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Software Engineering Game

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Abstract

Educational games has become the subject of more and more research the last couple of years and the games developed solely for educational purposes has started to make their way into all areas of education. The field of educational games have seen different degrees of success and failure, and during a literature study undertaken the fall of 2012 several major strategies used in educational games were identified and analysed.

The goal of this paper is to explore and evaluate the utility of different strategies used in educational games. These strategies include creating immersion and promote learning through visual gratification, feedback, scoring, reasoning, and cognitively demanding environments. A game prototype, based on the tactics and strategies outlined in the literature study, has been implemented and is subject for testing on students. The tests aims to determine how well different strategies would do in an actual implementation of a game.

A web based game giving the player the role as a project manager in a software company were developed and an early prototype version were tested on engineering students at the Norwegian University of Technology and Science. The game would introduce a set of challenges where the performance of the player were largely dependent on their knowledge of educational material made available in the game. The purpose of the game were to motivate the students to study this material in order to perform better in the game.

The prototype was tested through inviting students to attempt at completing the game. Data was gathered through observing the students while playing and through making players complete a questionnaire when finished with the game. A group discussion were held at the end giving the students the possibility to elaborate on their questionnaire and the observations.

Through analysing the results we were able to more accuratly describe the effect of different strategies, the different effect it had on groups based on gender and gaming experience, and how the strategies can be improved. Finally, the paper suggests how the game can be improved, and discusses the posibility of conducting a experiment to determine learning outcome through intergrating it into a university course.

Preface

This report and the implementation of the game presents the work done for my master thesis at the Department of Computer and Information Science at the Norwegian University of Science and Technology. The work was done during the spring of 2013 and concludes my master degrees in Computer Science.

I would like to thank the students who participated in the testing of the game, and especially my supervisor Alf Inge Wang for his invaluable guidance and feedback during my work.

Sondre Bjørnvold Bakken

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Contents

List of Tables

List of Figures

Part I

Chapter 1

Introduction

This chapter will describe the context of this thesis, the authors personal motivation in choosing and undergoing this project, and outline the project goals.

1.1 Context

This project is undertaken at NTNU during spring semester 2013 and will together with my specialisation project completed fall of 2012[1] conclude the work on my master thesis. My master thesis extends the work on my project, where a literature study were performed and suggestion for a educational game were put forward. During the work on my master thesis I will complete the design of the game, implement it and perform an experiment where student test the game.

1.2 Personal motivation

During my exchange program where I attended two semester abroad at 'The University of South Wales' I signed up for a course named 'Advanced Multimedia' which explored how todays advanced media features and technology could be used in creating engaging interactions, promote viewpoints, educate and give a much more immersive experience than what have been possible earlier through film, text or sound. These possibilities were especially explored and experimentet with through the use of computer games. As a eager gamer, this is what sparked my growing interest in using games for more than entertainment and what motivated me to engage in my specialization project fall of 2012[1] where I conducted a literature study and a

discussion on different approaches on how to develop a educational game.

Following my project I proposed for my supervisor a prototype game where I had incorporated some of the most important approaches in an attempt at creating a working educational game. As my thesis I will implement this game prototype and test it on a group of student with regard to the approaches chosen and the findings in my literature study.

1.3 Goals

In my specialisation project[1] I identified important strategies in order to create a good educational game. These strategies touch on the subject of both learning and immersion. The most prominent elements are:

1. Immersion:

    - A complex reward system
    - Creating a cognitivly demanding world
    - Immersion through reasoning.

2. Educational:

    - Motivate the player to gain knowledge necessary to succeed in the game.
    - Provide informational feedback and events for the player to understand logic framework in the game world. Encourages problemsolving.
    - Let the player obtain a feeling of flow. Tasks should be challenging, but not frustrating.
    - Provide challenges that requires reasoning.
    - Promote learning through rote-learning and repetition.

Under the part 'Own contribution' in the specialisation project proposal for an educational game were designed which incoorporate many of the identified strategies. This game took basis in teaching the player about software development. I chose to focus the game on this field, because in order to create a eductional game I needed to be both a game developer and a teacher with a strong comptence within a field. For me to best function as both in this project, the field of study incorporated in this game had to be of an disipline

where I have sufficient knowledge.

My goal of this thesis is to implement the game designed in my project and test it on a group of participants. Then through different methods of data gathering and analysis trying to decide how well these earlier outlined strategies promoted different aspects of learning and immersiveness.

Through my testing I wish to, through different methods of data gathering (discussions, questionaares and observation):

- be able to test the effect of different learning methods in terms of learning outcome and immersion.
- support my claims on how these strategies promoted learning and immersion.
- identified the level of effect the different strategies had on different players.
- observe how players of different background approach an educational game.

Chapter 2

Research questions & Methodology

2.1 Research questions

To structure our research, we have formulated the research questions found in table 2.1.

RQ1	Are players motivated through a complex reward system?
RQ1.1	Are participant motivated through the presentation of scores and progress data?
RQ1.2	Are participants motivated by scores being compared with others?
RQ1.3	Are participants motivated through visually gratifying presentations of progress data and scores?
RQ2	Does creating a cognitively demanding world based on 'learning content' promote learning and achieve immersion?
RQ2.1	Are participants motivated to study the educational content in the game in order to achieve a better score?
RQ2.2	Do participants learn through content being necessary to understand in order to be successful in the game?

RQ2.3	Are participants motivated by the level of reasoning required to make correct decisions in the game?
RQ3	Does the game manage to promote rote learning through repetition?
RQ3.1	Does the reward system making repetition enjoyable?
RQ3.2	Do the participants learn through repetition?

2.2 Research method

Zelkowitz and Wallace [3] describe four different research methods:

- Scientific method: Scientists develop a theory in order to explain a phenomenon and then propose a hypothesis. The hypothesis is then tested, and data is collected to verify or refute the claims of the hypothesis.
- Engineering method: Engineers develop and test a prototype to a hypothesis. Based upon the results of the testing, they improve the prototype until no further improvements are required.
- Empirical method: A statistical method is proposed in order to validate a hypothesis. Data is collected to verify the hypothesis.
- Analytical method: A formal theory is developed, and the results gathered from the theory is compared with empirical observations.

In this master thesis we will use the engineering method and the empirical method as our main research methods. A literature study will be performed and based on that research a prototype of an educational game will be designed and implemented. This prototype will be tested, and if time; improved. The final stage will consist of an experiment where players will test the game, and data related to the performance of educational games will be gathered through a questionnaire, observations and conversations with the players.

To gather data and evaluate this experiment we used a questionnaire based on System Usability Scale [4], EGameFlow [5], Heuristics and usability guidelines for the creation and evaluation of fun in video games[7], and A Model

for Evaluating Player Enjoyment in Games[6] , as well as observations made by the instructor during the playing and during and a group discussion held afterwards among the participants.

The results will then analysed in light of our research with the goal of answering our earlier stated research questions. See table 2.1.

2.3 Literature study

In order to create a good educational game, and to be able to produce an scientific and valuable analysis around the results obtained from the experiment a thorough literature study will be conducted.

The purpose of the literature study will be to:

- identify and evaluate different strategies within educational and immersive game techniques in terms of implementing them in the game prototype.
- investigate results of earlier conducted research in order to shed light on, compare and reason around results obtained from this experiment.
- obtain knowledge within the field of immersive game strategies, educational game strategies and the benefits and disadvantages of educational games.

The literature study will also look into the technology that will be used, and what currently exists within the genre of educational games

2.4 Game proposal

To be able to observe, evaluate and understand how people approach and play an educational game, we will need a game to the test. As a result, we will have to develop a prototype using the technology we chose based on the literature study. Based on the high availability, the high maturity and ease of use considering both deployment and testing, only web technologies will be considered.

During the literature study strategies and tactics within the field of educational games will be identified and evaluated. In order to test these the game design should attempt to accomodate as many of the strategies and tactics as

possible. Given that the successful implementation of these strategies only can be determined through continuous user testing, seen together with the fact that there will presumably not be much time available it was obvious from the start that our development process would most likely result in a prototype, not a finished product. Planned features and improvements that will not make it into the implementation will be discussed under section 9: 'Future work'. The game should regardless reach a state where several of the identified strategies and tactics will be testable.

2.5 Development

The development will use a iterative approach. Due to the uncertainty of the design, the inexperience around game development, only the essential gameplay features will be implemented in the first iteration, in order to have a playable game as early as possible.

This approach will work as a safety precaution to ensure that a playable game will be available for testing, in case development problems are encountered that significantly delays the implementation.

After the first iteration have been successfully completed planned elements will be implemented and tested during subsequent iterations, with focus on always maintaining a playable game.

2.5.1 Technology choice

An investigation into different technologies that are considered viable for this game will be conducted. The scope is limited to technologies that will allow the game to be deployed online and be playable through a browser.

The technologies will be evaluated on their features with respect to the game design, the maturity, availability, and the developers current experience and motivation.

2.6 Evaluation approach

The focus of the evaluation is to determine at which level the strategies and tactics in the game promoting learning and immersion had the desired effect.

This implies gathering data from the participants after they attempted the game.

The game will be evaluated through three methods:

- Questionnaire
- Observation
- Discussion

Testing a software and gather data around the participants experience concerning different elements in the software, has many similarities to normal user testing of information systems, but because of the nature of the project, some evaluation methods typically used in evaluating software may not be of much use to us. Games contains some different elements (fun, immersion and flow) compared to normal software, which is mainly focused on increasing effectiveness and efficiency in the completion of a task.

Due to the imaturity of the field, a study into how to properly evaluate different elements in educational games were conducted and statements used in the questionaire were retrieved or derived from the four papers presented in the following subsection.

2.6.1 Questionnaire

Questionnaires are an easy way to gather information about a system. They are easy to prepare and can be quickly answered by the participants.

Using a questionnaire instead of interviews for the main method of asking users of their opinion also allows us to ask them all the same questions and get answers in a quantitative form that allows us to easily analyse their responses.

There are several ways to design a questionnaire. For instance, there are four different scale types, which would obtain different kinds of information from the respondents. The four scale types are:[8]:

- Nominal: Classification without need for ranking.
- Ordinal: Classification with ranking but without need for equal intervals between ranks.

- Interval: Degree of presence of phenomena using equal intervals without need for absolute zero.
- Ratio: Degree of presence or absence of phenomena.

The questionnaire prepared and used in this thesis contains statements obtained from *SUS: a "quick and dirty" usability scale*[4], and *EGameFlow: A scale to measure learners enjoyment of e-learning games*[5] and statements based on heuristics obtained from *GameFlow: A Model for Evaluating Player Enjoyment in Games*[6] and *Heuristics and usability guidelines for the creation and evaluation of fun in video games*[7].

The questionnaire takes on the form of a interval type. It consists of 57 statements (alternating positive and negative statements) in which respondents have to express their degree of agreement or disagreement on a scale from 1 to 5, where 1 indicates strong disagreement and 5 indicates strong agreement.

Some of the papers mentioned contains questions, or different scales. These has been transformed to statements, and the scales has all been change to 1-5. The following four subsections briefly describes the papers researched in order to create the Questionnaire used in this thesis.

For an overview of the questions used in the questionaire, see Appendix A

System Usability Scale

The system usability scale[4] was created by James Brooke as a quick and dirty questionnaire in order to evaluate the usability of a system. The scale was created from a desire to have a way to measure usability both quickly and simply, and at the same time retrieve a reliable measurement.

EGameflow

The EGameFlow scale[5] is a scale that measures the experience offered by E-learning games, and helps the game designer to understand the strengths and weaknesses of the game efficiently from the learner's point of view. EGameFlow consists of a number of questions and statements in eight areas.

The eight areas of EGameFlow:

- Concentration: Games must provide activities that encourage the player's concentration while minimizing stress.

- Goal Clarity: Tasks should be clearly explained from the beginning.
- Feedback: Feedback allows a player to determine the gap between the current stage of knowledge and the knowledge required for completion of the task.
- Challenge: The game should offer challenges that fit the player's skill level, the difficulty of these challenges should change in accordance with the increase in the player's skill level.
- Autonomy: The learner should enjoy taking the initiative in game-playing and asserting total control over his or her choices in the game.
- Immersion: The game should lead the player into a state of immersion.
- Social Interaction: Tasks in the game should become a mean for players to interact socially.

Gameflow

Gameflow[6] draws together various heuristics obtained from literature into a concise model of enjoyment in games that is structured by flow. Flow includes eight elements that were found to encompass the various heuristics from the literature.

The GameFlow model, consists of eight elements (quite similar to EGameFlow) –

- Concentration
- Challenge
- Skills
- Control
- Clear goals
- Feedback
- Immersion
- Social interaction

Each element includes a set of criteria for achieving enjoyment in games. These criterias were evaluated through conducting expert reviews of two real-time strategy games, one high-rating and one low-rating. The result was a deeper understanding of enjoyment in real-time strategy games and the identification of the strengths and weaknesses. Statements created from this paper were based on these criterias if found relevant to the research goals put forward in this thesis.

Heuristics and usability guidelines

Heuristics and usability guidelines for the creation and evaluation of fun in video games[7] examines the implicit and explicit heuristics and usability evaluation processes utilized by a leading game developer. Five people from a single game team, each contributing in a different way to the game development process, were observed and interviewed. The heuristics created in this study are a starting point for the construction of a standard list of game heuristics for use by the game development community.

2.6.2 Observation

Observing participants attempting the game can allows us to discover different approaches, behaviour and problem areas that would not be revealed through analyzing the questionnaire results. Having an observer present also carries with it some advantages, as he can take on the role of a instructor if needed. An educational game would often be used in a classroom setting where a teacher would be present. Due to the early stages of testing, the observer will be allowed to interrupt players if they are stuck, and the participants are informed that they are allowed to ask questions. This differs from normal user testing, where the observer should be invisible. This is acceptable in this case because it is not the game itself which are the primary focus of this experiment, but the elements in the game created to promote learning and create immersion. If a participant is stuck in a early stage of the game without the possibility of asking for assistance, the player could risk not be exposed to some of these elements, and their answers on the questionnaire would give erroneous results.

While observing, the focus will be on how players interact with the game, in-game behaviour, decisions, reactions and observed approaches. The observations can be elaborated on during the discussion that will follow after the testing, but it might be hard for the participant to remember his thoughs and reasoning at particular moments during playing. Therefor the observer

is also allowed to interrupt and ask the participant to elaborate on particular actions or decisions performed in the game during the experiment.

2.6.3 Discussion

After the questionnaire have been handed in the participants will sit down together with the instructor for a unstructured or semi-structured informal discussion. This means that there will not be a set of defined questions we will ask participants, but the questions will be more open-ended and the participants will be encouraged to speak freely about the topic at hand. The structured questions we want answered will be in the questionnaire, and the discussions will act as a way to gain a more indepth understanding of what some users experienced, and following up on any comments they may have about the game.

Because participants are encouraged to speak freely, it is important to have an agenda about which topics to cover, so that the discussion stays more or less on topic.

