration for the game is described in section 1.2 – Goal: "to improve an educational game by adding motivational elements from puzzle games". This means that, the game should be based upon the structural elements we concluded earlier. The subject of our game should be easy and understandable, and it should be directed towards the chosen target group. Our game should also have an educational goal which can be reflected on real life activities and it has to be interactive.

In the section where we analyze educational games, we look at a game called "basic math©". This game is basically a game where the students have to solve math problems on screen instead of on paper, which is an educational goal reflecting real life activity. It is a very easy and understandable concept- the student has to solve math problems, and these math problems can vary in difficulty. We think that the idea of basic math would be suitable for our purpose, so we have used it as a source of inspiration to the idea and subject of our prototype.

The idea of our prototype will be that the student shall solve some kinds of math problems on the screen, these math problems should somehow vary in difficulty, but at the same time, for the student to be able to choose between them. The reason for this idea is (as mentioned earlier in section 3.1 - guidelines for developing a game - guideline 7) that the game should be challenging but easy to manage for the student to keep interested, and at the same time the student should be

able to maintain a controlling overview. This also answers to an important motivational element from the puzzle game-genre: that the game should be challenging but easy to see through.

Game appearance

For the game to be an educational puzzle game, it is very important that its appearance fits this description. Furthermore it is important that the graphics, sounds and music are in harmony, which means that they all underscore the subject of the game and that they, at the same time, fit each other.

We wanted the game to look and "feel" like a typical puzzle game, so we took a lot of inspiration from some existing puzzle games, which we discussed earlier (section 2.1.3 Analysis of a selection of puzzle games). According to the motivational features of a puzzle game, graphics also have to be appealing to the target group, and as mentioned we have chosen a class of 6th grade students, which means they are still pre-teens. Based on these guidelines, we have chosen to use soft, colourful and 'childish' graphics inspired by typical puzzle games. This graphical platform will then be underscored by fitting music and emphasizing sound effects.

Scoring

Furthermore the game should reward the student whenever he or she gets an correct answer, and to motivate the student even more, the game should give a better award for higher levels of difficulties. This could be done by using a score-system within the game. The result could also function as a goal to beat, which could be visible in a high-score list.

In addition to the award-feature of the game, we also have to motivate the student into concentrate upon the correct answers this could be done by implementing some kind of punishment. In almost every puzzle game there is, the player will lose a live whenever he or she is making a mistake, so we think that this would fit well into our game as another motivational element

As a describing summary of the above descriptions and considerations we can highlight the following key-features:

- **A challenging, interactive game play in an easy to manage environment, which combines real-life activities with an educational goal**
- **A soft, 'childish' and colourful graphical layout inspired by typical puzzle games combined with emphasizing sound effects and music**

- **Varying degree of difficulty with varying points resulting in a list of high-scores**
- **Loss of lives by incorrect answering**

Concept

Considering the mentioned key-features, we began to brainstorm upon the idea and the concept; we also discussed the appearance of the game in general and how to implement every detail from the above into a functional prototype. We finally came up with the following:

The name of our prototype is 'Ballon Popper' and is basically an advanced form of 'basic math©', included with the motivational elements of a puzzle game, such as a score- and lives-counter, soft, appealing graphics and sounds, easy but challenging game play and first handed-various difficulty.

Furthermore the rules are be very easy to understand and detect without any greater explanation or guidelines, the student simply opens the game, chooses "start" and he or she has begun playing. The controls are also very simple as everything is handled with the mouse.
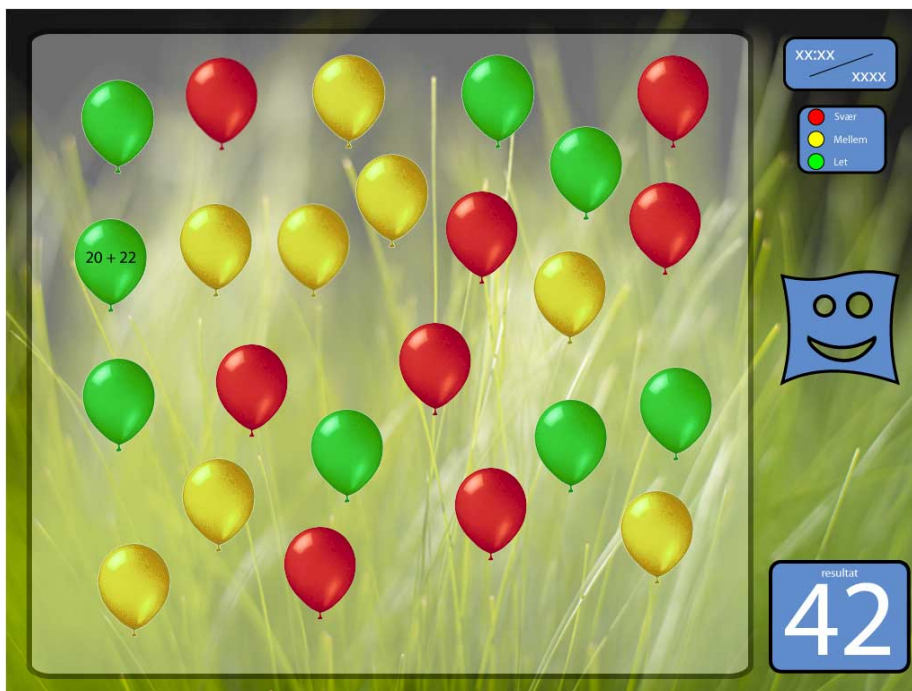
Figure 24 – Prototype layout

The objectives of the game are very simple: the student has to pop balloons holding the correct math-problems according to the correct answer displayed in the lower right corner. The balloons are popped simply by clicking on them with the mouse. This is somehow basic math in reverse as

the student will have to identify the right problem for the right solution. The reason for this is, that it will make it possible to create three different difficulty levels at the same time which we expect to provide the game with a first handed-various level of difficulty, for the student to be challenged into getting better at solving the problems.

The balloons are divided into three different colours- green, yellow and red, each colour represents a different level of difficulty. The scoring system is based upon these three different levels of difficulty- the green balloons are giving the smallest amount of points, the yellow ones pays off a little better and the red ones are giving the highest score. That is of course if the math problem within the popped balloon fits the displayed answer, if not, the student will 'loose a live'. The student has 4 lives, and after that- its game over, this feature shall work as an obstacle for the student, so that he or she will have to think before clicking.

The prototype will include 10 rounds with ten different results, each result has three correct answers, represented by- a green, yellow and a blue balloon. This leaves us with 30 different balloons. To complete the game, the student will have to answer correct enough times, within the ten rounds, without losing all of his or her lives. And to get an even better score the next time he or she plays the game, he or she will have to advance to a higher level of difficulty.

3.2.2 Tools of development

According to the 3rd step within Scoot Kim's 8 steps (Andrew Rollings, 2003), it is important to choose the right tool for the job when creating rapid prototypes for testing. He also mentions Macromedia Flash as a good tool for this. Given that visuals are important for us e.g. they are a part of the motivational elements, we decided to use this program for our preliminary prototype.

Macromedia Flash©

Flash is an excellent program to create visual content. Flash has its own programming language, called action script. Given that our knowledge of action script is limited we decided to use Macromedia Flash only to create and test the user interface. When creating graphics in Macromedia Flash, they are created in vector graphics, this gives us the possibility scale the objects to the exact size we wish without them getting pixelated.

Here is a screenshot of the user interface of Macromedia Flash©, with our work in progress:
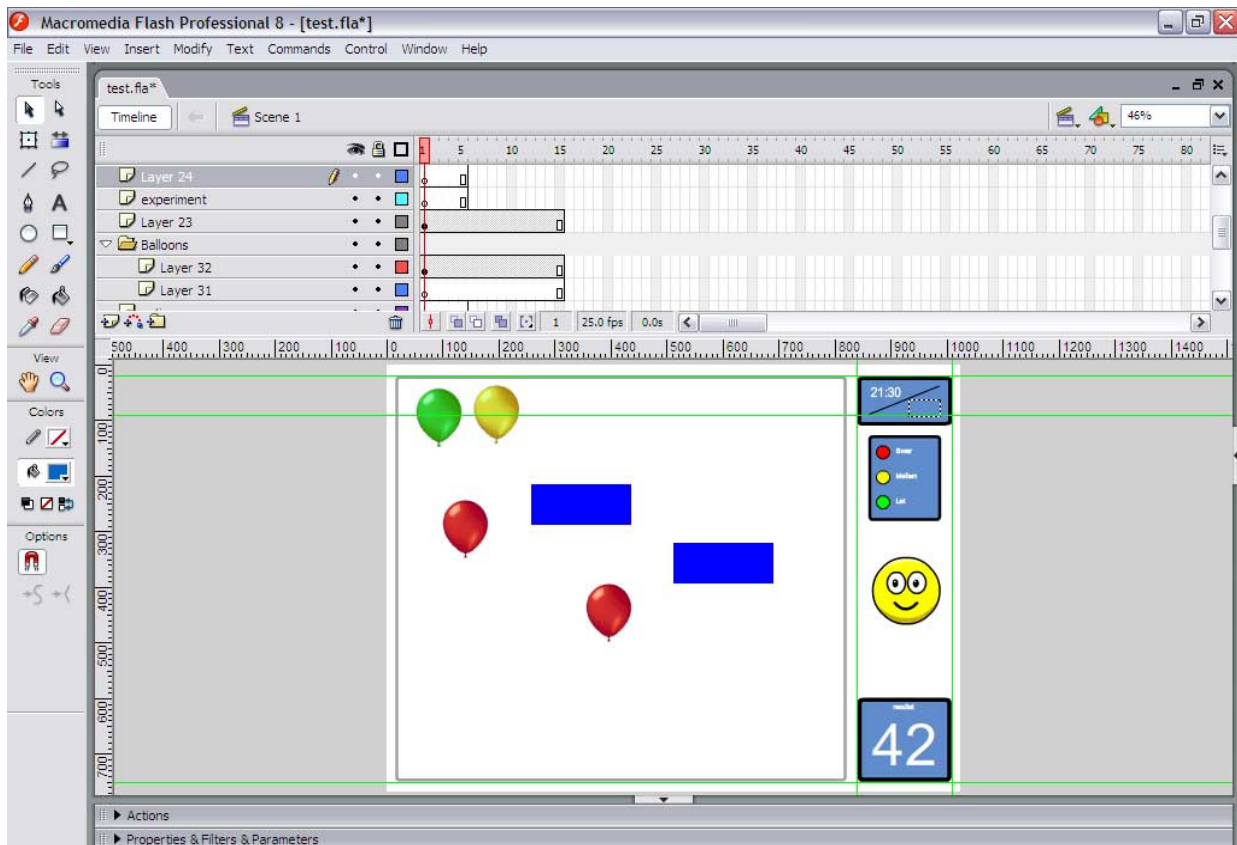
Figure 25 – Building the UI in flash