Interviews with each single participant were considered, but the tests were held during the students exam period, it was important not to make students wait for their turn seeing that we had no estimate of the length of interviews. Discussions also created a more open enviroment where participants could continue on each others train of thought, and where threshold for giving negative feedback were lower. Lowering the threshold for giving negative feedback will be important due to the fact that the instructor will also be the developer of the game, there might be personal relations between the developer and some of the participants, and that people might think that the developer would be offended by people not approving of the game.

2.7 Experiment

The experiment itself will consist of batches 2-4 students of sitting in the same room, each attempting to complete the game individually.
Before they start the game they will be shown a presentation[2] explaining the purpose,goal and idea behind the game and then given an short demonstration where the instructor will show how to navigate and perform the main tasks of the game.
The game will be made available online before the testing, so the students can attempt the game on either their own laptops or on the university work

stations. The environment of the testing will vary between conference and group rooms to the university's computer labs.

To be able to test the effect of the online score board it is important that atleast two student attempt the game at the same time. Students are neither encourage or discourage to talk or cooperate during playing the game, but are encouraged to ask the instructor. The role of the instructor is during the experiment is described more in detail under section 2.6.2.

2.8 Analyse

The data gathered from the questionnaire, the observations and the subsequent discussion will be categorized separately under Results and then be reviewed, connected and analysed in light of the information provided by the prestudies. The end result will be summarized under section 8: 'Conclusion' where the information revealed during the analysis will be used to answer the research questions presented in section 2.1

Chapter 3

Prestudies

3.1 Introduction

My thesis is based on my findings during a project undertaken the fall of 2012[1] where I did a complete literature study on different directions within the field of educational games. In the chapter 'Own Contribution' I outlined the most important strategies contributing to immersion and learning and designed a game prototype where it would be possible for me to test the effect and utility of the these strategies.

In order to follow the discussion and analysis based on the result later in this report it is important that the reader familiarize themselves with the most important findings in my prestudies.
While only short introductions to the different strategies related to learning and immersion, the different technologies considered and state of the art are made available in this paper, more in-depth descriptions are available in my specialisation project which are made available at www.sondrebakken.no/project.pdf

3.2 Psychosocial moratorium principle

The Psychosocial moratorium principle means that 'Learners can take risks in a space where real-world consequences are lowered'. Video games allow players to try-and-fail with impunity and no consequences. Having this freedom encourages more active experimentation and the possibility to repeatedly try out different strategies and trials.

3.3 Repitition, memory and understanding

There is two ways of remembering things. One is learning through understanding which among others can be obtained in video-games through the 'Psychosocial moratorium principle' (See section 3.2: 'Psychosocial moratorium principle') and the other is through rote learning.

3.3.1 Learning through understanding

Learning through understanding is closely connected to the 'Psychosocial moratorium principle' where the player is allowed to experiment and learn by watching the effects of different actions on a complex system.

Another type of learning through understanding is to present the player with a task which requires certain knowledge. This information is not made directly available, but through pieces of related information the player can derive the correct information. This will require the player to understandi and use logic inference to make the connections that are needed to solve the task given.

Learning through understanding is often rewarding solely through the cognitive challenge it presents and the process of solving a task through understanding can often be immersive on its own as opposed to rote learning.

3.3.2 Learning through repetition

Rote learning is learning through repetition, which is mechanical and requires little understanding.

Rote-learning or learning through repetition is often associated with boredom, but games can be a good tool to make rote-learning more engaging. One of the key factors to making repetitive game play rewarding is by introducing a good scoring and reward system.

3.4 Monitoring

Using games as a learning tools introduces the possibility of monitoring the students progress continuously. In a normal classroom the students are often only tested by the end of the semester, and the results were only used to

grade the student which means that all students received the same homework, and lecturing through the semester despite their varying level of skills.

Through continuously monitoring students, one can:

- Having the difficulty adjusted to their level of expertise. This also creates better flow.
- Recieve help, information and hints based on their performance within different subjects.
- The instructor could monitor the students progress and evaluate different learning techniques.

3.5 Flow

Flow is a philosophical concept. The idea of flow is that the experience of enjoyment comes from when one balances the experience perfectly between frustration and boredom.

Through games the student can adjust the level of diffculty, or better yet, the game can adjust the difficulty according to the students progress and increasing skill level, both with the purpose of having the student learn at his own pace and keeping the student in a state of flow.

This can be achieved through letting the game monitoring the student and provide help where the players performance is low and increase difficulty where the players level of skill exceeds the level of difficulty provided by the game.

3.6 Feedback

Feedback can be given through gameplay, through notifcations, through character progression or through the award system. Feedback in games covers anything that gives the player information about consequences or outcomes due to actions performed by the player and feedback triggered by events in order to inform and guide the player.

3.6.1 Unobtrusive feedback

Through a intelligently designed feedback system, it can both improve immersion and add pedagogical support when playing. These goals should be achieved without cluttering the gameplay with too much out of place or unrelevant information. The feedback system should be designed as to convey information in a non-invasive way that maintaines a consistent game world.

3.6.2 Skill activation interventions

Skill activation interventions may be applied if a learner gets "stuck" in some area of the problem space and some skills are not used although the user model assumes that the user masters these skills.

3.6.3 Skills acquisition interventions

Skills acquisition interventions may be applied in a similar situation, however, the user model assumes that the user does not master the unused skill.

3.6.4 Motivational interventions

Motivational interventions may be applied, for example, if the player does not act for a certain unexpected long time or if the player does not make use of certain possibilities.

3.7 Immersion

Immersion or more correctly 'spatial presence' is the most common word when summing up the feeling one gets when playing a good video game. Spatial presence can be de
ned as existing when 'media contents are perceived as real'.

Two characteristics of video games creating the spatial experience are:

- those that helps create a rich mental model of the game environment.
- those that create consistency between the things in that environment.

3.8 Immersion through perception

Immersion through perception is most common in fast paced action games FPS and arcade racing games, but are also present in strategy games.

Presenting data through graphical means like graphs, progress bars and piecharts instead of numbers or presenting scores through visually gratifying awards and badges both exploit the concept of 'immersion through perception'.

3.8.1 Completeness of sensory information

Completeness of sensory information means that the game world is consistent. Abstractions, events, happenings, environments and contrivances that does not fit with the players mental model of the world will spoil the players game experience in such a way that he will be constantly reminded that the game world is only fictional

3.9 Immersion through reasoning

When immersion through perceiving is most common in FPS and arcade style racing games, immersion through reasoning is as relevant to both FPS games and strategic games. Immersion through reasoning is based on keeping the player entertained by giving him challenging and rewarding problems to solve throughout the game.

Problem solving in games can take on a wide range of challenges, everything from riddles to strategic decisions when it comes to economy or military campaigns. One of the most important aspects when creating a game that tries to achieve immersion through reasoning is as earlier mentioned to keep the game world internally consistent (See section 3.8.1): 'Completeness of sensory information'. It should be possible for the player to solve game world problems with logic derived from earlier experiences and observations within the game.

It is not important that a game stays realistic as long as the player quickly grasps the logic framework of the alternative reality represented in the game.

Two utilities used in creating a immersive game world is a cognitively demanding environment and motivation, often based on profits and awards

obtainable through problem solving.

3.9.1 Cognitively demanding environments

Cognitively demanding environments means that the game world requires the players attention. It requires constant attention because it is subject to change, changes that affects the player avatar or the game state and the player need to adapt, make choices, think and do problem solving to get by in the game world. This is a very important element in game immersion because it ties up mental resources and allocates brain power to navigate and understand the world rather than notice it's shortcomings.

3.9.2 Narrative, plot and story

A story can create immersion on its own. Nothing has proven to have a bigger effect on immersion than skill-full story telling. If you take look at all the elements that make up immersive gameplay the one that can create immersion solely on its own is good storytelling. A movie differs from a game because it lacks interactivity, and a book can have nothing left than the storytelling, no pictures, no sound, no visual elements at all, but we all know how immersive a good book can be.

A game can tell a story, and unlike a book or a movie, it can let you join in, direct the story, and contribute to the ending. That leads to involvement and immersion. The narrative in a game can also help creating a good environment for learning by making the game universe seem more consistent by explaining unusual traits, player-skills, NPC behaviour or unusual rules being applied. To make an alternative realism seem logical and not only consistent, the game should provide plausible explanations for everything unusual going on. Story telling can make events, happenings or options that does not make sense, make sense within the game worlds logic framework. It should be possible for the player to solve game world problems with logic derived from both earlier experiences and observations within the game. This encourages problemsolving and expands the learning area from not only being focused around the tasks to solve, but also around information derived from the game story and observations made in the game world.

3.9.3 Incongruous visual cues

Friend notifications when playing your game from Steam, tutorial messages, achievement notifications and damage numbers over enemies heads can all disturb the feeling of spatial presence, but this might be a two-edged sword seeing that visual elements like this, might convey information that requires reasoning, or information that motivates by showing progress or earned awards.

Visual cues can be a possible pitfall and to much incongruous visual cues will disturb the gameplay, but in some game worlds a lot of information has to be transformed and re-represented through the aid of a visual elements and some incongruous visual cues are inevitable.

3.9.4 consistent game world and behaviour

Consistent behaviour means that all objects in the game behaves in accordance with with the rules and logic framework that exists in the game. Consistent behaviour address the same issues as 'Completeness of sensory information' (See section 3.8.1) in that it works to achieve a consistent game world.

Familiarity also play an issue in maintaining consistent behaviour. Many games attempt at depicting the real world. It is important that objects that are familiar to the player outside the game conforms to the experiences the player already have with these objects. If not, why and how they differ from the real world should be made clear in the game, in order to not confuse the player and degrade his mental model of the game world.

3.9.5 Randomness

By adding randomness the game designer adds a level of uncertainty that can trigger the players curiosity and add replay value to repetitive tasks. Making the outcome of a game or just a part of the game uncertain adds excitement as seen in gambling. Some games seem to succeed almost entirely on the basis of this principle.

3.10 Reward systems

Awards in form of trophies, points, leaderboards and badges are one of the most important layers in a game when it comes to create motivation.

A well designed award system can:

- make a repetitive task rewarding through the possibility to collect awards or points.
- add randomness to a repetitive task by varying the rewards and loot.
- add replay value by making players want to repeat a task in order
  - to beat high scores.
  - collect different rewards by completing a it differently.
- modify the players behaviour so the game will be played the way the game designers intended.

3.10.1 Pitfalls

To work, reward structures must be carefully planned. Nothing can change or modify behaviour more than the reward system and just adding points and leaderboards to task might actually distract or divert the player from the games intended purpose. This is a even more delicate problem in educational games where completing a task differently than the game designer intended might result in a lower or no learning outcome.

3.10.2 Points

Points can be used to track the players progress, measure the players level of success and to track behaviour. It can be visible to the user, or used behind the scenes to generate feedback and rewards. Most games operate with several point systems, where the different points are earned through different actions and follow different rules.

Points alone can be ambiguous and give the player no or little satisfaction through perceived value. To avoid this points can be renamed or presented in a form that is connected to the progress they present, or actions that affects them. This technique often plays on familiarity as it also often is presented as a entity most players would know from real life and hence can derive its meaning, value and connection to certain in-game actions or objects.

Some common types are:

- Skill points - presents the proficiency of a skill held by the player or the level of proficiency displayed by the player when playing
- Virtual cash - often given value through virtual items that can be bought
- Experience points - Show character progress
- Progress points - Shows an objects progress, or the progress on a task
- Influence points - keep track of your reputation or influence in a game where you character has to engage in situation that yields a social outcome.

3.10.3 Levels and progression

Levels and progression in a game usually consist of game progression and/or player progression.

1. Character progression is often a summarization of points where the principle of 'almost there' is put to use. Levels acts as intermediate goals in the development of the character and a form of reward is usually given when a new level is reached. (New skill, trait or item unlocked)
2. Game progression works in much the same way as character progression and utilizes the same principles. Game progression occurs when completing all necessary challenges to advance to a new level where the reward comes in the form unlocking new areas, new challenges and items.

3.10.4 Badges and trophies

Badges and trophies motivates the player to progress through the game, put in extra effort to complete side missions or to complete a mission in different ways. This creates replay value because the player wants to complete tasks in different ways to obtain different badges and trophies. By introducing badges and trophies that can be obtained by completing a task a certain way, the game designer can modify the players behaviour.

Through thoughtful graphical design or naming these badges or trophies can be categorised and serve as intermediate goals towards a bigger award where completing a collection of a certain type of badges would earn you a bigger reward.

3.10.5 Social media

Social media adds a new aspect to reward systems. By create rankings and leaderboards the game designer can add the feature of competing with friends' into a game consisting solely of single player gameplay. Leaderboards, highscores and badges can be shared and posted in order for both playing friends, and non-playing friends to see your achievements. This gives rewards a higher status, because the rewards will both be visible for the player's friends and give him a advantage when trying to bypass his friends on the leaderboards.

3.11 Technology

This section will look through the different web technologies that were considered when developing the game prototype.

The technologies considered were:

1. Unity
2. Adobe Flash
3. Java
4. Microsoft Silverlight
5. HTML5, JS and CSS3

The choice of technology is based on distribution, health, resources, experience and available SDKs and features relevant to my game idea:

- All technologies except HTML5 requires a plugin and the market penetration varies from 1 % (Unity) to 96 % (Flash). This would require end-users to trust, download and install software which complicates the process of playing the game, and might considerably affect the viral outreach of the game prototype. This mostly rules out Java, Unity, and Silverlight.

  Another consideration to be aware of is that market penetration does not take into considertion whether the plugin is up to date. Relying on plugins does also mean that you expect them to update it frequently.

- The web experience is rapidly moving onto different platforms like tablets and smart phones. Some of the major stakeholders in this area has decided not to allow RIAs on their devices. This lowers the expected lifespan of RIAs like Adobe Flash, Shockwave and Silverlight.

  Several sources also imply that RIAs are being made redundant with the release of HTML5.

- Through some research it seems safe to assume that all mentioned technologies has a huge community and a vast amount of resouces available for developers. HTML5 and Java2 does have an advantage in being more open than Adobe Flash, Unity and Silverlight being owned by commercial companies. The best SDKs for Flash, Silverlight and Unity does cost money, where HTML5 and Java does not depend to the same extent on SDKs.

- My past experiences are limited to Unity, Java and HTML, JS and CSS.

Adobe Flash and Silverlight are not potential choices due their distribution possibilities, and because of my evaluation of their lifespan after the release of HTML5.

I have developed in Unity before and my experience tells be that I will not benefit much from Unitys game engine, considering my game idea will have a complex user interface complex in a 2D environment.

The decision lands on HTML5, JS and CSS3 due to the ease of deployment both for the user and developer, the high availability of developer tools and frameworks, and the high maturity of the technology and the community.

3.12 State of the art

This section briefly summarizes some other educational games currently available. The full descriptions and discussions of these games are available in my specialisation project at www.sondrebakken.no/project.pdf

The literature study looked at three games that all have made an impact on educational games. These three games were chosen as they all excel in different areas of educational games. Each of these games differs significantly

in their targeted audience, educational level, target age and in content. They also use very different teaching and immersion techniques.

- DragonBox targets young children and attempts at gamify algebraic math. It does this by camouflaging variables and operators under colorful animations and pictures.
- Americas Army educates the player about different aspects and roles in the army while it lets the player engage in fire fights against other humans through online play.
- SimSe is a game that lets the player take on the role as a manager in a computer software company. Different variations of the game exists, where the player can attempt at completing projects using different software development processes.