When we finished testing our ideas and our concept, and we had an agreement about how our game should look, which rules should function within the game and with which elements included, we had to find a tool for creating the actual prototype of our game. The tool should be relatively flexible to use, for us to be able to modify and adjust along the process, and it should contain the needed features for our purpose. After a bit of research we found the program Game Maker, the program included several features and possibilities, both in graphical implementation and functionalities for us to create our prototype. Game Maker is designed to create game prototypes, but it is also capable of creating simple but full blown games.

Game Maker©

The program is a straightforward construction program. It works by first loading all the graphics in as "sprites" these are then placed on objects, and lastly the objects are placed in a "room".
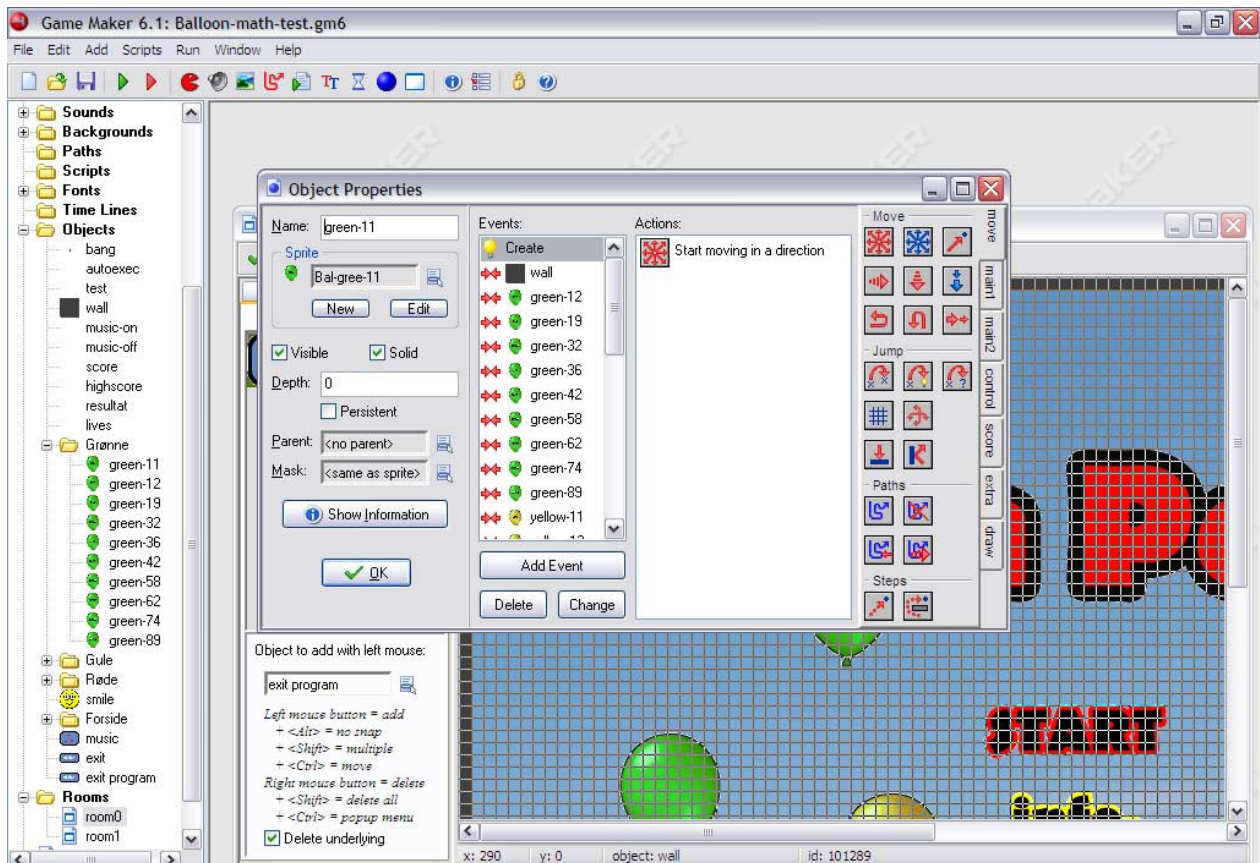
Figure 26 - Game Maker UI

To get some interaction events are placed on each object. Instead of traditional programming Game Maker uses pseudo code, which basically is like combining programming blocks with different functions. How we used Game Maker in action, to create our prototype, will be described later in the next section.

3.2.3 Developing the prototype

During the development of our prototype we will first describe and create the contents of our game. This content will include, the graphical elements, the user interface the music and the sound effects. Furthermore we will give a description on how we create our prototype by implementing the graphical elements, the sound and music and the functionality, using the program Game Maker and finally discuss the result.

Contents
Graphics

As mentioned in section 2.3.1 Puzzle games – Core of the game, it is important that the game is challenging, but at the same time it has to be easy to see through. We therefore decided to

implement a limited number of objects into the game, so that the student easily can get an overview of the content. These are the graphical elements we have included in the game:
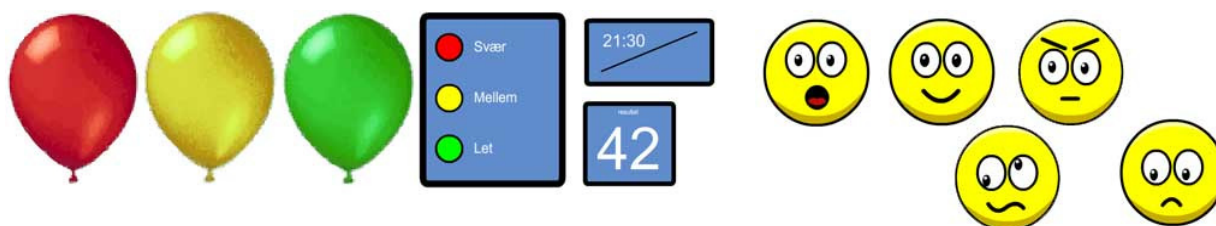
As described in our concept, the main objective of the game is that the student shall pop balloons. The reason why we have chosen balloons as our focal elements is that we needed moveable object which looked appealing, came in different colours and was easy to destroy.

It was important, that the students knew what to do with the game and how to decode the actions displayed on the screen, without any further explanation, we have therefore chosen elements we know most people know and have seen before. Popping a balloon is something we think everyone either have tried or seen someone do. This activity is indirectly listed on David Freeman's Types of Fun list, as *"Aiming, targeting, shooting"* (Freeman, 2004). Furthermore we needed an indicator of whether the student hit a correct balloon or a wrong one, we therefore implemented a changing smiley as this is a well known indicator, a so-called emoticon, for emotions. (Walther & D'Addario, 2001)

As mentioned in section 3.2.1 – Designing the prototype, the graphical style of our prototype should be "a soft, 'childish' and colourful graphical layout inspired by typical puzzle games combined with emphasizing sound effects and music". Because of this, as mentioned in the same section, we decided to look at games within the puzzle game genre. Underneath are 3 examples of graphical styles in puzzle games, these are some of the same games that have been analyzed in section 2.2.3.

Bejewled 2 ©

The UI in this game consists of three elements:

1. The jewel area
2. The menu
3. The score counter

Aside from the jewels there are no "sharp" edges on the graphics. When changing level the background changes which give a new look for each level.

Bust-a-move©

This is an older game, which means that the developers had some limitations on hardware and so on. The UI of this game consists of 3 elements.

1. The play area
2. The score counter
3. A background

The score counter is placed on top of the play area. The Bubbles are very colourful and it is clear which ones fit together. When the player completes a level the background changes, unlike Bejewled 2 it's just a texture that is tiled.

Hexic HD©

In this game the UI surrounds the play area. It looks like some kind of brushed metal, and have some lines in it, one underlines the top where the logo is. There are only a few elements displayed in the UI: Level, Combos remaining, and help which describe which buttons to use to turn the objects in the play area. All the hex shapes are outlined with a black line which helps separate them from each other. The background is an animation of interconnected hex shapes moving in several layers.