Chapter 4

Game design and implementation

This chapter contains information related to the development and the design of the game. This includes a description of technology choices, design choices and the development process. The first section describes the different stages in developing the game, which decisions where made concerning technology and the development process chosen. The latter three subsections gives the reader a brief introduction to the game model, what content was used during the experiment performed during this thesis and the purpose the game.

The game description has been split into two parts: 'Game model' (See section 4.2) which explaines the underlying generic model of the game, and 'Game content' (See section 4.3.1) which explains the in which context the game was set to when used for testing in this thesis. The reason this is done is because it helps the writer see how the game model is applicable in many different contexts and can be used as an educational game in different fields of study.

The game is available online for testing at www.spill.sondrebakken.no. Note that the game does only work in the newest browsers, and not in internet explorer.

4.1 Prototype development

The game prototype was first presented for my supervisor the fall of 2012 as a part my own contribution to the specialization project. The game was presented in the form of multiple screenshots, a feature set and gameplay de-

scription with emphasis on how the different parts of the game was derived from my recently conducted literature study. The goal of my prototype was to present an idea on how my findings could be put to use. No development plan or technical description existed at the time.

As a result of this, it was later decided that I would implement my idea and test how well my approach would do concerning learning and immersion. It was decided that the game should be available online, and therefor technologies which would make it playable through a internet browser were assessed.

HTML5, CSS3 and JS on top of a JSP servlet was eventually decided upon mostly based on the authors own personal motivation of diving into multiplatform web development. During the development four frameworks: JQuery-UI, JQuery, KnockoutJS, and Zurb Foundation were also used. To see a more in-depth description of the technologies considered, see section 3.11: 'Technology'.

Because of the complexity and the minimal development experience by the author, the game development was divided into three stages where the first stage included the most basic gameplay elements and each subsequent layer would add to the gameplay in form of features that would introduce more of the elements identified in the literature study. The reason behind doing this was to ensure that if the development time would exceed the planned time limit, and the whole game could not be completed, one would still have a playable game that would be worth testing. The features that was finished will be presented in the next section 4.2: 'Game model' and the features that were omitted will be presented and briefly discussed in terms of what could be interesting to implement and test in 'Future work' (See section 9.1.1).

4.2 Game model

This section will describe the underlying model of the game in a generic fashion.

In the game prototype the player is given the role as a manager. The player is presented with a project, consisting of a number of subtasks. A subtask has two values mapped to it, progress and quality, that are both initially 0 and can reach a maximum of 100. When progress reaches a value of 100 it indicates that the task is done and no more changes can be done to it. The

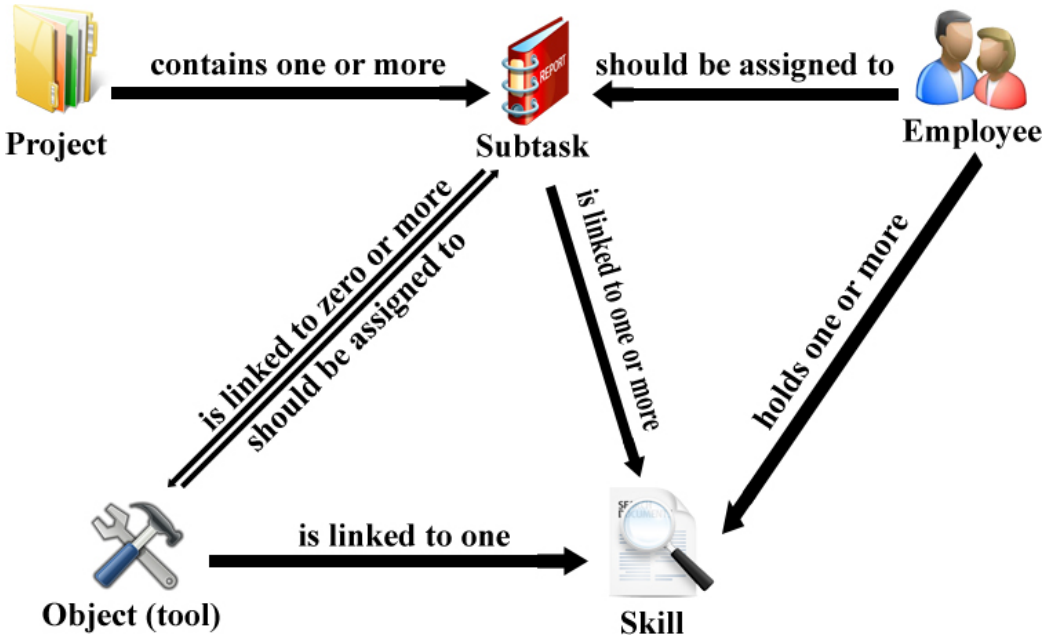
higher the quality value is when the subtask is finished, the better score the player will be awarded. When all the subtasks are done, the project owning the subtasks will be completed and the project quality will be the average quality of the all the subtasks. Depending on the content of the game the player would either have completed the game at this point or be given a new project

To make progress on the subtasks the player has to assign employees to them. Employees can be hired from a pool of available people. For some tasks it can also be necessary to assign certain objects to them. These can be objects that would aid the employees in their work or that are necessary to complete the task like tools. These objects can be bought in the game and then assigned to a task in the same way as employees are assigned to a task.

Each subtask is mapped to a set of skills and zero or more objects. Each employee in the game has a set of skills.
There are two kind of skills:

- Skills that are only mapped to a subtask
- Skills that are mapped to an object and a subtask.

In order to achieve progress and good quality on a subtask the player has to assign employees with skills that matches the skills required by the subtask to that subtask. If the skill is also mapped to an object, the object has to be bought and assigned to the same subtask in order for the employee with that skill to contribute to progress and quality.



The game model

When the player are done assigning employees and objects he can start the timer. For each unit of time that passes the change in progress and quality for each subtask is calculated. The more skills that are assigned to a subtash through employees that matches the skills required by the subtask, the more progress and higher quality is generated per time unit. The player can pause game at any time in order to assign, reassign or release objects or employees.

For the player to be able to make the right combinations between subtasks, objects, skills and employees, the games provides subtask descriptions, object descriptions and skill descriptions. These descriptions will contain indications and clues as to which skills and objects are required by which subtasks. The knowledge contained in these descriptions constitutes the material that is supposed to be learned through playing this game. These textual descriptions will from here on out be refered to as **'the educational material'** and skills and objects will be refered to as **'educational objects'**.
The game also consist of other elements that are not directly related to the underlying model of the game, but which relates to other properties of the game:

4.2.1 Staff training

The player could pay money to train employees in different skills. The employee would then be unavailable for some days and when returning holding the new skill that was chosen for training.

4.2.2 Quizing

During the game, quizes related to the *educational material* will appear. Answering them correctly would increase the player score and give a bonus on the project progress. Answering incorrectly would affect the score and project progress negatively. These quizes introduce rote-learning by encouraging the player to look through the *educational material* for answers repeatedly. See section 3.3.2

The quizes are portrayed as questions from hired employees in the game. This makes the quizes appear related to the situation depicted in the game, which ensures a consistent game world.

A quiz displayed as a question from a hired employee

The quizes contribute in creating cognitively demanding world because (together with events. See 9.1.1) they generate an environments that constantly requires the players cognitive input in order to progress. See section 3.9.1

A more complex reward system associated with the quizes are explained under section 9.1.2: 'Skill endorsements'.

4.2.3 Employee condition

The employees have a stress rating and a happiness rating that changes over time.

- Being assigned to a subtask where the employee has no matching skills would affect happiness negatively, while being assigned to a task with one or more matching skill would affect happiness positively.
- Being assigned to a subtask that would not finish within its deadline (needs more employees assigned to it) would affect stress negatively, while being assigned on a task with enough employees assigned would affect stress positively
- Happiness and stress is also affected by wage, the persons personality (some are easily stressed/depressed) and bonuses, training and time off between assignments.

Stress and happiness of employees would work as a correctional feedback that could be used by the player to decide if he made the correct assignments. If stress were to high or happiness to low over a certain amount of time, that employee would become sick and unavailable for a undetermined number of days.

Together with events explained in section 9.1.1: 'Stage 2', these employee conditions help creating a cognitively demanding environment (See section 3.9.1) that requires the player to monitor the continuously changing state of his staff, investigate reasons behind changes and adapt to accomodate the staffs wishes and needs.

4.2.4 Notifications

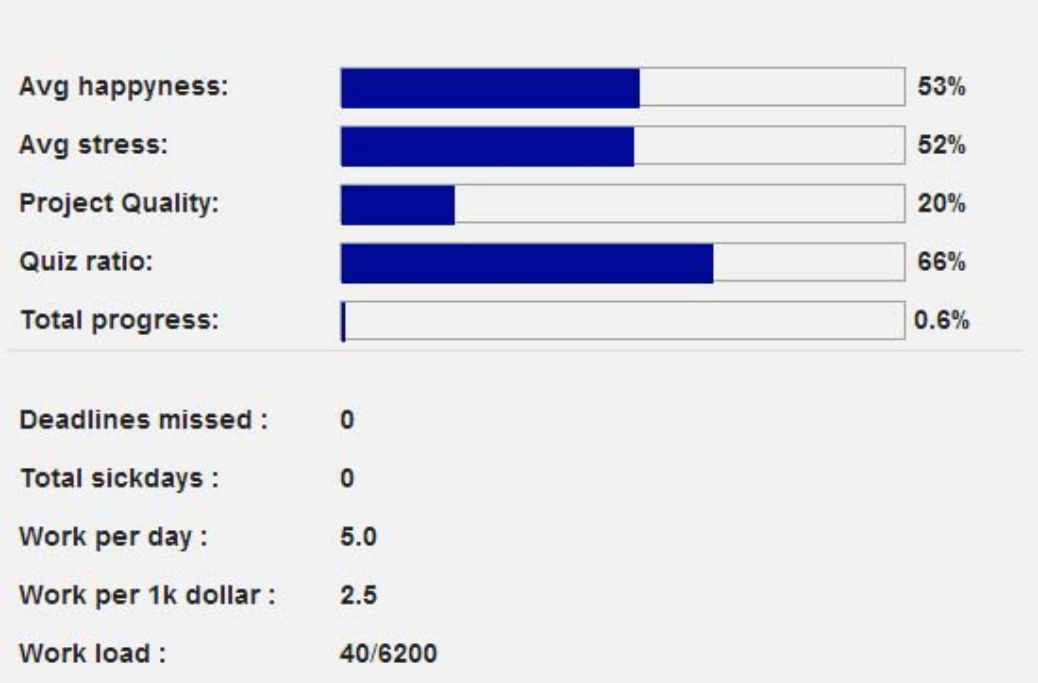
In the current version of the game notifications only informed the player on events during the game. Notifications should be developed further to give feedback and inform about continuously performed errors. (See section 9.1.2)

4.2.5 Progress indicators/bars

To show progress and quality of project the player was presented with an overall progress bar and overall quality bar aswell as a quality and progress

bar for each subtask. A 'project summary page' were also available containing:

- Overall stress
- Overall happiness
- Quiz correct/incorrect answers ratio
- Project progress / money spent ratio
- Daily progress
- Number of sick days



The project summary page

This data will partly be presented through visual means, in order to achieve immersion through perception. See section 3.8

A project consists of subtasks which are not only more relateable to real projects, but the principle of 'almost there' is put to use. Subtasks acts as

intermediate goals in the completion of the game where advancing to a new subtask requires the player to consider new objects and new skills. See item 2 under 3.10.3

4.2.6 Online highscore and player screen

The player could see a list of scores in the avatar page. The different scores are presented with familiar labels that indicates what they represent.

The scores listed under familiar labels

A player score summary consisting of:

- Wage - calculated from 'Project progress / money spent ratio'.
- Fortune - calculated from average wage over time.
- Title - Presented as levels where each level had a familiar career title. The title was calculated based on overall score. See item 1 under 3.10.3.
- Connections - calculated from average happiness of employees. See influence points under 3.10.2.

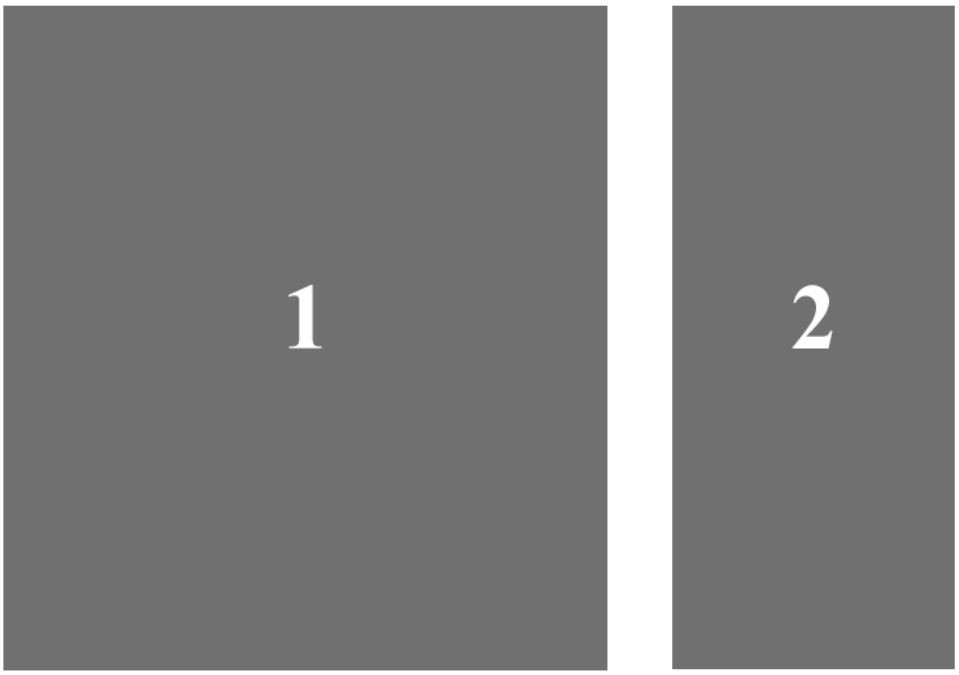
These scores are visible in the player page, which were not fully implemented. (See section 9.1.2) The scores were also visible at the bottom where the of the game screen, where the player could see high score in a list consisting of all players in a ranked highscore board. See section 3.10.5.

Highscore of player currently ranked as 16. The whole list becomes visible when clicked.

4.2.7 Softwarepedia

The *educational material* about *educational objects* in the game are made available in the game through a wikipedia (Known as 'Softwarepedia' due to the game content introduced in section 4.3.1: 'Game content'). The softwarepedia is organized as a collection of articles with the same name as the *educational object* it presents in the game.

The softwarepedia is visible next to the game area, so that it can be visible and navigated separately during any part of the game. This is to motivate the players to use the wikipedia actively during the game and in parallell when performing operations that require them to know the game content.