Our graphical style

Inspired by the three examples above, we have tried to combine their including elements to create a design for the UI of our prototype. The result of our first draft looked like this
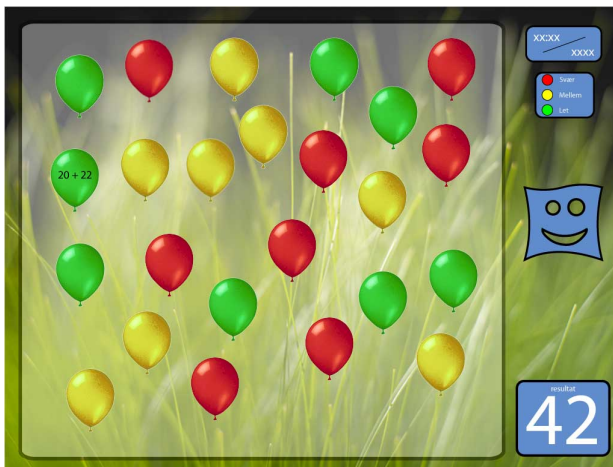
We have a large play area which is highlighted by a semitransparent white rectangle, outlined by a black line. In addition to the play area, we have 4 UI elements:

1. A score / time counter
2. Difficulties of the different balloons
3. A customized smiley that gives immediate feedback on the players input

4. A display of what the current result is

To create a more user friendly UI, and thereby strengthen a good and natural overview for the student, we have chosen to create our design considering the principles of gestalt (Soliz, 2003). Considering the objectives, our graphical objects, and the implementation of them into our user interface, we specifically have used the rules of closure, common fate, and similarity.

These three principles describe the way people perceive different objects, both according to each other and according to their surroundings. Closure is a description of how objects placed within a closed area are perceived as being together. Common fate describes the fact, that objects moving together with the same speed, in the same direction or in the same pattern are perceived as being related. The principle of similarity states that similar objects are perceived as being related. As mentioned, it is important for us to create an easy understandable user interface, and following the principles of gestalt is a very effective way of doing this. (Soliz, 2003)

- Closure, because the semitransparent white rectangle creates a barrier so the balloon can't escape.
- Closure, because the objects outside the rectangle also appear to relate
- Common fate, because the balloons move around in the closed area, while everything else is standing still. This also makes the balloons act as the centre of attention.
- Similarity, the balloons all have a similar shape this means they are all related.
- Similarity, the balloons of each colour is related because of their colour.

The final version of the prototype underwent a few minor changes. In addition to the main game we have added a welcome screen, where the player will be introduced to the game whenever it is loaded.

Figure 27 - Ballon Popper, welcome screen

The welcome screen is a small introduction to the game. It gives the player the possibility to start the game, get some help on how to play the game, watch the game credits, or leave the game.

We have selected a special balloon-like font that matches the game. In addition to that we have drawn a big black line around each letter, and lastly squished the letters a bit together. This fuses all the letters together into a cartoon-like logo.

The buttons have text with the same font as the logo, and a different colour line around them. The last button, the "Afslut" button is written with a normal font, and enclosed in a blue box with rounded corners.

We have chosen to use yet another principle of gestalt to enhance the perception of the most important buttons related to the objectives of the game. The principle of proximity or contiguity states that objects placed spatially together are perceived as related (Soliz, 2003). We therefore chose to centre all the buttons with the exception of the "Afslut"- and the music button. By placing the 3 most important buttons in the same manor, according to the principles of gestalt, we present them as being related. At the same time, this is done for the student to perceive these buttons as being important.
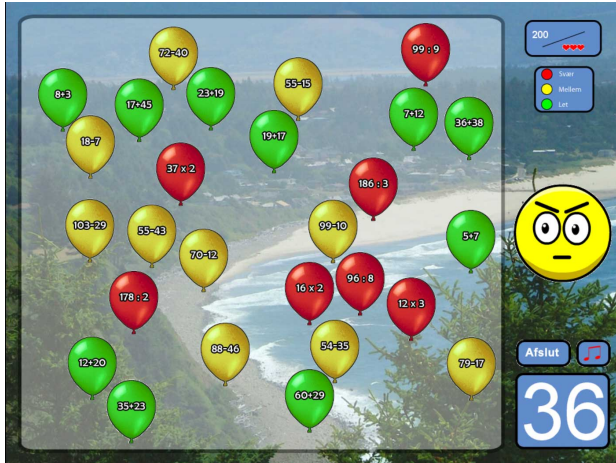
In the final prototype there are, as mentioned before a few changes.

1. The Balloons have a black line around them to make them clear
2. The score / timer have been changed to score / life-counter
3. The smiley designs have changed. The new smiley's are yellow and looks much clearer than the first ones we made
4. Two new buttons have been added, a "afslut" button and a button that stops / starts the music
5. In the result display we have removed the text "resultat"
6. All the balloons are moving around

Audio

We have two types of audio in the game. 1. Music, 2. Sound effects

Music has many different purposes in a game. It can be used to bind the entire content together. It can also be used to stress or calm the player. (Wikipedia, the free encyclopedia, 2006)

In our case, we have added music made on an old 1980's synthesizer. The music is primarily played in the lower frequencies, when a key is pressed it starts in the higher frequencies and slowly changes to low. In addition to this as there is a lot of stereo panning.

The musical style is a dark, almost spacey. This gives a good contrast to the bright colours of the game. These styles are from the 1980s and have been used in movies and computer games. (Wikipedia, the free encyclopedia, 2006) We decided to use this music as a tribute to the first puzzle games from that period.

Sound effects in a game have a completely different purpose than music. They are primarily used to emphasize things that are happening in the game. (Wikipedia, the free encyclopedia, 2006)

We only have a single sound effect in our prototype, a bang. The sound is played whenever a balloon is popped. The sound we use for this a sound from a military weapon being shot. This may seem a bit exaggerated but this is not uncommon is games. (Wikipedia, the free encyclopedia, 2006) We decided to tone the sound effect a bit down by cutting the first part of the explosion out.

Development process

As described in the previous section, we have chosen to use Game Maker for creating our prototype. The following will be a step-by-step walkthrough of the creation of one of each of the different elements within the game.
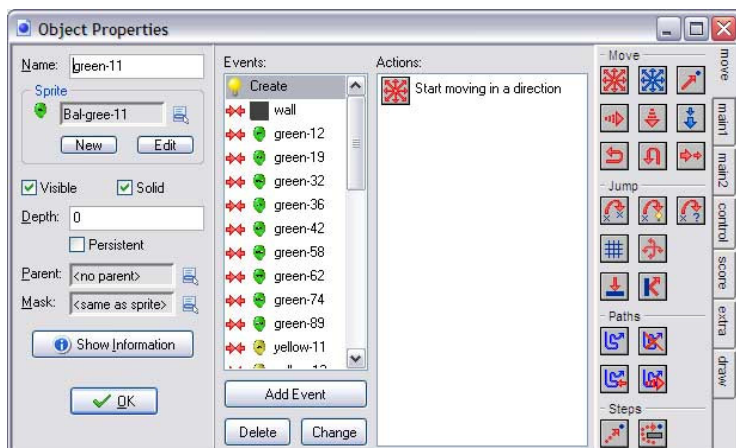
Under each event there are different actions, for example when hitting a wall the object bounces in another direction. By adding different events to certain objects it is possible to create an entire game. The crucial thing is to have some control over what need to do what.

In our prototype we have 3 types of objects:

1. Objects that display something.
2. Moving objects that can be interacted with.
3. Stationary objects that can be interacted with.

In order to give some clarification we will describe one of each of the objects described before.

1. A displaying object
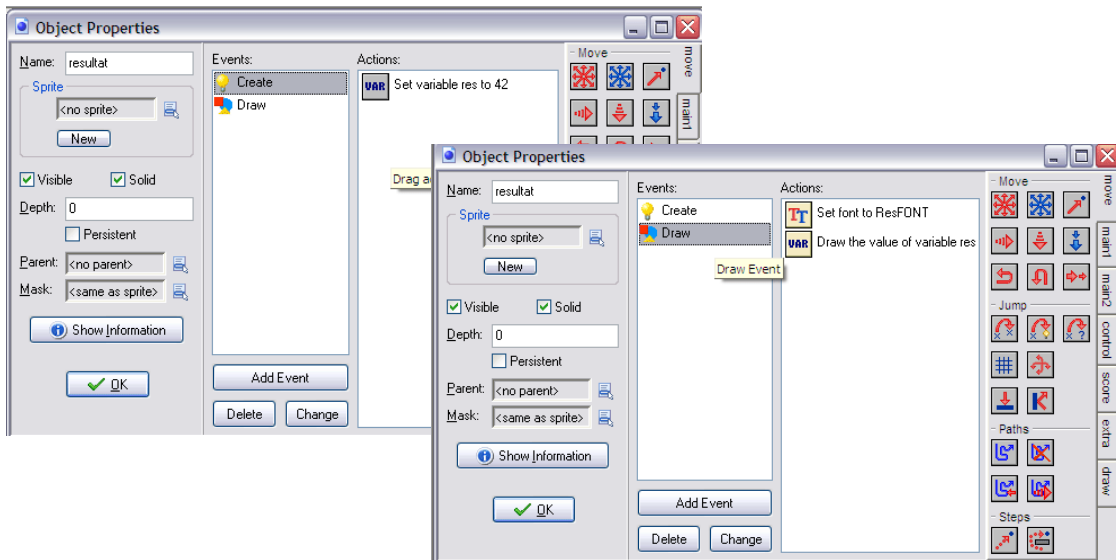
In the first event we create the object, and create a new variable "res" and set the variable to 42. In the second event, draw, we select an imported font and then draw the value at a specific coordinate.

2. Moving objects
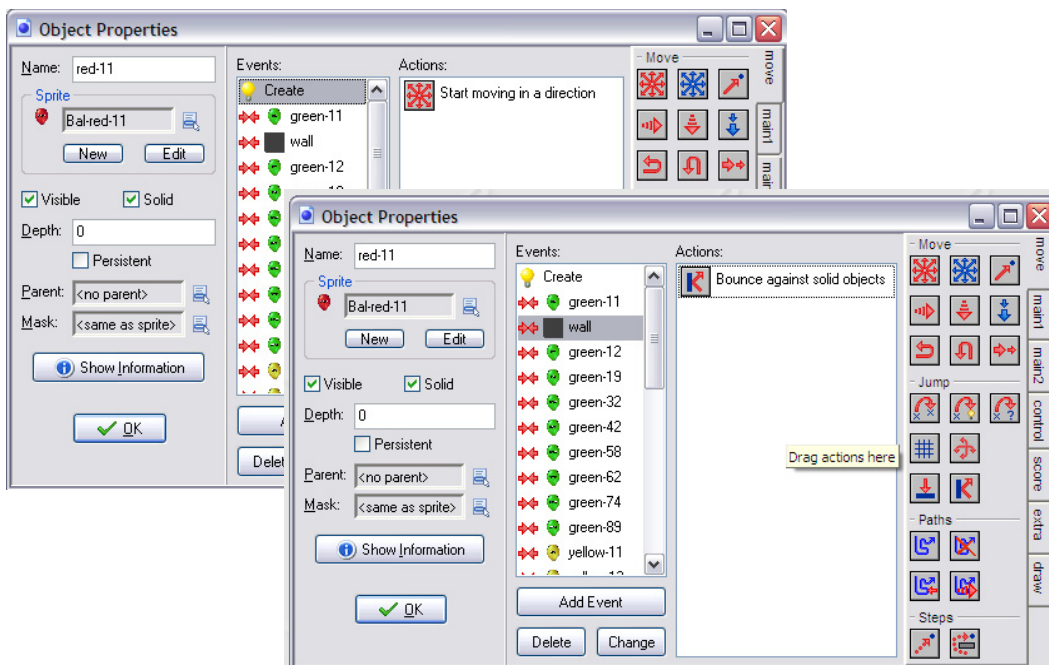
In the game it is only the balloons that are moving, so we will display the creation of the first red balloon called "red-11".

The first event is the create event. When the balloon is created, it is supposed to begin moving in a random direction i.e. the balloon can move up-left, up-right, down-left or down-right.

The 2nd to the 29th event is an on-collision event: this means that if the balloon hits either the wall or one of the other balloons it should bounce in the opposite direction.

The 30th event is the controlling event. This event controls what is going to happen if the player clicks on the balloon 11.
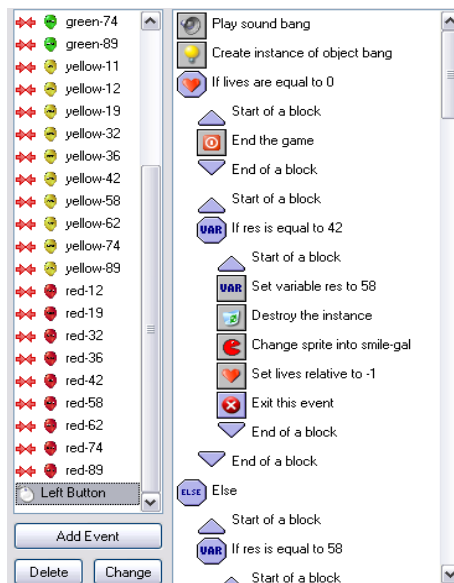
First a sound is played (here we have implemented the sound of our small explosion), then the following:

1. An animation of a explosion replaces the balloon sprite and is deleted after it have been run once.
2. It checks if lives are 0, if they are it ends the game.
3. Then the evaluation starts:
   a. The variable "res" has the wrong answer (i.e. the player popped the wrong balloon) It withdraws one life from the life counter, changes the smiley to an angry one, and sets the variable "res" to the next answer
   b. The variable "res" has the right answer. It adds 100 points to the score, changes the smiley to an happy one, and sets the variable "res" to the next answer
4. If the variable "res" is 32 (i.e. the last math problem in our game) it ends the game and triggers the high-score table

3. Stationary Objects

These objects are simple buttons that can be triggered by clicking on them, they can for example end the game or pause the music and so on.
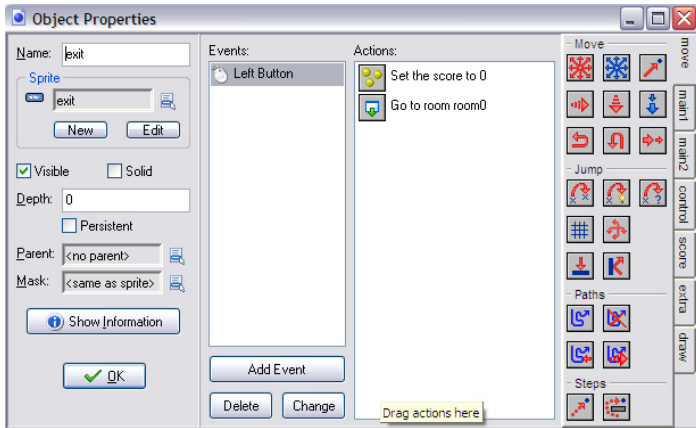
In this example the button sets the score to 0 and returns to room0 which is the intro screen.

After creating the background image, containing the boundaries and basic graphical elements, and creating all the objects, defining the rules for them and their functionalities, the final step in the prototyping is to combine everything. This means a wall have to be created, and instances of object are dragged onto the room. Objects without sprites are displayed as question marks.
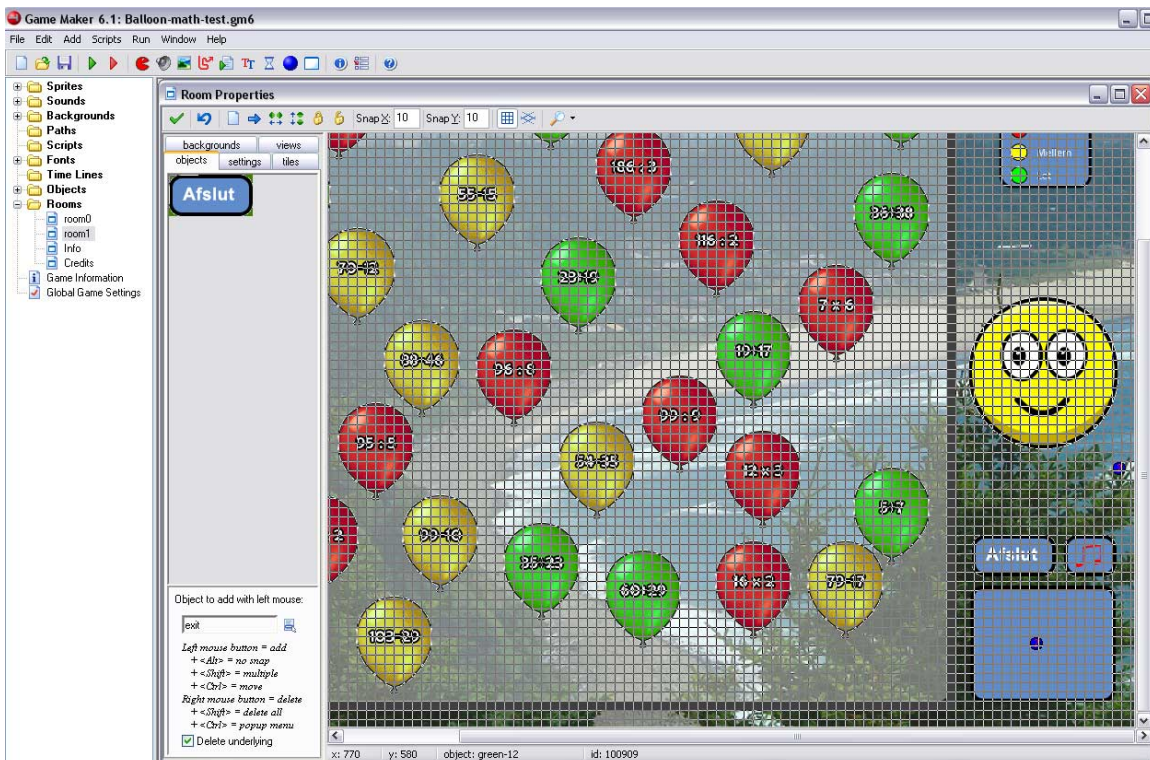
Result

Our final prototype was exactly what we have planned it to be, the graphics and sound worked fine together and the functionality was flawless. When clicking the balloons they react as they are meant to the score is related to the difficulty of the different balloons and the lives are lost by incorrect answering according to the result displayed.

To find out whether our idea of creating an educational game with the motivational effects of a puzzle game would make the game more interesting and appealing for the students to play, we decided to set up a test of our prototype for our target group. The following section will describe both the test and the results we received.

4. Experimenting with the prototype

In this part of our assignment we will concentrate the process around the user-test of the prototype of our educational puzzle game, which we developed and described during the previous sections.

We created the prototype according to the combination of the basic elements included in an educational game and the motivational elements that are used in puzzle games.

We devised a test of a 6th grade math class at Præstegårdsskolen in Esbjerg. The collaboration came into place after we contacted the school where we presented our idea. They found it very interesting and contacted a math teacher, Kevin Stenstrup, who was willing to help us. After we had a meeting and described our idea and goal for him, we devised the experiment together.

The test-participants should test the game, and compare it with both ordinary math problems on paper but also with the games they already know from their math-classes.

During this section we will first explain the goal with the test, which answers we are looking for and why. Then we will create a number of questions for our questionnaire and explain their purpose. Furthermore we will describe the aspects of the actual test, and finally we will show and discuss the test-results.

4.1 Goal

According to our hypothesis we want to find out, whether we could create an educational puzzle game in which we raise the level of interest by motivating the students to play more.

To get an answer for that, we have to investigate how the target group reacts upon our game, if they like it, if the game is usable as an educational tool etc. This means that they have to play the game and then evaluate it. We believe that the students are qualified to evaluate the game on basis that they have been using educational software during their math classes.

We haven't tried to do a user test during our education, but after researching a bit we have found a framework called D E C I D E (Rodgers, Preece, & Sharp, 2002) which we have created our experiment from.

This framework has 6 steps.