1. The game area: Where the game is played.
2. The softwarepedia: This area is reserved for the softwarepedia only

4.3 Purpose of game

The purpose of the game is to make the player read, remember and reason around the *educational material* put into the softwarepedia (explained in section 4.2.7). This is achieved through letting the player attempt at completing the subtasks within their deadlines with the highest quality possible, at the lowest cost possible. As explained in section 4.2 this is achieved through assigning the right objects and workers possessing the correct skills to the correct subtasks.

To figure out which object and which workers should be assigned where the

player would have to read the articles in the softwarepedia related to them. The articles and the project/subtask descriptions is written so that there is no clear link between the subtasks and the skills and objects that should be assigned to them. To understand which goes where, the player has to analyse the subtask descriptions along with articles explaining the objects and skills available in the game. By analysing the subtask description up against the skill and/or object description the player should be able to form an opinion on which worker and/or object should be assigned to which task, hence learn and remember the content of the game. This encourages 'learning through understanding' (See section 3.3.1) and creates 'immersion through reasoning' (See section 3.9).

4.3.1 Game content

In this thesis the game puts the player in the role of a software project manager. The project is a software development project where the player is given given a project developing a web delivery system for a 'pizza bakery' and the subtasks are presented as deliverables that represent the most common stages in a software development process. The objects mentioned in section 4.2 are development tools.

Because of testing purposes and because most of my testing participants will be students enrolled in engineering courses all tools and skills are imaginary however they are based on real life tools and skills.

The reason behind this decision is:

- A player could make assumptions about objects in the game based on correct real life knowledge obtained prior to playing the game, that are not considered in the game because of scope limitations, causing frustration and confusion and making the player perceive the game as inconsistent. See section 3.9.4-
- A player could have knowledge about objects in the game prior to have played the game which would not require him to investigate the material included in the game. Which would make playing the game pointless.

Importance of game content

The game focuses around the tools and the employee skills, which are all connected to their individual textual description. These in combination with the project description make out the *educational material* of the game, which carries a similar role in this game as the story or the plot would in any mainstream role playing game. See section 3.9.2 All of these are text are closely connected and the single biggest factor to how successful a player is in the game is based on how well the player manages to derive useful information through inference between these text. Therefor it is very important that the game content is very well written and thoughtfully designed seeing how the strategy 'immersion through reasoning' (See section 3.9) is dependent on a well designed *educational material*.

Chapter 5

Experiment description

This chapter will describe how the experiment was performed.

5.1 Methods of testing

The experiment consisted of three phases:

1. **Participants plays the game**

   Participant will have an attempt at the game under an instructors supervision.

2. **Participants will complete a questionnaire**

   When the player had made a fair attempt at beating the game and familiarized themselves with the concepts of the game they went on to answer the questionnaire.

   The last page of the questionnaire were blank. The participants was encouraged to write down their own thoughts, questions and experiences after completing the questionnaire.

3. **The participants participate in a short discussion**

   The participants took part in a short informal discussion after completing the questionnaire. This discussion allowed the participants to elaborate on the intructors observations, aswell as freely discuss and elaborate on their experiences and impressions after playing the game.

5.1.1 Testing of game

The testing consisted of students attempting to complete the game after a short presentation which explains the purpose of the game, the context of the game and how to play the game. (available at [2, Game introduction]) Followed by the presentation the instructor will give a quick demonstration. A full 'how to play' description was available, but due to its in-depth and detailed description it was perceived as to much to read, and a demonstration on how to perform the most essential tasks were preferred as the majority seemed to prefer to discover features through exploration above reading about them.

Participants were picked among available students and a number of 15 students tested the game in batches of 2-4 at the time. The number of participants in each batch were kept low in order to gain the most from instructor observation and through discussion. In order to test the social aspects of the game it was important to have at least two students played the game simultaneously.

The information gathered from the participants were field of study, gender and earlier gaming experience.

- The group consisted of 10 males, and 5 females.
- The group consisted entirely of engineering students.

The testing was done in 5 separate sessions:

1. A group of 3rd grade computer science students consisting of 3 males.
2. A group of 4th grade mathematical students consisting of 2 females.
3. A group of 5th grade informatics students consisting of 1 male and 2 females.
4. A group of 1st grade energy and environmental engineering consisting of 1 female and 3 males.
5. A group of 5th grade computer Science students consisting of 3 males.

The participants were first asked to create an avatar and then to play the game. The player was given as much time as needed to play the game in

order to fully understand the concept and having achieved some progress based on actual reasoning rather than 'try n' fail'.

The players was encourage to ask questions during playing, both regarding gameplay challenges or difficulties related to the interface.
The duration on play varied and was ended normally after the participant felt that he had mastered the different elements of the game. 15 minutes were originally dedicated to playing, although the average player used closer to 40 minutes If the participant had not grasped the key elements of the game at the time he was about to stop playing, he would be encourage to continue playing and while given some extra guidance. This was to ensure that all players had touched upon the most important aspects of the game before going on to the questionnaire and discussion.

5.1.2 Questionnaire

After the participant felt he/she had mastered the game he/she was given a 3 page questionnaire with one additional blank page where they were encourage to put down thoughs, opinions, experiences related to the game.

The questionnaire consisted of 57 statements which they were asked to rate on a scale 1 (strongly disagrees) to 5 (strongly agrees). The questionaire is available in Appendix A,the raw results are added as an attachment while the results are presented in section 6.1: 'Questionnaire'.

5.1.3 Observations and discussion

The instructor takes on the role as a moderator and secretary both taking notes and supplementing the discussion with his observations and the notes provided by the participants on the blank page of the questionnaire. The participants were able to share their views, discuss them, and build on each others observations and form new ideas and opinions around the game. The results of the observations and results are presented under section 6.2: 'Observation and participant discussion'.

Chapter 6

Results

This chapter will present the reader with the results gathered from the testing. The first section will contain the results from the questionnaire where the statements have been categorized based on what issues they addressed. The second section list different topics that were brough up during the discussion with the participants after the testing. The observation and discussions were merged together since the observations themselves often provided little or no meaning, but when brought up and elaborated on in cooperation with the participants often provided valuable insight.

6.1 Questionnaire

This section presentes the results from the questionnaire. The first subsection presents some vital data about the participants that are considered relevant to the discussion and analysis provided in Part 2.

The statements presented in the questionnaire are grouped logically in terms of what issues they addressed and a short explanation of the purpose behind each group of statements are provided.

In the following tables the scale of 1 to 5 has been divided up into 'Disagrees','Neither', and 'Agrees' with 1,2 summarized under 'Disagrees', 3 under 'Neither', and 4 and 5 under 'Agrees'.

6.1.1 Game experience

The participants were asked to rate the correctness of the statement: "I am an experience gamer." 8 out of 10 males rated the statement 4 or 5, while all females rated the statement in the area of 1 and 2.

Nr.	Statement	Disagrees	Neither	Agrees
1	I am an experience gamer	46,7%	0,0%	53,3%

6.1.2 Usability

The questionnaire included 9 standard usability questions taken from SUS. In order for the other game mechanics to be properly tested and understood by the participants a requirement was that the game prototype would perform over average in a usability test. These results are not highly relevant for the subsequent analysis or for the purpose of this thesis, but could help to explain unexpected or poor results or difficulties encountered by participants. If sections of the game failed at providing the participants with logical choices this would have a negativ impact on the participants rating of that feature, but the result might not be applicable in order to determine the actual utility of the strategy behind it.

Nr.	Statement	Disagrees	Neither	Agrees
2	I found the system unnecessarily complex.	66,7%	13,3%	20.0%
3	I thought the system was easy to use.	20,0%	13,3%	66,7%
4	I think that I would need the support of a instructor person to be able to use this system	60,0%	33,3%	6,7%
5	I found the various functions in this system were well integrated.	0,0%	13,3%	86,7%

6	I thought there was too much inconsistency in this system	80,0%	13,3%	6,7%
7	I would imagine that most people would learn to use this system very quickly.	20,0%	20,0%	60,0%
8	I found the system very cumbersome to use.	66,7%	20,0%	13,3%
9	I felt very confident using the system.	26,7%	40,0%	33,3%
10	I needed to learn a lot of things before I could get going with this system.	33,3%	20,0%	46,7%

6.1.3 Game interface, navigation and information retrieval

This game centers around the players ability to find the correct information and complete certain tasks. The interface or the navigation required to find the information and use it in collaboration with solving task should not put any restrictions or hinder the player in anyway since this would move the focus away from the learning and problem solving. The controls should be intuitive and mapped in a natural way, interfaces should be consistent in control, color, typography, and dialog design, and icons and symbols should speak to its function

Nr.	Statement	Disagrees	Neither	Agrees
11	The interface was easy to understand.	6,7%	6,7%	86,7%
12	The buttons was grouped naturally in order for you to complete tasks.	13,3%	13,3%	73,3%
13	The icons was easy to understand and consistent throughout the game.	13,3%	6,7%	80,0%
14	It was easy to navigate in order to find information.	0,0%	26,7%	73,3%

15	Tasks were being complex to perform due to a lot of navigation.	20,0%	46,7%	33,3%
16	There was a lot of navigation in order to look up needed information	40,0%	6,7%	53,3%

6.1.4 Knowledge improvement

The game's main purpose is to promote learning, and encourage the player to understand and study the *educational material* in the game in order to solve the related tasks. These questions investigate how the player learns through repetition, how the player learn through 'cognitivly demaning environment' and reasoning, and whether the player feels that he would remember the information afterwards.

The results from the statements in the following table shows how well the participants were motivated to learn, reason and use the information in the game to solve the challenges given to them during the game.

Nr.	Statement	Disagrees	Neither	Agrees
17	I try to apply the knowledge in the game.	6,7%	20,0%	73,3%
18	The game motivates the player to integrate the knowledge taught.	0,0%	26,7%	73,3%
19	I learned some of the content I did not already know, from the quizing.	20,0%	6,7%	73,3%
20	The mapping of developers to deliverables required me to understand the content in the game.	0,0%	26,7%	66,7%
21	The game motivated me to research before taking actions as opposed to trying/failing.	6,7%	26,7%	66,7%

22	The information presented in the game were overwhelming.	26,7%	20,0%	53,3%
23	The quizes in the game made me study the content more.	40,0%	6,7%	53,3%
24	My skill gradually improves through the course of overcoming challenges.	6,7%	0,0%	93,3%
25	I am encouraged by the improvement of my skills.	6,7%	13,3%	80,0%

Learning is also achieved through repetition or 'rote learning'. The game attempts at achieving replayability through a complex gameplay that encourages different approaches and strategies.

Nr.	Statement	Disagrees	Neither	Agrees
26	You find it interesting to try the game again in order try to achieve a higher score	13,3%	20,0%	66,7%
27	You considered different ways of completing the game.	20,0%	26,7%	53,3%
28	You can think of other strategies that might give a higher score.	0,0%	46,7%	53,3%
29	I feel that I can use different strategies freely.	13,3%	40,0%	46,7%

Designing an experiment where it is possible to measure learning outcome is listed as a suggestion under section 9.2: 'Test learning outcome'. The following table shows the participants perceived learning outcome.

Nr.	Statement	Disagrees	Neither	Agrees

30	The game increases my knowledge.	20,0%	26,7%	53,3%
31	I remember the content from the game afterwards.	0,0%	53,3%	46,7%
32	I think this is a good way to learn new content.	0,0%	6,7%	93,3%

6.1.5 Rewards and scoring

Player scores were presented in the game with the purpose of motivating the player towards raising his performance

Nr.	Statement	Disagrees	Neither	Agrees
33	I checked my score regulary.	73,3%	13,3%	13,3%
34	It was easy to check your own score.	6,7%	6,7%	86,7%

The score were also presented on a continuously updated highscore board were the player could compare his achievements towards other players. This was implemented in an attempt to raise motivation through appealing to the competitive nature of players.

Nr.	Statement	Disagrees	Neither	Agrees
35	I feel competitive toward other classmates.	6,7%	13,3%	80,0%
36	I compare my scores towards other continuously while playing.	53,3%	20,0%	26,7%

6.1.6 Immersion

The game implements several strategies which purpose is to create immersion. The following statements summarises the success of these strategies by measuring the players feeling of immersiveness when playing the game.

Nr.	Statement	Disagrees	Neither	Agrees
37	I can become involved in the game.	0,0%	13,3%	86,7%
38	I enjoy the game without feeling bored or anxious.	6,7%	20,0%	73,3%
39	The game provides content that stimulates my attention.	6,7%	26,7%	66,7%

6.1.7 Feedback

Feedback in a game serves many purposes. Amongst them are raising motivation in form of presenting progress, guiding the player through hints and informative responses, and give the player a feeling of control through informing them about the impact of their actions. These statements measure how well the feedback functions performed throughout the game.

Nr.	Statement	Disagrees	Neither	Agrees
40	The game helped you performing the correct actions when playing.	33,3%	26,7%	40,0%
41	I receive feedback on my progress in the game.	6,7%	13,3%	80,0%
42	Your actions induced a logical response from the game.	6,7%	20,0%	73,3%

43	Your actions greatly affected the outcome of the game.	0,0%	20,0%	80,0%
44	You received sufficient feedback on the impact of your actions.	26,7%	20,0%	53,3%
45	It was easy to keep track of progress.	6,7%	26,7%	66,7%
46	It was easy to look up different and understand different data/statistics during play.	0,0%	53,3%	46,7%
47	The stats and progressbars in the game help guide you to perform better at the game.	6,7%	20,0%	73,3%
48	The progressbars and stats were motivating to observe.	0,0%	13,3%	86,7%

6.1.8 Introduction and game goals

In the beginning of the experiment, the participants were given a short introduction[2] to the game aswell as a small demonstration performed by the instructor where he showed the participants how to do the most important tasks. These statements measure whether the participants felt that the goals were presented clearly and if the introduction were helpful.

Nr.	Statement	Disagrees	Neither	Agrees
49	Overall goals were presented in the beginning of the game.	0,0%	0,0%	100%
50	Overall game goals were presented clearly.	6,7%	6,7%	86,7%
51	The intro given by the instructor were helpful.	0,0%	0,0%	100%
52	The intro contained the most important aspects of the game.	0,0%	6,7%	93,3%

6.1.9 Flow

Flow is a state where the challenges matches the players skill level, so the game does not become frustratingly difficult, but enjoyable challenging. These statements measure the players feeling of flow in the context of some common strategies for achieving this.

Nr.	Statement	Disagrees	Neither	Agrees
53	The game does not allow players to make errors to a degree that they cannot progress in the game.	26,7%	40,0%	33,3%
54	The game provided new challenges with an appropriate pacing.	13,3%	40,0%	46,7%
55	The game provides hints that help me overcome the challenges.	46,7%	20,0%	33,3%
56	I am not burdened with tasks that seem unrelated.	20,0%	33,3%	46,7%

6.2 Observation and participant discussion

This section briefly presents some of more important observations aswell as some cases that were brought up during the group discussions held with the players after the testing.

6.2.1 Different learning styles

During the testing of the game two very different playing styles were identified. These two styles were different in how the player would approach challenges. The two styles are explained as follows:

Type 1

The player belonging to the first group would approach the game by:

1. Carefully going through the *educational material*, examine which possibilities were available, and how the different functions in the game worked. Work out as much of the game as possible before starting to play.