- **D**etermine the overall goals that the evaluation addresses
- **E**xplore the specific questions to be answered

- **C**hoose the evaluation techniques to answer the questions
- **I**dentify the practical issues
- **D**ecide how to deal with ethical issues
- **E**valuate, interpret and present the data

Our goal with that evaluation is to find an answer to the following questions:

- Does the target group like to play games?
- Do they like to use games as an educational tool?
- Does 'Ballon Popper' work according to our concept?
- Is 'Ballon popper' as easy to handle as regular math problems on paper?
- Does the target group think that the ordinary educational games need improvements?
- Do they like 'Ballon Popper'?
- Does the target group think that 'Ballon Popper' is a better game than the regular educational games which they already know from their education?

Furthermore we have to ensure, that the evaluation of our game is carried on correctly, according to the DECIDE framework, and that the result of the evaluation is useable for our hypothesis. So to control the process and to ensure that we can use the results of the test, both the questions and the test itself has to be directed towards our goal and we have decided to use the guidelines described in the book Interaction Design – Chapter 13.

4.2 Questions

According to the goal and to the questions we need answered, we have produced a number of questions which should cover the area of interest according to our thesis. The questionnaire was written in Danish in order for the test subjects better to understand them and the originals are included in the appendix – section 7.1. Underneath are a translation of the questions and a description of the answering possibilities, we will afterwards explain why each question is important for us:

1. Gender
2. Have you used computers as part of the mathematical lectures?
3. Computer games are funny
4. It is funny to use computer games as part of the lectures
5. It is funnier to play educational games than solving math problem on paper

6. The selection of educational games the school have is boring

7. We use educational games too little in lectures

8. Educational games are about winning

9. In educational game you fight to get a higher score than your classmates

10. What could be improved in the educational games used in the lectures?

11. The written exercise was harder than the game

12. "Ballon Popper" is a good game

13. "Ballon Popper" is better than the games you have tried as part of the lectures

14. Name five things that make "Ballon Popper" better / worse than the educational games.

15. Other remarks

In question 3 to 9, and 11 to 13 the student is asked to agree or disagree with our statements this is done in 5 levels, where 1 is strongly agree, 2 is agree, 3 is neutral, 4 is disagree and 5 strongly disagree.

Question 1 is a male / female question, and 2 is a yes / no question.
Question 10, 14 and 15 asks the student to write his or her opinions.

1. Gender.
It is important for us to get a fair uniform representation of males and females, because our game should be usable for both the genders within a classroom.

2. Have you used computers as part of the mathematical lectures?
This is the very important for us to know, if they haven't tried to use a computer as part of the education, they most likely haven't tried educational games at school, and are therefore not within our target group

3. Computer games are funny.
It is important for us to know whether the test-participants like computer games, because if they don't, they probably won't like our prototype either. So, if the test participant answers no to this, this would most likely be reflected in the subsequent questions.

4. It is funny to use computer games as part of the lectures.
Related to question 3 we would also like to know if the test-participants like educational games.

5. It is funnier to play educational games than solving math problems on paper.
Related to question 3 and 4, we think it would be interesting to know if the test participants think

it is funnier to play games than solve math problems on paper. If we receive a mostly positive response to this question, it will seem that the idea of using educational games in the classroom is a positive thing.

6. The selection of educational games the school has is boring.

It important for us to know what the test participants thinks about the entertaining value of the selection of educational game the school already has, because we want to know if there is a general wish of improvement.

7. We use educational games too little in lectures.

We would like to know if the test participants think that educational games are used to little as part of the lectures, the reason is the same as with question 5.

8. Educational games are about winning.

This is the first of two questions about how the test participants play the game. In this we would like to know whether the test participants perceive the game as a competition hence to the motivational aspect of the game.

9. In educational games you fight to get more points than your classmates.

Again we want to enlighten the motivational aspect of the game, what drives the test participant to enhance during the game play.

10. What could be improved in the educational games used in the lectures?

Here we give the test participants the possibility to give their opinion about how to improve the educational games they have played. It could be interesting for us to see, if they mentions some of the motivational elements we have found and included in our prototype.

11. The written exercise was harder than the game

This is somehow a trick question. The math problems are of the exact same kind and level of difficulty as the ones within the game. If the test subject agrees or disagrees, it shows that the presentation of the math problems is important. The game only allows the test participants to choose which type of difficulty of problem they want to solve, whereas the written problems allowed complete freedom to solve any of the math problems at any time.

12. "Ballon Popper" is a good game.

We would like to know whether the test participants like the game in general, to find out whether we have used the correct tools and guidelines concerning the construction of the game, according to the selected target group.

13. "Ballon Popper" is better than the games you have tried as part of the lectures.

This is the most important question for our purpose, because this will show us whether we have improved an educational game using the motivational elements from puzzle games, according to our target group.

14. Name five things that make "Ballon Popper" better / worse than the educational games used in your lectures.

We want to know what they like / dislike about 'Ballon popper'. This should also give us a picture of what we can do to improve the game.

15. Other remarks

We have added this in case the student has any additional remarks to any part of the questionnaire.

4.3 The experiment

In this section we will explain how we performed the test on the 6th grade math class at Præstegårdsskolen, to describe the flow and some of the observations we made during the test.

We started by introducing ourselves and explained that the test would be divided up into three steps, and that each step would take about 5 minutes. Then we explained the three steps:

- Step 1 a written exercise where they were to solve as many math problems as possible, and that they could solve them in any order they like.
- Step 2 the game test. The test participants were instructed that they could play as many times as they wanted to within the given 5 minutes, and only the highest score would count.
- Step 3 the evaluation. They then had 5 minutes to answer the different questions in the questionnaire.

To maintain a steady flow throughout the experiment we decided to use 3 students at a time in each step of the experiment.

We then set up 3 laptops running the prototype of "Ballon Popper" the version they tested didn't include credits and info, otherwise it is the same version that is included on the CD-Rom of this report.

In addition to the 3 laptops we created 2 areas, one for the solving of the math problems on paper before the test on the laptops, and one for answering the questioners.

Figure 28 - Step 1, the written math problems

Figure 29 - Step 2, playing "Ballon Popper"

Figure 30 - Step 3, answering the questioner

We did some interesting observations during the test. Some of the students needed a short introduction to the game and its rules. A few of them had trouble understanding what the result field was for. But besides that, the test went of exactly as planned, the students knew how to follow the instructions we gave them at the beginning of the test, they moved effectively between our three test-areas and they seemed to perfectly manage the procedure. Half way through the user test, one particular good student proclaimed that he had beaten the high-score, and made the other students work even harder in order to beat the high-score. We also observed that most of the student began to discuss their scores and compare them with each other.

4.4 Results

In this section we will show and describe each of the results in the questioners. The results will be displayed graphically to obtain a better overview. We will review the results according to our goal and to the game in general, furthermore we will discuss the answers and how we perceive them according to our thesis. Afterwards we will use the results as a part of our final conclusion.

All the results have been rounded up to get whole numbers.

We have shortened the answers in the 5 answer table, this means that SA = Strongly Agree, A = Agree, N = Neutral, D = Disagree, and SD = Strongly Disagree

Question 1 - Gender

Gender	Num.	%
Male	8	47
Female	9	53

We wanted the target group to be represented by participants of both genders, so this was the diverse selection we were looking for.

Question 2 – Have you used computers as part of the mathematical lectures?

	Num.	%
Yes	17	100
No	0	0

Again this was what we were hoping for. Should there have been no-answers most of our questions would have been worthless to these participants. But with all the participants using computers during their education, they are the perfect target group for our purpose.

Question 3 - Computer games are funny

	SA	A	N	D	SD
Num.	14	31	0	0	0
%	82	8	0	0	0

100% % 0%
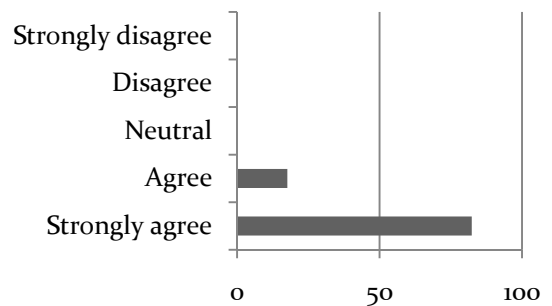
This is a very interesting answer for us. It shows that almost all the participants find playing games funny, and the majority, 82 % strongly agrees with the statement, this means that they have a positive approach towards both our game and most of the test in general.

Question 4 – It is funny to use computer games as part of the lectures

	S A	A	N	D	S D
Num.	6	10 5	0	0	1
%	35	9	0	0	6

	94%	0 %	6%
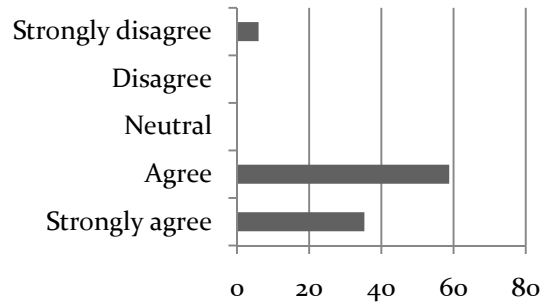
The result of this question shows us, that almost every test participant thinks that it is a good idea to use educational games. Only one student strongly disagrees whereas the rest of them partly agrees and partly strongly agrees. We interpret these answers as very positive according to the question about whether the use of educational games is appealing to the students.

Question 5 - It is funnier to play educational games than solving math problem on paper

	S A	A	N	D	S D
Num.	9	7 4	0	0	1
%	53	1	0	0	6

	94%	0 %	6%
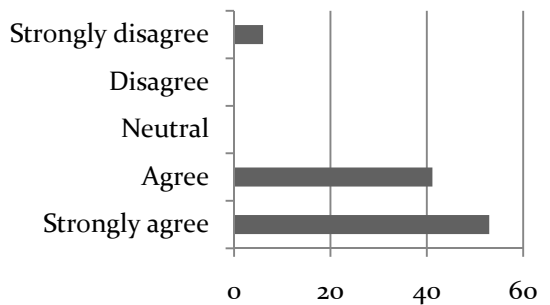
This result is almost identical to the past one. Once again there is only one student who disagrees whereas the rest of them are positive. We believe that it can be interpreted as a positive response, and with that we can see that as a contribute to the last answer, the use of a computer game to solve math problems is more appealing to the students than the regular math problems on paper.

Related to question 3, 4 and 5 we believe that we have made a strong point according to the use of educational games in the lecture. During our research we clarified that the use of educational games is a good contribution to the traditional education. Even with a single experiment and the

small number of students, the result of the above three questions clearly shows that this is correct.

Question 6 - The selection of educational games the school has is boring

	S A	A	N	D	S D
Num.	4	3	3	6	1
		1		3	
%	24	8	18	4	6

42%	18 %	40%
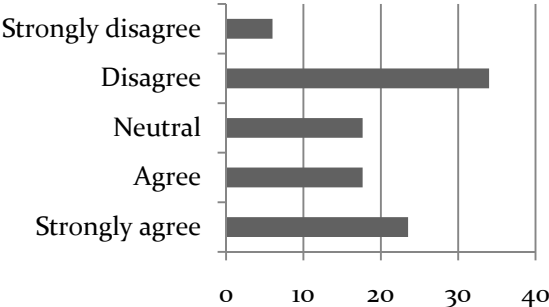
We wanted to know whether the test participants were satisfied with the selection of educational games at the school. As the result shows, 42 percent of them agree to the question, which means that they think the selection needs improvement. On the other hand, 40 percent of the participants are satisfied with the selection, and 18 percent are neutral. This is a much differentiated feedback which could mean that they are perfectly satisfied with the games they use at school, or because they like using games in the education, they like the selection of them. However we believe that with an agreement of 42 percent there is room for some improvement.

Question 7 - We use educational games too little in lectures

	S A	A	N	D	S D
Num.	5	7	2	3	0
		4		1	
%	29	1	12	8	0

70%	12 %	18%
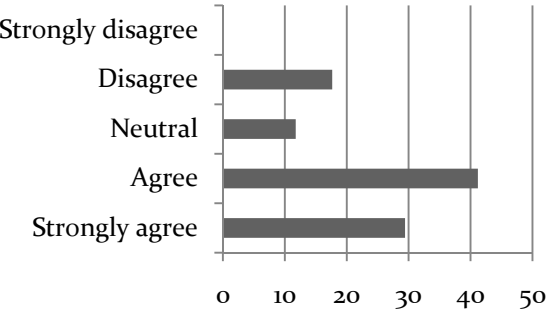
The result of this question shows us, that 70 percent of the test participant agree that the use of educational games in their lecture should be increased, and 18 percent of them disagrees whereas 12 percent are neutral.

This shows us, that the majority would like to spend more time with educational games than they do now. This strengthens the idea of games as an addition to the traditional education even more, and that using educational games in the classroom is a wanted thing.

Question 8 - Educational games are about winning

	S A	A	N	D	S D
Num.	4	3 1	4	2	4
%	24	7	24	11	24
	41%		24 %		35%
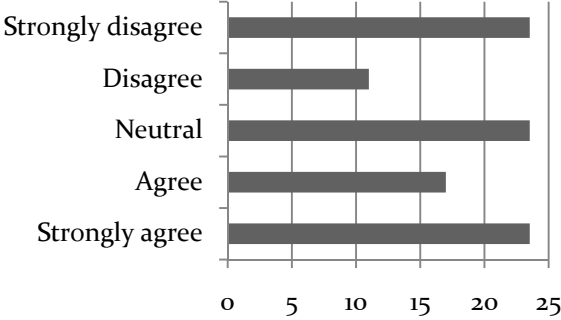
We thought it would be interesting to discover if the test participants directly perceived the motivational element of winning according to the educational games they were used to, as this is usually not an included factor within these games. The result shows us that 41 percent agreed to the question, 24 percent where neutral and 35 percent disagreed.

Looking at the numbers, there are exactly the same number of answers concerning SA, N and SD. We can however see that with 41 percent, the majority actually believes that educational games are about winning. This result suggests that including this factor as an emotional element is a good idea.

Question 9 - In educational game you fight to get a higher score than your classmates

	S A	A	N	D	S D
Num.	6	2 1	6	1	2
%	35	2	35	6	12
	47%		35 %		18%
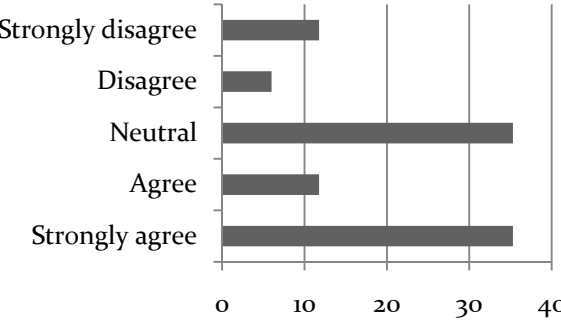
The result of this question should also give us a stronger insight according the motivational aspect of competition when playing an educational game. With 47 percent, the majority once again agrees whereas only 18 percent disagrees and 35 percent is neutral. Again the results are showing that some of the test participants actually perceive the educational games as competitions.

Question 10 - What could be improved in the educational games used in the lectures?

- They could be funnier and more difficult
- They have ugly graphics there need to be better graphics, and they need to be funnier and better
- They need to be funnier and more difficult
- One needs to train a lot in order to become better, and I think math is difficult
- There needs to be more things to do instead of doing the same all the time
- Nothing
- Nothing really, I think educational games are funny enough
- Don't really know
- Create some funny faces, some nice background colours, and make them more fun
- That I understand it

We wanted to hear the opinion of our target group to the question about what could be improved in the educational games they already used. The answers above primarily tells us, that the test participants would like to include the factor "fun" in the games, and that they should be more difficult and thereby more challenging. Furthermore they answered that the games should contain better graphics and more variety. The words fun, challenge and graphics are all elements which we have included as improving elements in our prototype.

Question 11 - The written exercise was harder than the game

	SA	A	N	D	SD
Num.	1	4 2	3	9 5	0
%	6	4	18	2	0

18

30% % 52%
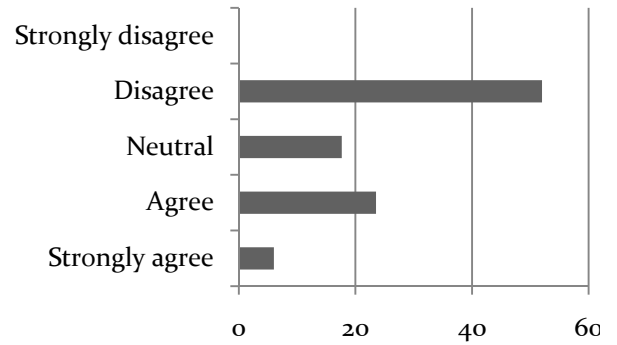
As mentioned in the description of the questions, this question is a trick question, because both the type of the problems and the level of difficulty are identical in both the game and the written exercise. Both type of math problems were found and generated at the website http://www.matematikbogen.dk and were selected according to a 6th grade level. We wanted to find out whether the presentation of the questions was of any importance according to the level of challenge. According to the result, 52 percent disagrees with the question, 18 percent are neutral and 30 percent agrees. This show us, that the presentation of the math problems does have an influence on the level of challenge, and that the majority of 52 percent thought that the game was more challenging than the written exercise.

Question 12 – 'Ballon Popper' is a good game

	SA	A	N	D	SD
Num.	8 4	9 5	0	0	0
%	7	3	0	0	0

0

100% % 0%
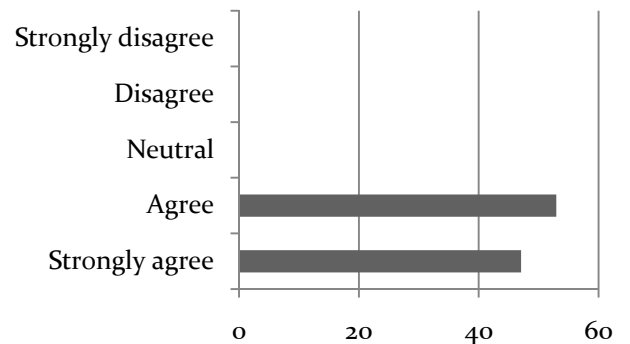
To find out if our game was a success according to the target group and with that, if we have used the correct tools and guidelines concerning the construction of the game, we asked them if they thought that 'Ballon Popper' is a good game. The result of that question shows us a positive reaction with 100 percent agreement, where 47 percent of them strongly agreed.

Question 13 - "Ballon Popper" is better than the games you have tried as part of the lectures

	SA	A	N	D	SD
Num.	8	7	1	1	0
%	47	41	6	6	0
		88%	%	6%	
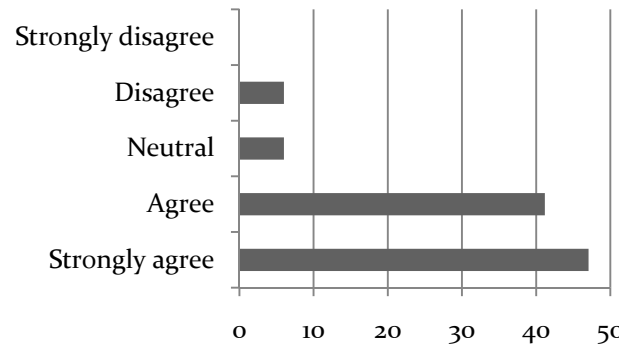
To find out whether we have improved an educational game using the motivational elements from puzzle games, we asked the target group if 'Ballon Popper' is a better game than the ones they knew from their education. 88 percent agreed to that and within those 88 percent 47 percent strongly agreed. 6 percent of the test participant where neutral according to the question, and 6 percent disagreed. With a percent of 88 we believe to have proven, that according to the selected target group, 'Ballon Popper' is an improvement with respect to ordinary educational games.