2. Once they felt confident about what they should do, they would make their first move in the game, carefully examine its effect in light of their expectations.

3. If the effect corresponded with their expectation, they would proceed in the game. If not, go back to the *educational material* in order to investigate and make sense of the unexpected effect.

This group would naturally do actions that they expected to give positive effects, but whether the effect were positive or negative did not determine whether they would proceed in the game, or go back to the *educational material* and study it again. If the effect where positive, but not as expected, and the player could not make an reasonable assumption on why what happened happened, the player would go back to investigating the *educational material* again.

Type 2

The players belonging to the second group would:

1. Examine what features and operations were available to the player.

2. Do a move, examine its feedback and categorise it as positive or negative.

3. If negative, they would try something different, remembering what move generated the negative effect and avoid similar moves in the future. If positive they would proceed in the game, remembering the move and try to apply it to similar scenarios in the future.

6.2.2 Usability

Usability is a fundamental property for any computer software. For the game to function as an educational game, and for the participants to be able to play the game and then give the game a fair evaluation at the end, the usability has to be satisfactory. This were tested through 9 statements taken from SUS, but were also a subject during observation and discussion.

- Participants were encourage to ask any question, but few questions regarding difficulties related to usability were asked.
- No observations of participants getting stuck and not being able to make progress in the game due to difficulties related to the user interface.
- Participants complained about the lack of a 'back' button.
- The demonstration were mentioned as very helpful.

6.2.3 Navigation and information retrieval

Some players were observed using pen and paper to keep notes when playing the game. When this was brought up during the discussion it was revealed that this was due to tasks often requiring the player to remember information visible at a earlier stage in the task. Information presented in the game area opposed to in the wiki, would often not be visible when performing other tasks, and the player would often have to cancel the task in order to look up the information again.

6.2.4 Information organization

Employees, skills, tools, and articles in the softwarepedia were all presented to the player in list forms.

The players missed normal list functions to make the finding of information easier:

- To filter or sort the lists.
- View a summary, or quick view of an item in a list. The current implementation usually required the player to view the item page for more information. Something that made browsing lists, when missing a back function, cumbersome.

Another problem reported mostly by Type 1 players was the amount of information presented. Finding the relevant information in order to complete the first few tasks of the game required them to browse through every text in the Softwarepedia. Some players described it as "looking for the needle in a haystack". They requested some way of either limiting the information, outline information relevant to the tasks performed at the moment or giving indications as to where to look.

6.2.5 Quiz feedback

After answering a quiz question the dialog box would inform the player whether he was correct or not. The player was only shown a generic text telling them if they had answered the question correctly or not. The player requested more informative feedback containing:

- Information about the penalty/bonus.
- The correct answer, or hints about where to find the correct answer.

Example of generic text showing after answering a quiz.

The players also requested some sort of event if continuously answering the questions wrong as they saw it as unatural that no actions were taken by superiors or employees if they proved themselves to be completely incompetent as a manager.

6.2.6 Intrusive quizes and automatic pausing

During gameplay quiz/event boxes containing question or information related to the project would pop up.

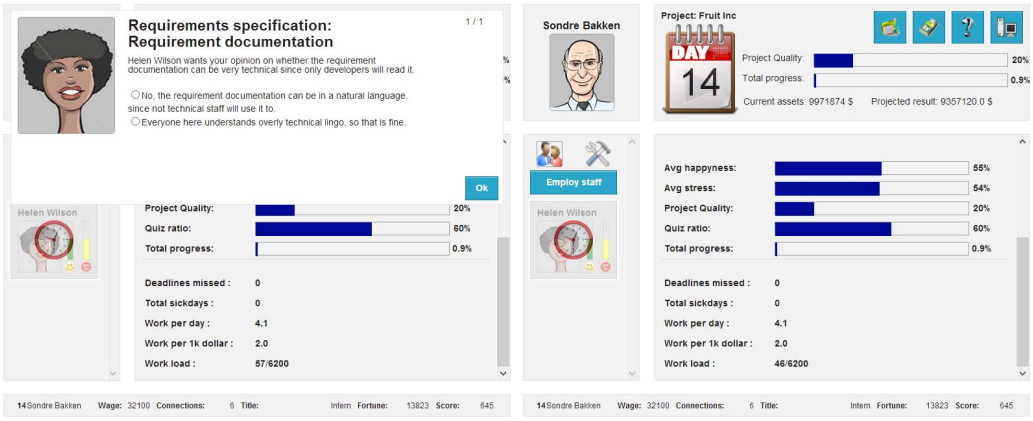


Image showing what were covered by a dialog box

Some of the participants found the presentation of events and quizes to be intrusive. The quiz/event box covered a big part of the game area, and it covered certain buttons and areas containing information that the player might find important at the time. See section 3.9.3.

Example:

The dialogboxes would cover the pause/play button and cover the calendar showing the day count. Even though the game clock were automatically paused when these boxes occured, the participants were not informed about it. This led some of the participants to think that time was still running, and that time was of the essence when responding to these questions/events. Because of this some of the players perceived the quizes as test, and tried to answer the questions without looking at the game material.

6.2.7 Highscore

Most players said they did not check the scores frequently even though they were visible at the bottom of the game area through the whole game. When asked why the players replied: Because they did not know what they meant.

At later testing the players were briefly informed about the meaning of the different scores list in section 4.2.6: 'Online highscore and player screen'. After the score had been explained players were observed comparing the different scores towards another, discussing which score was more important.

6.2.8 Progress feedback

Despite the high visibility and unambiguity of the overall progressbar some players still found it lacking. The progressbar only represented the currently achieved progress, and did not tell the player anything about daily progress, needed progress to finish before deadline, or projected process, which were all very relevant for the players success. A half finished project with no daily progress would look similar to a half finished project that would finish in two days. The only way for a player to determine the daily progress produced by the assigned developers were to unpause the game and view the change of the progress bar, which was cumbersome and inaccurate due to the fact that the progressbars were influenced by several factors: number of assigned developers, their skills and the players answers to quiz questions.

6.2.9 Stress and happiness

The element identified by players as the best indicator on player action impact was the stress and happiness level of the employees. Type 2 players admitted baseing their try and fail approach solely on the stress and happiness level of their employees because:

- Happiness being a clear link to how well the employee would do on a subtask
- Stress level indicating whether the subtask would finish in time
- Stress and happiness level for each employee were visible at all time
- Stress and happiness levels being color coded from red (critical) to green (satisfactory)

The bars indicate the employees level of stress and happiness

It could be discussed whether this made it to easy, and that it encouraged a try and fail approach. What still made the investigative approach superior to the try and fail were the lack of immediate feedback. The happiness and stress level would adjust over time, which made a try and fail approach costly in missed work days and lost work progress.

Part II

Chapter 7

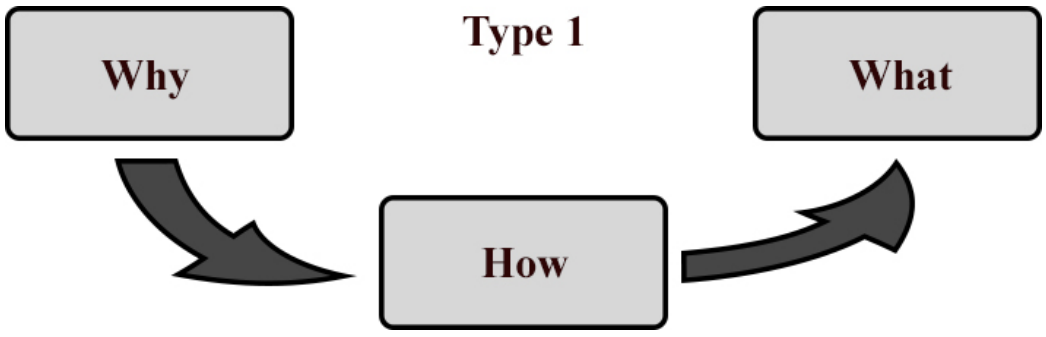
Discussion

This chapter discusses the different aspects of the game, using the results presented in the previous chapter

7.1 Different learning styles

As mentioned and described in section 6.2.1: 'Different learning styles' two different types of players were identified. **Type 1**'s approach summerized as:

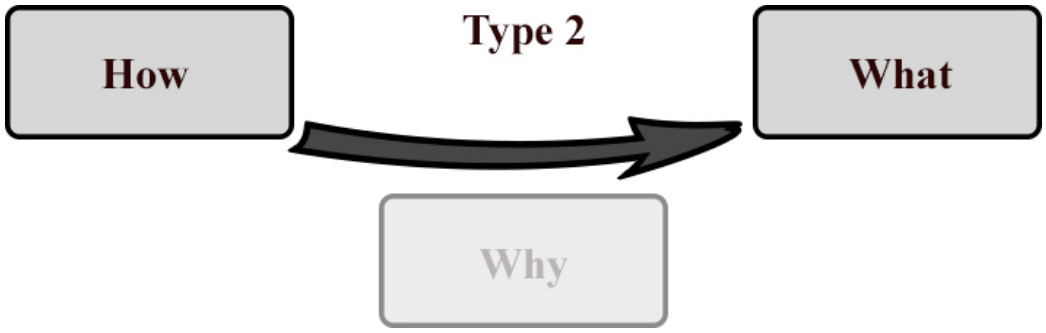
1. Why - Why would I do it
2. How - How do I do it
3. What - What happens when I do it



Type 1 players approach

and **Type 2**'s approach summerized as:

1. How - How do I do it
2. What - What happens when I do it



Type 2 players approach

These two types of players are interesting for several reasons. They will be refered through constantly through the rest of this thesis as they perceived the game differently .

Other interesting properties of these two players is that almost all female players belong under Type 1 players, while all Type 2 players were males.

Scores, rewards and progress presentation creates immersion, but a common pitfall is that they can also encourage undesirable behavior. As mentioned in section 6.2.1, the Type 2 players determined the success of their actions based on the scores, rewards and progress presentation during their try and fail approach. The purpose of the game was to teach the player the *educational material* through making the knowledge essential for making correct decisions in the game. This was achieved by the Type 1 players approach, but not by the Type 2 players try and fail approach. This is an example of how a reward/scoring system can undermine the purpose of the game. See section 3.10.1

7.2 Usability

The usability statements in the questionnaire does are not directly relevant to the goal of the game, but for the game to function as an educational tool it had to satisfy the most basic requirements concerning usability.

The overall rating of the 9 statements taken from SUS were 61,4 % positive and 17,8 % negative. Based on these rating combined with the observations listed in section 6.2.2: 'Usability' where there was few signs of players struggling with the game because of low usability it is assumed that the games usability did not have an impact on the players experience when using the game.
Statement 9 and statement 10 in table 6.2 had the highest negative rating and they are both related to the complexity of the game.

There was some high degree of variations in the usability related statements. This could be because of the somewhat unstructured demonstrations. It would be reasonable to think that the demonstrations varied a bit in quality and that not all participants gave the demonstration full attention. This would be improved upon by providing a in-game tutorial with steps to go through. See section 9.1.2.

I felt very confident using the system

The reason behind the negative ratings given for statement 9: 'I felt very confident using the system' in table 6.2. was subject for discussion after testing and the problem was identified as a lack of 'corrective and informative feedback'.

- Players were mostly given positive or negative feedback, but sometimes had difficulties understanding why they received the feedback they did: "What did I do wrong/correct?"
- Players in situations where they only received negative or positive feedback sometimes had problems understanding how strong the feedback was. Since all the players played the game for the first time, they had nothing to compare against. Example: Players had problems telling if their solution was very good, or if they should try to do better.

Strategies that could deal with these problems are discussed in section 7.7.4: "Informative feedback", and 7.7.3: "Corrective feedback".

I needed to learn a lot of things before I could get going with this system

The game is quite complex and there are several things that are not intuitive. This could be improved upon by introducing a tutorial, tool tips and pop-up

suggestion or help boxes.

This statement were also a subject when discussing the game with the participants, and most of them identified this as not being a problem due to the presentation and demonstration performed before playing. The rating of this statement combined with the facts revealed during the discussion points out the importance of a good introduction. This however could be done as mentioned with a good tutorial and in-game help functions.

Go back

During discussion the lack of a 'back button' were frequently mentioned. A lot of the operations that were performed in the game was laid out as going through multiple screen, which each or some of the screen presenting information that would be relevant at a later stage in the operation. The possibility to go back to investigate this information, or to simply back-track and change something was not implemented and the player would have to start the process over again.

Example: When clicking the project screen which would present the subtasks in the project and show developers assigned to it, it was often necessary to click the developers in order to navigate to their page to see happiness, stress and skills. When investigating several developers (which would often be a necessary task during the game) the player would have to reopen the project screen, scroll to the correct subtask and then scroll to the next developer to investigate, something that led to a lot of unessecary navigation and cancelling and restarting operations because the player had forgotten information presented earlier that became relevant at a later stage in the operation.

7.3 Game interface, navigation and information retrieval

Section 6.1.3'Game interface, navigation and information retrieval' is related to usability, but focuses more on the layout of the game, and navigation required when doing certain tasks.

Statement 11, 12, 13 and 14 in table 6.3 deals with whether it was easy to perform tasks and look up information in the game. These statements were

rated 78,3 % positive and 8,3 % negative.

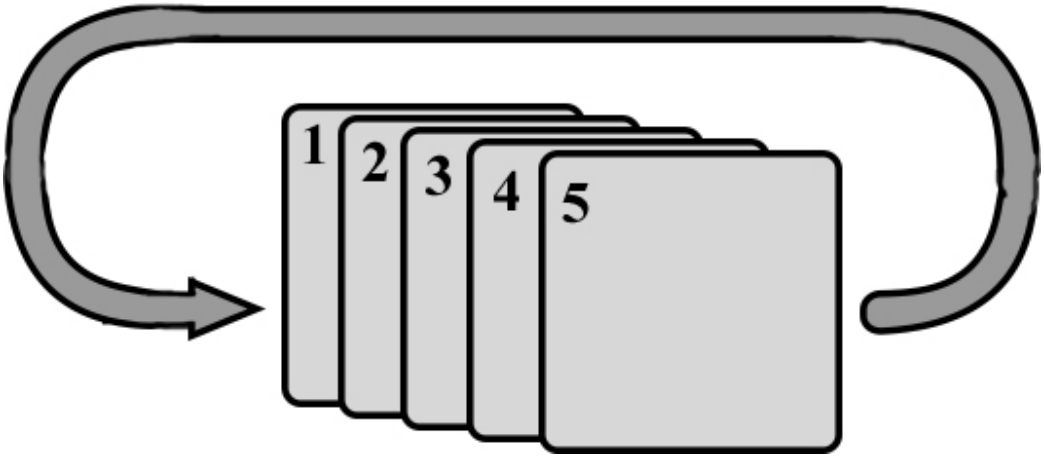
Statement 15: "Tasks were being complex to perform due to a lot of navigation" and statement 16: "There was a lot of navigation in order to look up needed information" in table 6.3 received a 43,3 % negative rating and just a 30 % positive rating. These two statements will be discussed more thorougly in the following two sub-sections.