Question 14 - Name five things that make "Ballon Popper" better / worse than the educational games

- It's nice that has easy, difficult, and medium
- You need to use the head, it's funny, and it's easy
- It's better it's a bit more difficult
- It would have been more addition and subtraction questions
- It is funnier (than the educational games), a bit boring, it could be a bit longer. It is nice that it have been created as a game
- It is nice that it's hard, medium, and easy
- It's funnier
- It is mostly "child friendly". It's funnier.
- It's much better because it has movement and it's funny
- It's a funny face
- You can get some more help, nothing else (worse than educational games)
- It's good because the balloons are large, this makes it easier to see the numbers

- It's good because the balloons are large, and one gets better at math
- It was an exciting game and I got a lot of points
- In educational games you cannot guess the answers

To find out which factors they like or dislike about 'Ballon Popper' we asked them to mention 5 things about the game which either makes it better or worse than the ordinary educational games. The results of this question should tell us if they had discovered the motivational elements within the game and furthermore what we could improve about the game in general.

The answers showed us, that the test participants actually reacted positively to the motivational improvements. Among other things they answered that it was a good idea with the three levels of difficulty, and that the game seemed more challenging. Furthermore they mention, that 'Ballon Popper' is more fun than ordinary educational games and that it is good that it has movement and big balloons. This implies that the graphical contents work.

Another answer says that the game is boring, because it should be longer, but that it is still better than ordinary educational games. This tells us that to make the game more challenging, it would maybe a good idea to extend the game and maybe create some variety in the game by adding differentiated levels.

Question 15 - Other remarks
- The games needs to be better
- Math is difficult but nice (when) you're good at it
- No it's good

The last question was in the case we had missed something important for the test participants to add. The very limited number of answers suggests that this was not the case or that kids that age do not like open questions.

Summing it up we can see that the students who have tested our prototype all think that the game is a good games. We are however aware that this is the first time any of them have tried this game, and there therefore is a tendency for the students to like everything that is new. If we conducted the user study over a period, a longitudinal study, of several months there would be more students who weren't overwhelmingly positive about the game. However, we think that the

fact that 88% of the students agreed that our prototype was better than the games they have tried as part of the lectures, we can conclude that our hypothesis was probably true.

5. Conclusion

The conclusions and perspectives of this thesis is divided into five separate sections.

- During our research of educational games, we wanted to identify the structural elements of games represented within this genre. We discovered that an educational game primarily contains interaction, a main subject, something which makes the game challenging, an educational goal and contents related to real life activities. All of the mentioned elements needed to be part of the conceptual game, in order for it to be educational.
- Furthermore we wanted to determine the motivational elements within a puzzle game for us to implement them into our conceptual game, combined with the educational features. We identified the following motivational elements within puzzle games: an easy and understandable concept, easy but challenging, the game needs to be interactive, single-/ multiplayer, compelling graphics, compelling music, compelling sound effects, there should be some form of scoring, there should be a high-score, global high-score and lives.
- To create an educational puzzle game we combined both the educational features and the motivational elements from both genres, which resulted in the following structural elements: a main subject, an educational goal reflected on the subject and game play, the contend and subject shall reflect a real-life-activity, interactivity, compelling graphics, compelling music and sounds, a challenging game play dependent on target group but easily seen through, a score, a high-score, a global high-score, count of lives, possibility for single / multi-player.
- Using the combined elements as structural elements we have composed the idea, concept and functionalities of an educational puzzle game. Furthermore we have constructed a working prototype of that educational puzzle game called ´Ballon Popper´ to test whether the fusion of the mentioned game genres is possible and if this fusion has a positive effect on the chosen target group.
- The test showed a positive result to the questions according to the improving effect caused by the mentioned fusion.

By looking back at the goal of this project we think we have solved everything we set out to do. We have defined what the structure of an educational game is we have located the motivational elements of puzzle games, and used them in a educational puzzle game prototype which have been tested on a 6th grade class who then have confirmed that the prototype is an improvement upon the games they have used in their education.

_____   _____

    Mike Mattesen   Torsten B. Fix

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7. Appendix

7.1 Questionnaires in Danish

Please be aware there is a typo in numbering of the questions, in the report the questions are referred to as question 1-15 ignoring the wrong numeration.

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: _Danni_
Point: _320_

1. Køn
2. Har du prøvet at bruge computer i matematik undervisningen?

Pige ☐ Dreng ☒
Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☒
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☐	☐	☒	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☒	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☒	☐	☐	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☒	☐	☐	☐
7. Undervisningspil handler om at vinde.	☐	☒	☐	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☒	☐	☐	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

_____
_____
_____

10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☒	☐	☐
11. "Ballon Popper" er et godt spil.	☒	☐	☐	☐	☒
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☒	☐	☐	☐	☒

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

_____
_____
_____

14. Har du andre bemærkninger:

_____
_____
_____

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: _Martin_

Point: _260_

1. Køn — Pige ☐ Dreng ☒
2. Har du prøvet at bruge computer i matematik undervisningen? — Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☒	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☒	☐	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☐	☐	☐	☒
6. Vi bruger computerspil for lidt i undervisningen.	☒	☐	☐	☐	☐
7. Undervisningspil handler om at vinde.	☐	☒	☐	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☒	☐	☐	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

_____
_____
_____

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☐	☒	☐
11. "Ballon Popper" er et godt spil.	☐	☒	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☒	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

_____
_____
_____

14. Har du andre bemærkningen:

_____
_____
_____

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

1. Køn — Pige ☐ Dreng ☒
2. Har du prøvet at bruge computer i matematik undervisningen? — Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☒	☐	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☒	☐	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☐	☐	☒	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☒	☐	☐	☐
7. Undervisningspil handler om at vinde.	☒	☒	☐	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☒	☐	☐	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

De kunne blive sjove og svære.

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☐	☒	☐
11. "Ballon Popper" er et godt spil.	☒	☐	☐	☒	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☒	☐	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

det er godt at der er let svær og midel

14. Har du andre bemærkningen:

Nej

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Meho
Point: 120

1. Køn   Pige ☐   Dreng ☒
2. Har du prøvet at bruge computer i matematik undervisningen?   Ja ☒   Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☐	☒	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☒	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☐	☐	☐	☒
5. Skolens udvalg af matematikspil er kedeligt.	☒	☐	☐	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☒	☐	☐	☐	☐
7. Undervisningspil handler om at vinde.	☒	☐	☐	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☒	☐	☐	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

Det er dårligt grafik der skal være bedre grafik og det skal være sjovre og bedre.

10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☒	☐	☐	☐
11. "Ballon Popper" er et godt spil.	☐	☒	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☐	☐	☒	☐

13. Næsvn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

DU skal bruge hjernen og det er sjove og den er let.

14. Har du andre bemærkninger:

Spillet skal være bedre.

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: _Argjent_
Point: _530_

1. Køn — Pige ☐ Dreng ☒
2. Har du prøvet at bruge computer i matematik undervisningen? — Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☒	☐	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☒	☐	☒	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☐	☐	☒	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☐	☒	☐	☐
7. Undervisningspil handler om at vinde.	☒	☐	☐	☒	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☒	☐	☒	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

de skal være sjove og svære.

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☒	☐	☐
11. "Ballon Popper" er et godt spil.	☒	☐	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☒	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

det er bedre at det er
lidt svære.

14. Har du andre bemærkningen:
_____
_____
_____

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Yasin
Point: 20

1. Køn — Pige ☐ Dreng ☒
2. Har du prøvet at bruge computer i matematik undervisningen? — Ja ☒ Nej ☒

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☒	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☒	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☐	☐	☒	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☐	☒	☐	☐
7. Undervisningspil handler om at vinde.	☐	☐	☐	☐	☒
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☐	☐	☐	☒

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

at man skal trene sig meget, for
at blive bedre jeg syndes mtt
er svært.

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☒	☐	☐	☐
11. "Ballon Popper" er et godt spil.	☐	☒	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☐	☒	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

det kunne være sjovere huis
der kun var +/-.

14. Har du andre bemærkninger:

mtt er svært men hyggeligt
hvis man kan det.

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Mehmed
Point: 260

1. Køn
2. Har du prøvet at bruge computer i matematik undervisningen?

Pige ☐   Dreng ☒
Ja ☒   Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☒	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☒	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☐	☒	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☒	☐	☐	☐
7. Undervisningspil handler om at vinde.	☐	☐	☐	☒	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☐	☒	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

Der måtte gerne være flere ting at prøve end bare det samme hele tiden.

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☐	☒	☐
11. "Ballon Popper" er et godt spil.	☐	☒	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☒	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

Det er sjovere, lidt kedeligt den skulle være lidt længere, Det er godt fordi det er lavet som spil,

14. Har du andre bemærkningen:

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Søren

Point: 520

1. Køn
2. Har du prøvet at bruge computer i matematik undervisningen?

Pige ☐ Dreng ☒
Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☒	☐	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☒	☐	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☒	☐	☐	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☒	☐	☐	☐
7. Undervisningspil handler om at vinde.	☐	☒	☐	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☒	☐	☐	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

Ikke noglt

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☒	☐	☐	☐
11. "Ballon Popper" er et godt spil.	☒	☐	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☒	☐	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

det er godt der er svære, middel, nem,

14. Har du andre bemærkninger:

Nej det er godt

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: _Louisa_
Point: _280_

1. Køn
2. Har du prøvet at bruge computer i matematik undervisningen?

Pige [X] Dreng [ ]
Ja [X] Nej [ ]

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	[ ]	[X]	[ ]	[ ]	[ ]
4. Det er sjovt at bruge computerspil i undervisningen.	[ ]	[X]	[ ]	[ ]	[ ]
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	[X]	[ ]	[ ]	[ ]	[ ]
5. Skolens udvalg af matematikspil er kedeligt.	[ ]	[ ]	[ ]	[X]	[ ]
6. Vi bruger computerspil for lidt i undervisningen.	[ ]	[ ]	[ ]	[X]	[ ]
7. Undervisningspil handler om at vinde.	[ ]	[ ]	[ ]	[ ]	[X]
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	[ ]	[ ]	[ ]	[ ]	[X]

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?
Ikke rigtig noget. Syntes undervisnings-spillene er sjove nok.