7.3.1 Tasks were being complex to perform due to a lot of navigation

Several of the decisions made by the player during the game had to be based on their knowledge about the game content. This often required the player look up information several times during an operation consisting of multiple steps.

The learning material in the game were available through the softwarepedia (See section 4.2.7) which can be navigated separately, but some information were only available in the game area which as pointed out in section 6.2.3: 'Navigation and information retrieval' introduced problems:

- When performing tasks, information only available in the game area would become relevant and the player would have to abort his current task in order to look up the information.
- When performing a task, some information could be represented during the task, but not appear as relevant to the player. When this information would become important at a later stage in the task, due to the lack of a back function, the player would have to restart the task.



Shows a operation taking you through 5 screens: For the player to retrieve information from screen 4 when it required in screen 5, he would have to restart the operation to reach see screen 4 again.

7.3.2 There was a lot of navigation in order to look up needed information

As pointed out in section 6.2.4: Information organization' the players requested easier ways to browse information.

In a game like this, where the information is the focus of the game, and there presumably is more information than in an average computer game, functions aiding in information retrieval are crucial. The sole purpose of this game is to make the players study the *educational material*. Everything else in the game are just means towards this, and therefor the developers should put extra effort into making the retrieval of information as easy as possible.

Statement 16 were subject to some variation. A objects description could be displayed by clicking on it. This was not always made clear during the demonstration which would require the player to look up all information in the softwarepedia. This could explain the variation.

This statement closely relates to statement 22 in table 6.4 and approaches to deal with information management are examined closer in section 7.4.4: 'Game content and information presentation'.

7.4 Knowledge improvement

The purpose of an educational game is that its player learn something. This something in this context is the textual description of the objects in the game. The game attempts to do so by giving the player choices where knowledge about the objects will help them towards choosing the best option.

The game should:

- The game motivates the player to research and use the *educational material* provided in the game
- The game makes the player repeatedly go through the *educational material* either through making the game replayable or by introducing several challenges where the player can apply the same knowledge.
- The players remember the *educational material* from the game after playing.

7.4.1 Research and use of game material

Making the content in the game directly relevant to the tasks the player is asked to undertake is a key factor. It should give the player a feeling of being better equipped to make decisions in the game after reading the *educational material*. 73,3 % agreed on Statement 17 and 18: "I try to apply the knowledge in the game" and "The game motivates the player to integrate the knowledge taught" in table 6.4. This shows that the player found that the *educational material* in the game were applicable to the tasks and challenges in the game.

Two main tasks where the player could apply the information in the game were implemented:

The mapping of developers to subtask

Understanding what skills a developer should have to be successful at a task. Feedback in form of happier employees, higher progress per turn, better quality on the subtasks and a higher score (See section 7.5: 'Progress feedback, rewards and scoring') were forms of feedback that motivated the player to make an effort in picking out the best matches between subtasks and developers.

Statement 20 in table 6.4: 'The mapping of developers to deliverables required me to understand the content in the game' received a positive rating of 66,7 % and a negative rating of 0,0 %. It can be assumed that Type 1 players where among the overrepresented among the players rating this statement positively, while Type 2 players were mostly found in the 'Neither' category.

The purpose of the game would be faulted if it encourage a 'try and fail' approach and therefor is designed towards motivating the players do research before taking actions. As mentioned in section 6.2.1: 'Different learning styles' this game was developed with Type 1 players in mind, and due to very strong feedback, most Type 2 players adopted the playing style of Type 1 players after a while. 66,7 % of the players also agreed to Statement 21 in table 6.4: "The game motivated me to research before taking actions as opposed to trying/failing" while only 6,7 % disagreed. This can be seen as a success, but further development of this game should focus around both player styles and implement functionaly that accomodates both. See section 7.7.4: 'Informative feedback', 7.4.2: 'Informative quizes', and 9.1.2: 'Informative feedback and corrective feedback'.

Quizes questions

Quizes introduces a cognitively demanding environment where the players will have to apply their knowledge continuously. See section 3.9.1

The quizes intention was for the player to examine the *educational material* looking for the correct answer for the question. The mapping of developers and tools to subtasks only required the player to briefly skim the belonging text, while the quizes required the player to examine the texts more thoroughly looking for specific details. Statement 23 in table 6.4 shows that only 53 % said that the quizes made them study the content more. This negative result could stem from two identified reasons:

1. The feedback was not prominent enough:

   - The positive/negative impact answering the questions correctly/incorrectly had on progress and quality was not strong enough.
   - The quiz score were not presented clearly, and appeared to be just a mean to gain a small progress and quality bonus. This is subject to improvement as described in section 9.1.2: 'Skill Endorsement'.
   - The players requested more informative feedback when answering the

quizes correctly/incorrectly. See section 6.2.5: 'Quiz feedback'.

2. The quizes were perceived as test, instead of questions that allowed investigation. See section 6.2.6: 'Intrusive quizes and automatic pausing'.

   Because of the misconception around quizes working as tests, with no access to the softwarepedia, it could be assumed that the majority of the 40 % that did not agree about this statement 23 in table 6.4 were subject to this misconception. The ratings given to statement 23 also had a high variance which supports this assumption.

7.4.2 Informative quizes

The quizes also had an unexpected effect. When designed its sole purpose was to make the players go back to the *educational material* and study it more thoroughly, but some players pointed out that they would remember their quiz questions and their answers making it a source for learning. The quizes was identified as one of the main sources of learning by Type 2 players and when asked to rate statement 19 in table 6.4: "I learned some of the content I did not already know, from the quizing" 73,3 % rated it positively and only 20 % negatively.

The players rating on statement 19 and 23 were varying which could be caused by the misconception that quizes were subject to time as described in section 6.2.6.

One step towards making the game accomodate both Type 1 and Type 2 player styles is to make the quizes more informative (Another strategy is informative feedback: See Section 7.7.4: "Informative feedback"):

- Designing the question to contain information
- The feedback could contain an explanation to the answer
- The consequences could be less generic (bonus/penalty to progress and quality) and more specific to the question, showing the player the effect his choice would have.

Example of how a quiz question is currently structured:

Question: Is JSON structured the same way as XML?

Answer 1: Yes, it is structured the same way.
Answer 2: No, it is not structured the same way.

Feedback: (Wrong answer chosen) You answer is wrong. You gained a penalty to the progress and quality on the deliverable: Implementation.

How a quiz question could look like to take advantage of its role as a information source:

Question: JSON, or JavaScript Object Notation, is a text-based open standard designed for human-readable data interchange. Extensible Markup Language (XML) is a markup language that defines a set of rules for encoding documents in a format that human-readable. Are JSON structured the same way as XML?

Answer 1: JSON is not a document markup language, while XML is, so they do not have the same structure
Answer 2: JSON has the same interoperability potential as XML, which means they have the same structure.

Feedback: (Wrong answer chosen) JSON is much simpler than XML. JSON has a much smaller grammar and maps more directly onto the data structures used in modern programming languages, while XML is document-oriented. Because you answered wrong your developers software API for client-server communication has to be redone and you lose 10 % of your progress.

7.4.3 The players are motivated through learning

A computer game plays upon several elements to create immersion and engage the player, but an educational game should also create immersion through rewarding the player when his knowledge increases.

Much like a role playing game, players are motivated when their avatar skills are increased and he can perform new actions or accept more difficult quests. In a similar fashion should the educational game motivate players when their own skills are increased through feeling increasingly competent to undertake tasks and experience a higher degree of success proportional to the increase

of his knowledge of the *educational material*.

This is achieved through:

- Making *educational material* learned applicable throughout the rest of the game, not only relevant to one task.
- Not consistently introduce new, unrelated tasks, but rather introduce tasks that require a deeper understanding of the same material, or material that builds on already learned material.
- Let the player undertake the same or similar tasks later in the game in order for them to be able to mentally compare their (hopefully increased) success with earlier attempts.
- Introduce different levels of success rather than just win/lose and provide detailed feedback displaying increased success due to better solutions. This will motivate players to reattempt already completed task in order to increase their score which increases replayability. See section 3.3

93,3 % of the players reported that they their skills gradually improved through the course of overcoming challenges (See statement 24 in table 6.4) and 80 % reported that they were encouraged by the improvement of their skills (See statement 25 in table 6.4) which indicates that the game successfully managed to reward the players when performing better.

7.4.4 Quantity of information

As reported by players in section 6.2.4: 'Information organization' they had problems with the amount of information available at all times in the game. This claim is supported by the results of Statement 22 in table 6.4: "The information presented in the game were overwhelming" where 53,3 % agreed and only 26,7 % disagreed.

Especially Type 1 players found it hard to research the *educational material* in order to find information concerning the first tasks, since only a small portion of the information where relevant for those tasks, but the *educational material* for the whole game where available and the game made no effort in pointing the player in the right direction. This could also be the reason why someone attempted the Type 2 approach, simply because they were demotivated by the amount of text to read.

Steps that can be taken to avoid overwhelming the player with information, without removing or cutting down on the amount of information, are:

1. **Gradually introduce:** Different information becomes relevant at different stages of the game. Information that is not yet needed, needs not to be displayed. The game can introduce events where new information is made available for the player. Making small parts of the information available as the game progresses would make the player more likely to examine it, and it would also be easier to display it in alternative ways (opposed to as a full article in the Softwarepedia).

2. **Hints:** When tasks are started or completed events and dialog boxes can be used to give indications on what information should be examined for this part of the game.

3. **Informative feedback:** Feedback can be more than positive or negative, but can also serve the player information where needed. See section 7.7.4: 'Informative feedback'.

4. **Manual sort and filter:** Manual sort and filter of information and objects would increase the players confidence and feeling of control. It would also make browsing lists and collections easier.

5. **Automatic sort and filter:** Is in the same category as **Gradually introduce**. The game can automatically filter and sort information and objects based on the games state:"What would it be natural to assume that the player is looking for right now".

7.4.5 Replayability

Learning is often achieved through repetition and rote learning. Some games apply repetitive tasks, or similar tasks that requires the player to apply the same knowledge several times. Another way for a game to achieve repetition is through replayability. The time allocated for testing of the game did not allow for this to be tested, but the game had elements whos purpose were to motivate replayablitiy. See section 3.3

- Trade-offs: Through training the player could choose to use more money, but achieve higher quality on the project.

- Levels of correctness: Tasks are not just completed, but they are completed with varying level of success.

- Prioritizations: The game introduces several scores where the player has to choose what to emphasize: Spending money vs happy employees.
- Psychosocial moratorium principle (See section 3.2): There is no penalty for restarting the game and the player can make an unlimited number of attempts, which encourages the player to experiment and try different strategies opposed to in real life where failure would have negative consequences.

4 statements in the questionare (26,27,28,29 in table 6.5) relates to replayability investigating if the players would try again to get a higher score, if they saw different ways of playing the game, and if they think the game allowed different strategies. 55 % rated these statements positively which indicating that the game achieved some level of replayability, but he game could have scored somewhat higher if these elements were better described during the presentation and the demonstration.

7.4.6 Learning outcome

It is by measuring learning outcome we define the success of most learning techniques. This experiment does not test the learning outcome, but investigates the perceived learning outcome by the participants.

The questionnaire defined three statements in order to collect the perceived learning outcome of all the test participants. The rating given these statements should be interpreted as a indication on how well all the elements in this game worked together as an educational tool.

Statement 30 in table 6.6: 'Learning outcome' showed that only 53,3 % agreed on "the game increased my knowledge" versus 20 % that disagreed with this statement. This is a bit lower than expected seen how it should be close to impossible to have any progress in the game without examine some of the *educational material*. The average female rating of this statement leaned more towards 'agrees' than the male rating. This could be an indication on which player types reported what since most females were strong Type 1 players while a significant number of males where closer to Type 2. So it can be assumed that players with the Type 1 approach reported to have learned more than Type 2 players.

Statement 31 in table 6.6:'Learning outcome' stated that players would remember the *educational material* afterwards. 46 % agreed on this statement

while none disagreed. Remembering *educational material* rather than understanding it, is closely related to repetition and rote-learning, which requires time. The exposure to the *educational material* were limited due to the fact that players would only attempt the game once and play it for 10-40 minutes. It would be reasonable to assume that players would remember more of the *educational material* if they spent more time playing the game.

93 % of the players agreed on the statement 32: "I think this is a good way to learn new content" in table 6.6: 'Learning', which shows that this is a direction within educational methods that are worth exploring. Chapter 9: 'Future work' suggests, based on the findings in this thesis, what needs to be added to the game for it to better function as a learning tool. See section 9.1.1, aswell as to test the actual learning outcome by using it in an course. See section 9.2.

7.5 Rewards and scoring

The score system in the game were not properly implemented at the time of testing. The different scores in the game are listed in section 4.2.6: 'Online highscore and player screen'.

As mentioned in section 6.2.7: 'Highscore' the scoring system in the game did not gain much attention despite the fact that the scores were constantly visible at the bottom of the screen. 86,7 % agreed on Statement 34 in table 6.7: "It was easy to check your own score", but 73,3 % disagreed on Statement 33 in table 6.7: "I checked my score regulary".

The reason for why the scoring failed to gain the players attention was identified in the following discussion where players revealed that they had no idea what the different scores meant, how they differed and what they measured. Instead the players looked to the progressbars and data like quality, quiz ratio, average happyness, because these were more intuitive. The game presented the different scores under familiar labels, as explained in 4.2.6, in order to give them some imaginary value. See section 3.10.2 This strategy seems to have failed because they were not understood and therefor could not be appreciated by the player. In subsequent test sessions the player were now informed about what the scores meant, and there was observed a increased interest in the scores. The scores were also just presented in text, and gave no visual gratification.

7.5.1 Online score

A highscore list were implemented in the game and by one click the player could compare his own score towards other players in a ranked list. See section 3.10.5 Only 26,7 % agreed, while 53,3 % disagreed on statement 36 in table 6.8: "I compare my scores towards other continuously while playing", but 80 % agreed on statement 35 in table 6.8: "I feel competitive toward other classmates" which are two results that seems to contradict each other. The reason behind this was observed by the instructor during testing: The testing were done in sessions consisting of 2-4 players sitting in the same room, and the score and progress were compared verbally during playing. It would be expected that if these players were separated in some manner that ruled out any way of communicating, they would look to the highscore in order to compare themselves towards the other players.

Ratings given statement 36 also had a high degree of variance which will be discussed in section 7.11.1: 'Competitiveness'.

7.6 Immersion

Overall on statements related to immersion 75 % answered positively, that they did get immersed in the game. The game attempts at immersing the player by applying three strategies:

7.6.1 A complex reward/score system

A reward and scoring system containing:

- Different data and bars giving the player continuous feedback on deliverable progress, project progress, overall quiz score, staff happiness and stress levels.
- A live leaderboard, visible in-game, presenting the different personal scores for all players.

Due to the lack of explanation and hasty implementation around the personal scores listed in section 4.2.6: 'Online highscore and player screen' it seemed like the data concerning project progress, project quality, quiz score, staff stress and happiness levels was the main source of immersion. Assumably because it was more intuitive to understand and more easily relatable to perceived level of proficiency.

86,7 % players agreed on statement 37 in table 6.9: "I can become involved in the game" which concludes that the game were successful in applying strategies that would create an immersive game experience.

7.6.2 Creating a cognitively demanding world

The game attempts at creating a cognitively demanding world (See section 3.9.1) both for creating immersion and to motivate learning. A player would be better equipped managing the game world and the tasks given him when learning the *educational material*. Some of the strategies that are used to achieve a cognitively demanding world are:

- Members of the staff will ask the player questions related to the skill they hold and the deliverable they are assigned to. The player will be given a penalty or bonus depending on the answer.
- The player has to keep a constant look at the employees and take action if their stress is to high or happiness becomes to low.
- The player needs to keep an eye on the budget, weighting different options against their costs.
- In order to complete the project a player need to think ahead, not only assigning employees, but also train them for subtasks later in the game.

A cognitively demanding world should introduce tasks of suitable difficulty, and it should introduce these events in an appropriate pace. A game that provides no challenge, and/or to much time between each event can be perceived as boring, while a game at the other end of the spectrum could be perceived as stressful and leave the player feeling anxious.
A game need to find a balance between being demanding and stressful in order to make the player continue playing. See section 3.5: 'Flow'.

73,3 % players reported that they could enjoy the game without feeling bored or anxious (statement 38 in table 6.9) which indicates that the game is well balanced in terms of a 'cognitively demanding world'.
This could be due to the players option to pause the game at any time, and that the game automatically pauses during quiz questions leaving the player to spend as much time he wants on making a decision.

Another strategy to achieve a well balance game considering difficulty is to let the game track the players level of proficiency and ajdust the difficulty See section 3.4 .

7.6.3 Achieve immersion through reasoning

Two strategies where used to achieve immersion through reasoning See section 3.9:

- Members of the staff will have a bar representing happiness and stress levels. These will changed due to different factors in the game. In order to identify these the player would have to investigate the employee in question and read a set of statements indicating what the employee thinks about the current work situation.

- In order to assign the right employees and tools to the right subtask the player needs to analyse the project text and deliverable description and then read the in-game wiki articles of different skills and tools in order to figure out which skill/tool should be assigned to which subtask.

The *educational material* in the game is what the player would base his reasoning on. Therefor it is important to pay attention to the *educational material* and make it directly relatable to the tasks in the game. 66,7 % players agreed on statement 39 in table 6.9: "The game provides content that stimulates my attention" indicating that the material in the game was well structured in terms of encouraging reasoning.

7.7 Feedback

Feedback in educational-games takes on several responsibilites, amongst them are:

- Show the impact of actions performed by the player

- Motivate correct behaviour by presenting the impact as either some degree of positive or negative.

- Show the current state of the game, and the status of objects in the game.

- Provide corrective feedback: Track player behaviour and encourage change in player behaviour where appropriate.

- Provide informative feedback: Shed light on events or impacts by providing relevant information.

This section will take on two discussions. As stated in section 4.1: 'Prototype development' some of the planned feedback functionality were left out. Therefor this section will discuss both how well the feedback in the game worked, and how the planned but not implemented feedback strategies could improve the game.

The feedback in the game can be divided into two categories when looking at strategies for displaying feedback to the user:

1. **Category 1**: Feedback in the form of events brought to the players attention through dialog boxes (sometimes requiring a user action)
2. **Category 2**: Unobtrusive feedback as a part of the information displayed on the screen. Sometimes requiring a player action to be displayed, like navigating to a certain screen.

In the current implementation of the game the majority of feedback is of category 2 in form of numerical data and progressbars representing progress, quality, and staff stress and happiness. This data often requires the player to navigate to a certain screen in order to be displayed. Some common pitfalls are that this data representations can be hard to find or requires to much navigation to view. When asked to agree or disagree with statement 46: "It was easy to look up different and understand different data/statistics during play." in table 6.10 only 46,7 % agreed, and 53,3 % chose 'neither'.

The game attempted at making progress data easy to see by making summary data easily visible. In the game an overall progress and overall quality bar were always visible in the upper section of the game area. Other data were placed next to their related functions and objects. Subtask progress and quality bars were always visible when assigning developers, tools or reading the subtask description. In addition the game had own sections were more in-depth feedback and data could be viewed.

Despite the poor rating on Statement 46: "It was easy to look up different and understand different data/statistics during play." in table 6.10 other statements related to feedback gave an impression that the feedback in the game were adequate.

7.7.1 Progress feedback

The games progress is directly related to the project progress. In the game a 'overall progress' and 'overall quality' progressbar were always visible. The

progress bar presented the current progress, while the quality bar can be seen as skill points which presents with which level of proficiency the player has progressed. See section 3.10.2 Similar progressbars for subtasks were always visible when working with the subtasks. 80 % of the players agreed with statement 41: "I receive feedback on my progress in the game" in table 6.10 while only 66,7 % agreed on statement 45: "It was easy to keep track of progress." in table 6.10.

The reason why not everyone found it easy to keep track of their progress despite the high visibility of the progressbar was identified during discussion with participants after the testing. See Section 6.2.8. This problem can be countered by introducing a higher level of complexity to the progressbar with different colored bars showing projected progress and projected progress.

7.7.2 Player impact

A game should provide feedback on player actions, so that he can analyze the impact of his choices. This is especially important in educational games where it would be pointless not to aim at improving the players level of proficiency since this is usually directly linked to the players understanding of the *educational material*. On whether the players received sufficient feedback on the impact of their actions (Statement 44 in table 6.10 only 53 % agreed while 26,7 % disagreed, but 80 % agreed and 0 % disagreed on statement 43: "Your actions greatly affected the outcome of the game." in table 6.10. This suggests that player were under the impression that his actions had a big impact on the game world, but that the immediate feedback on his actions were lacking. This can partly be related to problems revealed during the discussion in section 6.2.8: "Progress feedback". The player had to unpause the game and view the changes over time. This raises the question if some immediate feedback should be available to all user actions even though part of the learning effect lies in analysing the consequences of an action over time.

Another important role of player impact feedback is to give the player a sense of control. The player gains motivation through the impression that he can manipulate the game through his actions. The two most important factors in order to give the player a feeling of control is to let the player actions induce a significant impact and a logical response. We determined that the players feel that their actions affected the outcome of the game and 73,3 % agreed on statement 42 in table 6.10: "Your actions induced a logical response from the game".

7.7.3 Corrective feedback

Feedback should give the players enough information so that they can review their actions in the game, and learn from them. This implementation lacks in 'corrective feedback' and this section will discuss the indirect corrective effect of the feedback that exists in the game aswell as some corrective feedback strategies that could improve the game.

Only 40,0 % agreed to Statement 40 in table 6.10: "The game helped you performing the correct actions when playing." while 33,3 % disagreed. This was expected, since as earlier mentioned, this implementation had no feedback which primary task were to correct player behaviour.

On statement 47 in table 6.10: "The stats and progressbars in the game help guide you to perform better at the game" 73,3 % of the players agreed which shows that although there exists no feedback with the sole purpose of correcting the player behaviour in the game, players were able to reason about the impact of his actions and consider better alternatives based on information derived from the feedback provided.

The element identified by the players during discussion as having the biggest corrective effect were the staff stress and happiness. See section 6.2.9: "Stress and happiness". The players felt it was hard to use the progressbar as a indicator on how well the assigned employees matched their assignments since the progressbar were affected by many factors as described in section 6.2.8: "Progress feedback". Stress and happiness (See section 4.2.3) on the other hand were a direct indication on how much progress each assigned employee produced and gave a clear indication on whether more workers needed to be assigned to a subtask.

A part of the game that did not make it into the implementation, were a feedback mechanism that monitors how long a player does a faulty action, or avoid correcting something that is negative for progress, also know as 'skill activation interventions'.See section 3.6.2 If the player shows persistent faulty behavior the game would inform the player through events that held a strong indication on what the player should correct. See section 3.4 and 9.1.2.

7.7.4 Informative feedback

In the game the *educational material* would only be available through the softwarepedia, and it required the player to navigate and search for the in-

formation needed. As explained in section 6.2.1: "Different learning styles" this best suited Type 1 players, and while the game successfully converted Type 2 players into Type 1 players (See section 7.4.1) it was also mentioned that future versions of the game should attempt at accomodate both learning styles. One strategy already discussed was making quizes more informative (See section 7.4.2), another strategy is to introduce informative feedback. See section 9.1.2.

The strategies for implementing informative feedback could take on the form of notifications or dialog boxes giving the player bits and pieces of information directly related to the current operation being performed or the current state of the game. This information could be proactive, contain information related to upcoming tasks and challenges ahead, but this would possibly decrease the players motivation to investigate on their own. Another strategy is reactive, where the the informative feedback could bring clarity to the type of impact of different player actions. Both these strategies would have also have a strong corrective effect.

7.7.5 Motivational feedback

As mentioned in section 7.5: "Scoring and rewards" it was observed that players shared their score verbally rather than checking the scoreboard. What were also noticed was that they did not compared their scores, but rather their different progress data. Due to the lack of understanding of the different highscore categories listed in section 4.2.6: 'Online highscore and player screen' it seems (See section 6.2.7: "Score and rewards") that the immersive effect normally generated by a scoring system were instead generated by the progressbars and numerical progress data. This is backed up by statement 48 in table 6.10: "The progressbars and stats were motivating to observe" where 86,7 % agreed. See section 3.8

Another reason why the players did not check their score page or online highscore board could be due to the fact that they did not know that these possibilities existed. If the game registers that some functionality is never used, it could use 'motivational interventions' in order to make the player use these. See section 3.6.4

7.8 Introduction and game goals

The game contained a 'how to play' section, but because it was quite comprehensive and would take some time to read, players were not encourage to use it. Instead all players were shown a presentation special made for the test session where the main goals of the game were outlined, and how the game would be played. The advantage of doing this rather than letting the players read through the manual was that every player started playing the game with the same prerequisite knowledge. As mentioned in section 4.3.1: 'Game content' this was a important precondition for getting unbiased results.

The players were asked to rate four statements (Statement 49, 50, 51, and 52 in table 6.11) on whether overall goals were presented, and if they were presented clearly, if the introduction given were helpful and if it contained the most important aspects of the game. 95 % of the answers were positive. The representation given are available at [2, Game introduction]

7.9 Flow

Flow is a term used to describe the players feeling of enjoyment and immersiveness when playing the game. Flow can be obtained by balancing challenges in the game towards the players level of skill. See section 3.5
Four strategies for achiving flow used in this game are:

1. The game introduces no absolute errors which would require the player to restart the game.
2. The game attempts at introducing new challenges with an appropriate pacing.
3. The game attempts at giving the player feedback in order to overcome challenges.
4. The player should not be burdened with tasks which seems unrelated.

7.9.1 Error recovery

On Statement 53 in table 6.12: "The game does not allow players to make erros to a degree that they cannot progress in the game." only 33,3 % agreed, while 26,7 % disagreed. A player can infact not do any errors that would

force him to either quit or restart the game. The two seemingly logical ways to lose the game would either be to a) spend all the money or b) not finish the subtasks in time, but these two possibilities were eliminated by giving the player an sum equivalent of unlimited money, and the possibility to continue the project if deadlines were missed.

An error in the game could be: giving a unecessary raise or bonus, buying a tool that is not required, and assigning a person to a task he is not qualified to do. Even though these decisions are not irreversable, they are correctable. The players can rectify the loss of money on unusable tools, or the wasted days where no work were performed by elevating their performance. The reason why such a high percentage, despite the actual fact, disagreed with statement 53 could be the inability to undo errors.

Despite the players feeling of poor posibilities regarding error correction no one chose to restart the game. The participants were informed that they could restart the game at any time by simply pressing F5 and they were encouraged to do so if they felt they were off to a bad start. This was so that a bad start would not discourage participants from doing their best.

7.9.2 Appropriate pacing

On Statement 54 in table 6.12: "The game provided new challenges with an appropriate pacing" 46,7 % agreed and 13,3 % disagreed. The player had the option to pause the game at any time, which would give the player unlimited time to make changes, decide between different options and study the *educational material*.

One incident that had an impact on the rating of this statement was the automatic pausing of the game clock during quizes described in section 6.2.6. This undermined the purpose of the quizes acting as a motivation to dwelve deeper into the game material and caused student to guess answers quickly, sometimes not even properly reading the question or the answers. Players informed that they found quizes to be stressful and instrusive, disrupting the gameplay. Participants that realized that the game clock automatically paused during these quizes and were able to investigate in order to answer the questions correctly did not share this opinion.

7.9.3 Providing help and hints

Help and hints as described under section 7.7.4: 'Informative feedback' and section 7.7.3: 'corrective feedback' were not implemented. The game left the player to reason by himself whenever he failed to have the progress he expected. The rating of statement 55: "The game provides hints that help me overcome the challenges" in table 6.12 supports this. 46,7 % disagreed with this statement, and only 33,3 % percent agreed. The reason some agreed with this statement were because the game gave the player plenty of feedback to investigate when not achieving the wanted impact of their actions. As mentioned in section 6.2.9 Stress and happoness' the stress and happiness level of employees gave clear indications to which degree the player actions were negative or positive.

7.9.4 Unrelated tasks

20,0 % disagreed on statement 56: "I am not burdened with tasks that seem unrelated" in table 6.12. When asked after playing which tasks seemed unrelated the amount of navigation required to do some tasks were singled out. This issue had earlier been identified in section 7.3.1. So there were no specific tasks that triggered some player to disagree with the statement, but rather the seemingly unessecary complexity of them.

7.10 Game experience

Whether a participant would define himselves as a experience gamer or a non-gamer were also of interest. A classroom in any educational institution are bound to have student of both categories and it would therefor be important to identify differences in order to be able to construct educational games that accomodate both gamers and non-gamers.

Of the 15 participants in this experiment 53,3 % of the participants defined themselves as experienced gamers, while 46,7 % had little or no earlier experience with computer games.

7.10.1 Complexity, navigation and ease of use

Three statements that concerns complexity, ease of use and information navigation (statement 2 and 3 from table 6.2 and statement 14 from table 6.3) all showed a significant difference between experienced gamers and non-gamers.

Despite what might be expected these three statements had a higher negative rating amongst experience gamers, than amongst participants that rated themselves as not having much game experience.

Two possible reasons why the results show that gamers rated the system to be more difficult to use than non-gamers are:

1. The experienced gamers are confident that they are able to understand complex games, and have experience when it comes to navigate complex interfaces and perform difficult tasks in a game environments.

   Because of this they were more confident when rating the system. They did not perceive this statement as questioning their own ability to use the system, but rather how well the system was constructed and structured around the tasks it asked them to do. Non-gamers on the other hand, might have rated this statement lower, as to increase their own perception of themselves and their skill level when it comes to being able to use a complex system.

2. Experienced gamers are used to games that have spent years in development and that are at the pinnacle when it comes to intuitive interfaces and information presentation. Gamers might have rated this statement more negatively, because they have high standards.

7.10.2 Icons

Despite gamers rating the system as more complex, more difficult to use, and harder to navigate and find information they also rated icons to be easier to understand and more consistent througout the game.

More gamers agreed to statement 13 “The icons was easy to understand and consistent throughout the game” than non-gamers.