10. De udleverede opgaver var sværer end opgaverne i spillet.	[ ]	[ ]	[ ]	[X]	[ ]
11. "Ballon Popper" er et godt spil.	[ ]	[X]	[ ]	[ ]	[ ]
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	[ ]	[X]	[X]	[ ]	[ ]

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen
Det er sjovere.

14. Har du andre bemærkninger:
Nej!

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Pinaluk
Point: 200

1. Køn   Pige ☒   Dreng ☐
2. Har du prøvet at bruge computer i matematik undervisningen?   Ja ☒   Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☒	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☒	☐	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☒	☐	☒	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☒	☐	☐	☐	☐
7. Undervisningspil handler om at vinde.	☐	☐	☒	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☒	☐	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

ved ik hdt

10. De udleverede opgaver var sværer end opgaverne i spillet.   ☐ ☐ ☐ ☒ ☐
11. "Ballon Popper" er et godt spil.   ☐ ☒ ☐ ☐ ☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.   ☒ ☐ ☐ ☐ ☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

Det er mest børne-venlig Ballon popper
Sjovere er det

14. Har du andre bemærkninger:

ik for mange af de svare !

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Katrine
Point: 360

1. Køn — Pige [X] Dreng [ ]
2. Har du prøvet at bruge computer i matematik undervisningen? — Ja [X] Nej [ ]

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	[ ]	[X]	[ ]	[ ]	[ ]
4. Det er sjovt at bruge computerspil i undervisningen.	[X]	[ ]	[ ]	[ ]	[ ]
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	[X]	[ ]	[X]	[ ]	[ ]
5. Skolens udvalg af matematikspil er kedeligt.	[ ]	[ ]	[X]	[ ]	[ ]
6. Vi bruger computerspil for lidt i undervisningen.	[X]	[ ]	[ ]	[ ]	[ ]
7. Undervisningspil handler om at vinde.	[ ]	[ ]	[X]	[ ]	[ ]
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	[ ]	[X]	[ ]	[ ]	[ ]

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

_____
_____
_____
_____

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	[ ]	[ ]	[ ]	[X]	[ ]
11. "Ballon Popper" er et godt spil.	[ ]	[X]	[ ]	[ ]	[ ]
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	[X]	[ ]	[ ]	[ ]	[ ]

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

det er meget bedre fordi det er mere bevoglig
og sjovt

14. Har du andre bemærkningen:

_____
_____
_____

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Emilie

Point: 210

1. Køn
2. Har du prøvet at bruge computer i matematik undervisningen?

Pige ☒ Dreng ☐
Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☒	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☒	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☒	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☒	☐	☐	☒	☐
6. Vi bruger computerspil for lidt i undervisningen.	☒	☐	☐	☐	☐
7. Undervisningspil handler om at vinde.	☐	☐	☒	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☐	☐	☒	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

lave nogle sjove ansigter, nogle pænere baggrunds farver, og gøre dem lidt sjovere

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☒	☐	☒	☐
11. "Ballon Popper" er et godt spil.	☐	☒	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☒	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

der et sjovt ansigt

14. Har du andre bemærkningen:

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Iben
Point: 9 10

1. Køn   Pige ☒   Dreng ☐
2. Har du prøvet at bruge computer i matematik undervisningen?   Ja ☒   Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☐	☒	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☒	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☐	☒	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☒	☐	☐	☐
7. Undervisningspil handler om at vinde.	☐	☐	☐	☒	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☐	☒	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

Det har jeg ingen svar på? jeg ville være bedre til at få flere point i stedet fo 10 point

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☒	☐	☐
11. "Ballon Popper" er et godt spil.	☐	☒	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☒	☐	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

at man kan få lidt mere hjælp, ikke noget andet

14. Har du andre bemærkninger:

Nej

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Meral
Point: 200

1. Køn
2. Har du prøvet at bruge computer i matematik undervisningen?

Pige [X] Dreng [ ]
Ja [X] Nej [ ]

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	[X]	[ ]	[ ]	[ ]	[ ]
4. Det er sjovt at bruge computerspil i undervisningen.	[ ]	[X]	[ ]	[ ]	[ ]
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	[X]	[ ]	[ ]	[ ]	[ ]
5. Skolens udvalg af matematikspil er kedeligt.	[ ]	[X]	[ ]	[ ]	[ ]
6. Vi bruger computerspil for lidt i undervisningen.	[ ]	[ ]	[ ]	[X]	[ ]
7. Undervisningspil handler om at vinde.	[ ]	[ ]	[ ]	[ ]	[X]
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	[ ]	[ ]	[X]	[ ]	[ ]

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

ikke noget det var godt nok

10. De udleverede opgaver var sværer end opgaverne i spillet.

| [ ] | [ ] | [ ] | [X] | [ ] |

11. "Ballon Popper" er et godt spil.

| [X] | [ ] | [ ] | [ ] | [ ] |

12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.

| [X] | [ ] | [ ] | [ ] | [ ] |

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

Det er god fordi ballonerne er store så kan man se tallene bedre

14. Har du andre bemærkninger:

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: _Sengül_
Point: _70_

1. Køn   Pige ☒   Dreng ☐
2. Har du prøvet at bruge computer i matematik undervisningen?   Ja ☒   Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☒	☐	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☒	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☒	☐	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☐	☐	☒	☐
7. Undervisningspil handler om at vinde.	☐	☐	☐	☐	☒
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☐	☒	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

ikke noget det var godt nok

10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☐	☒	☐
11. "Ballon Popper" er et godt spil.	☒	☐	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☒	☐	☐	☐	☐

13. Næyn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

det er godt fordi ballorene er stør og det
man bliver god til at regne

14. Har du andre bemærkninger:

Nej

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Wuma
Point: 100

1. Køn
2. Har du prøvet at bruge computer i matematik undervisningen?

Pige ☐ Dreng ☒
Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☒	☒	☒	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☒	☐	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☒	☐	☐	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☒	☐	☐	☐
7. Undervisningspil handler om at vinde.	☒	☐	☐	☐	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☐	☐	☒	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

at Jeg forstå det

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☒	☐	☐	☐	☐
11. "Ballon Popper" er et godt spil.	☒	☐	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☒	☐	☐	☐

13. Nævn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

det var en spændende spil
Og jeg fik mange point

14. Har du andre bemærkninger:

det var lidt svært første gang

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Spørgeskema til 6 klasse på Præstegårdsskolen

Navn: Rodus
Point: 170

1. Køn — Pige ☒ Dreng ☐
2. Har du prøvet at bruge computer i matematik undervisningen? — Ja ☒ Nej ☐

	Meget enig	Enig	Neutral	Uenig	Meget uenig
3. Computerspil er sjove!	☒	☐	☐	☐	☐
4. Det er sjovt at bruge computerspil i undervisningen.	☒	☐	☐	☐	☐
5. Det er sjovere at spille undervisningsspil end at løse opgaver på papir.	☐	☒	☐	☐	☐
5. Skolens udvalg af matematikspil er kedeligt.	☐	☐	☐	☒	☐
6. Vi bruger computerspil for lidt i undervisningen.	☐	☐	☒	☒	☐
7. Undervisningspil handler om at vinde.	☐	☐	☐	☒	☐
8. I undervisningsspil kæmper du for at få flere points end kammaraterne	☐	☐	☒	☐	☐

9. Hvad kunne gøres bedre i de spil der bruges i undervisningen?

at der også var noget sjovt med i det forebsempel er matematik spil.

	Meget enig	Enig	Neutral	Uenig	Meget uenig
10. De udleverede opgaver var sværer end opgaverne i spillet.	☐	☐	☐	☒	☐
11. "Ballon Popper" er et godt spil.	☒	☐	☐	☐	☐
12. "Ballon Popper" er sjovere end de spil du har prøvet som en del af undervisningen.	☐	☒	☐	☐	☐

13. Næyn 5 ting du synes gør "Ballon Popper" bedre / dårligere end spillene i undervisningen

for de i undervisning spil der skeal man ikke p grotte noget med regning

14. Har du andre bemærkningen:

Mange tak for hjælpen
Aalborg Universitet Esbjerg

Appendix 7.2 – Math problems used in the user experiment

Navn: _____

$24 + 87 =$
$38 + 23 =$
$9 + 30 =$
$46 + 20 =$
$19 + 80 =$
$59 + 20 =$
$55 + 75 =$
$16 + 68 =$
$14 + 73 =$
$80 + 39 =$

$63 - 27 =$
$79 - 36 =$
$67 - 39 =$
$41 - 34 =$
$58 - 24 =$
$47 - 34 =$
$32 - 21 =$
$50 - 18 =$
$51 - 20 =$
$66 - 43 =$

$14 \cdot 11 =$
$3 \cdot 14 =$
$14 \cdot 10 =$
$12 : 6 =$
$48 : 6 =$
$36 : 18 =$
$12 \cdot 2 =$
$4 \cdot 14 =$
$56 : 4 =$
$48 : 6 =$