The use of icons often does not depict the actual function of a button or the content of a section. An example is the comonly used icon for the save button. This icon depicts a floppy disc, which to many of todays young computer users bear no meaning in itself. They might never seen a floppy disc, but they still understand the icon because it is consistently used as an icon for the save function. This game might have used icons that are subject to the same effect and therefor might be harder to understand for

non-gamers than for gamers that connects these icons to specific tasks despite their arbitrary icons.

7.10.3 Participant performance

As mentioned in section 7.10 experienced gamers rated the system to be more complex, harder to use, and finding information more cumbersome. Despite this, the observations done indicated that gamers seemed to be able to overcome these challenges easier than non-gamers who used more time familiarizing themselves with the interface. This could explain more gamers agreed on statement 17: "I try to apply the knowledge in the game" in table 6.4. Gamers spending less time and resources on mastering the game, could focus more on applying the *educational material*. This shows the importance of making a intuitive interface in an educational game, so that players don't tie up mental resources in understanding how the game is played, but actually on learning the *educational material* of the game.

7.10.4 Creating immersion and involvement

Statements stating something about whether different elements managed to create motivation, immersion or involvement where consistently rated less positively by gamers. Statements 21, 48, 38, 25: "The progressbars and stats were motivating to observe", "I can become involved in the game", "I enjoy the game without feeling bored or anxious" and "You find it interesting to try the game again in order try to achieve a higher score" from table 6.5, 6.9 and 6.10 all received a less positive rating amongst the experienced gamers than amongst non-gamers.

This can presumably be related to what is mentioned under item 2 in section 7.10.1. Experienced gamers have higher standards as to what motivates them in games. These games, although they aim to serve a different purpose which is to educate and not only entertain, find themselves competing in the same category as commercial games with million dollar budgets and that spends years in development.

7.11 Gender differences

Differences between the two genders were also discovered, although these results could be somewhat misleading, due to the fact that 80 % of the males

rated themselves as experience gamers and none of the females did. Several of the statements discussed in section 7.10 showed the same differences between male and females than gamers and non-gamers. These will not be discussed here.

7.11.1 Competitiveness

Statement 36: "I compare my scores towards other continuously while playing" and statement 35: "I feel competitive toward other classmates" both showed a significant difference between females and males. Females agreed less to these statements that males did, which shows that competitiveness is a lesser factor when creating an immersive game for girls.

Chapter 8

Conclusion

This thesis looks into the world of educational games and investigates what research and studies currently exists in this field. Through a literature study we identified and outlined several prominent strategies concerning educational games. The next step were to look into how these strategies could be put to use, and to test how well they would perform when tested on students. Important elements that were identified during the literature study included: Immersion, reward systems, rote-learning/repetition, learning through reasoning and learning outcome.

The literature study were performed the fall of 2012 and concluded during November 2012. In December 2012 a complete design for a educational game accommodating approaches to the earlier identified strategies were put forward. After a discussion with my supervisor we decided to implement the game, in order to be able to test these strategies on students. in the beginning of 2013 the process of developing and implementing this game were started.

A set of research question were also drafted at the beginning of 2013, right before starting the development of the game. The research questions in their final form can be seen in table 2.1.

8.0.2 Motivation through complex reward systems

A good reward system acts as the backbone when making otherwise tedious tasks rewarding and immersive. Educational games have the advantage of being able to sprinkle otherwise mundane learning tasks with rewards and scores and make them significantly more interesting and enjoyable to undertake. Therefor, one of the elements that received a great amount of attention

when designing and testing the game where the reward system(RQ1).

Unfortunately the reward system was not completely implemented due to lack of time, and the effect of the reward system were somewhat poor. See section 7.5 It is important to also look at the progress feedback when discussing the effect of scoring and rewards. Both progress feedback and scores present the progress and the level of proficiency (deliverable quality) by the player. Often the scores are just re-representations of progress in more visually or textually gratifying forms. Hence the wording of RQ1.1: "Are participant motivated through the presentation of scores and progress data?". Overall, based on observations, discussion, the results from the questionaire, it is clear that much of the motivation when playing comes from obtaining a sense of achievement, which a reward system can help create. Players strongly stated that they were motivated by watching the progressbars which indicated that the game managed to motivate through scoring, rewards and progress presentation (RQ1.1).

A online leaderboard were also implemented in order to test whether introducing a element of competitiveness would further motivate players. The statement "I compare my scores towards other continuously while playing" in table 6.8 received somewhat poor ratings, but statement 49: "I feel competitive toward other classmates" in table 6.8 received very positive rating, which indicates that player were motivated to perform better due to competitive elements (RQ1.2). The reason for these contradiction statements are discussed in section 7.5.1: "Online scoring".

What suffered the most because of the lacking implementation of the reward system was the visual elements. The scores presented in the game when tested were only presented numerically. Therefor it would be hard to answer RQ1.3: "Are participants motivated through visually gratifying presentations of progress data and scores?", but one reason why progress data were perceived as more motivating than scores can be due to their graphical presentations in the form of progress bars rather than just numerical. See section 7.7.5

Although the testing focused around "Motivation through complex reward systems" suffered somewhat under the lack of implementation, the testing provides some evidence that a reward system can help provide a sense of achievement, motivation and immersion to an educational game (RQ1).

8.0.3 Cognitively demanding world promotes learning and immersion

Creating a cognitively demanding world (See section 3.9.1) can create both immersion and promote learning. The game attempts at wrapping a cognitively demanding environment around educational material, where the knowledge derived from this material in vital to the players success in the game. 73,3 % agreed on Statement 17 and 18: "I try to apply the knowledge in the game" and "The game motivates the player to integrate the knowledge taught" in table 6.4 which indicates that this strategy motivates the player to study the educational content in order raise their level of proficiency in the game (RQ2.1).
The educational content put into the game in constructed in a way where the answers are not just discovered by searching through the material, but the players need to analyse and reason around the information in order to make the correct connections necessary to complete tasks correctly. This strategy attempts at increasing the learning outcome by making the player understand and process the material(RQ2.2), and also increase immersion through making problem solving and information finding more interesting and cognitively challenging(RQ2.3). Statement 20 in table 6.4 which asks whether the game required players to understand the material in order to complete the tasks received a positive rating of 66,7 % (RQ2.2), and 66,7 % players agreed on statement 39 in table 6.9: "The game provides content that stimulates my attention."

The results indicate that creating a cognitively demanding world where challenges arising are based on the educational material in the game both motivates the player to research, understand and use the knowledge needed in the game (RQ2). Presenting the material in such a manner that the player needs to figure out the answer rather than being handed it directly, the problemsolving is perceived as more interesting and cognitively challenging which leads results in immersion.

8.0.4 Promoting rote learning through repetition

Another prominent learning technique is rote-learning. Rote-learning is often perceived as boring, but effective. Educational games can improve this learning technique through making it more enjoyable. In contrast to learning through understanding, rote-learning is based on repetition of often simple tasks that are not to mentally challenging. The game attempts at achieving this through quizes, which simply asks a question that can be answered

through the *educational material* provided in the game. The idea being that the players will read through the *educational material* repeatedly when answering quizes throughout the game.

The quiz element in the game were also subject to some misunderstandings that might have affected the results. See section 6.2.6 and 6.2.5 Statement 23 in table 6.4 shows that only 53 % said that the quizes made them study the content more. It is believed that this would have a far better rating if the misunderstanding described in section 6.2.6 were prevented. Observation of the players that were no subject to this misunderstanding showed that the quizes had their desired effect: Players looked up and studied information in the game repeatedly which is reflected in the result from statement 19 in table 6.4: "I learned some of the content I did not already know, from the quizing" where 73,3 % rated agreed (RQ3.2).
Correctly answering the quizes gives the player a progress bonus, which should be viewed as a reward. In addition a more complex reward were designed, but not implemented. See section 9.1.2. Based on my results and observations from the testing of my game I find it hard to conclude that "reward systems making repetition enjoyable" (RQ3.1), although based on my literature studies and own experience I find it very likely. See section 3.3.2

Chapter 9

Future work

This chapter discusses how:

- the results can be used to improve the design of the game by suggestiong how some of the strategies for immersion and learning can be further developed.
- this game can be applied to another experiment which includes testing of actual learning outcome and applying it to different fields of study.

9.1 Improve game design

In this thesis a prototype of an educational game has been tested. Several elements that were planned were not implemented, and through the results obtained from the testing one can reason around which strategies worked, how they worked and how they might be improved. This could be viewed as the first iteration of a developing cycle, where the next natural step would be to improve the game based on the results from the testing aswell as adding the leftout elements that were not included in the implementation due to time restrictions.

9.1.1 Finish Implementation

Stage 1 in the development process included the game model described in section 4.2: 'Game model', while stage 2 covered random events and stage 3 covered the possibility of different work process.[1]

[1]The current implementation only allow a waterfall model to be executed. Future releases might allow iterative and cyclical approaches

Stage 2

Stage 2 covered the implementation of random events. A part of this has already been implemented. The quizes described under section 4.2.2: 'Quizing'.

Other random events that were proposed included: Staff incident (Arguements, conflicts, sickness etc), hardware incidents (physical damage to servers, lost data, theft), company incidents (change of management, budget cuts) and client incidents (change of requirements) which required the player to make choices, or changes in their playing style to accomodate these incidents. These events would add to the diversity of a cognitively demanding world, hopefully increase immersion and also give the player a deeper insight into the work and challenges of being a project manager. See 3.9.1

Adding random events to the game will increase replayability and excitement due to uncertainty. See section 3.9.5

Stage 3

Stage three covered allowing the player to choose between different work processes when completing the subtasks. This would give the player an arena to experiment with different software development models. This would give the player the possibility to experience their pitfalls, disadvantages, and advantages by trying and failing. This takes advantage of the Psychosocial moratorium principle (See section 3.2) where the player can experiment freely without being exposed to any of the negative consequences associated with choosing a unfit software development model for a project in real life.

This would be implemented by having a timeline with events that would either be triggered by the time processed, the process on a subtask, or the overall process on a project. These events would often introduce some changes to the process. The idea would be that the project text and/or subtask description would indicate what events and where these events would occur so that the player could plan his staff assignments and planned on the different task to best accomodate the changes introduced by these events. This is best described with an example:

A task describing the process of creating documentation strongly indicates

that based on the subsequent task, which is creating a prototype that will be the subject of frequent tests, it would have to accomodate these test.
In practice this could mean that for every 20 % of process that is completed on the prototype a test is performed and the result is brought to the player through a dialog box. This dialog box informs the player that because of the results from the test and the changes that will be done to the prototype, any process over 20,40,60 and in the end 80 % on the documentation will be lost.

The player could accomodate this by working on the prototype and documentation in parallell, choosing an alternative to the waterfall based process, which would be inneffective in this case. This way the player not only had to reason around which tools and skills that would be needed to complete each task, but which work process which would work best in order to finish the project.

9.1.2 New elements

During the experiment some potential new elements and improvements where identified. These should be included in future versions of the game.

In-game tutorial

Before the participants attempted the game they sat through a presentation explaining the elements, functions and purpose of the game. See section 7.8. In future versions of the game, there should be a in-game tutorial in form of tool tips, dialog boxes and helpeful tips explaning new functionality, the purpose of different sections and other important elements in the game. This is also know as 'skills acquisition interventions'. Through monitoring the player the game knows if the player has done a certain operation before, if not, it is reasonable to believe that the player does not know how to perform the operation, and the game can introduce some sort of guidance or help. See section 3.6.3 This could improve the game experience as the player would have the possibility to go back and reference the tutorial whenever in doubt.

Informative feedback and corrective feedback

Informative and corrective feedback as discussed in section 7.7.3 and 7.7.4 is believed to improve the game in several ways.

Informative and corrective feedback was planned as a part of the game prototype but were cut from the implementation due to time limitations. A set

of company executives were created with the purpose to appear in dialog boxes where they, based on player behaviour, would give feedback, suggestions, point out common errors and provide relevant hints. The feedback would mostly be based on behaviour tracking, were the game would monitor the player progress and be able to customize the feedback so it would appear highly relevant to the player.

Through making the feedback appear as being given by the players executives in the game, the feedback is perceived as less intrusive and conserves a consistent game world. See section 3.6.1 and 3.8.1

Score and visual gratification

As listed in section 4.2.6: 'Online highscore and player screen' the player is introduced to several different values that aims to present the players success. These are nothing but re-representations of data concerning the players progress in the game, and serve no other purpose than to increase immersiveness and movitave the player.

As discussed in section 7.5 the player scores failed to interest the player due to the fact that they were poorly introduced, and the player did not understand them, and they lacked in visual presentation. In addition to the scores being presented as numerical values in a highscore board, the player also had a player page, where the scores were presented in a way that resembled a LinkedIn profile page. Future versions of this game should use this page to create a visually gratifying and understandable presentation of the player scores.

Skill Endorsement

Learning through repetition is introduced through a quiz system that will repeatedly quiz the player on content in the game (See section 3.3.2). To make answering these questions more rewarding a reward system that accommodates visual gratification and plays upon familiarization were a part of the design.

The quizes are formed as questions coming from the employees and are related to a specific skill in the game. If answering these correctly, the player will, in addition to a progress bonus, recieve skill recommandations on his linkedIn page on that particular skill from the employee that asked the question.

Skill endorsement on the player score page

These avatar thumbnails is expected to create immersion through visual gratification and as badges. See section 3.10.4.

9.2 Test learning outcome

The ultimate goal of any educational game is to teach the player some material. The experiment performed and described in this thesis investigates several strategies that promotes learning and which motivates and creates an involving game. These are all means to an goal, which is to make the player learn the material embedded in the game, preferably better and more effective than traditional study methods. The actual learning outcome after playing the game is discussed in section See section 7.4 and the participants are asked to which degree they felt that they learned the material. This only measures perceived learning outcome, and is no definit way of determining how well the game works in terms of making players learn and understand

its content.

To measure the learning outcome one could design an experiment with the basis in an actual exercise in a university course. The purpose of the exercise would be to learn the students a certain part of the course syllabus.

The experiment could be designed as follows:

- The class would be divided into two groups, where one group would learn study the content over a given time in whatever way it would traditionally be done. Assumably by reading, taking notes, or similar.
- The other group should play through the game.
- The course lecturer would have the responsibility of fitting the syllabus into the game. How well the syllabus is transformed into educational game content would greatly affect the results.
- It would also be of interest to set some requirements to how the students would complete the game in order to avoid try and fail approaches. Some datas in the game are good measurements on how well the student knew the content, one of these are 'quality' and 'quiz ratio'. The exercise text could read: Complete the game with an overall project quality of 60 %.
- The syllabus learned should be testable, and after the experiment the participants should be tested in order to see how well the game teaches the syllabus versus traditional study methods.
- Other data should also be logged: Time spent on studying/playing and study techniques used if not playing.

Using the game in other areas

The game model described in section 4.2 can be applied to several fields of study. The experiment proposed here could be applied to different courses in order to see how well it does in different fields.

Cooperation versus work independently

During testing it was observed that some students cooperated. Some of the observations suggested that participants improved their learning outcome by discussing the game content amongst themselves while playing. Based

on these observations, an experiment that measured the learning outcome when playing independently versus playing in teams of two, would also be of interest.

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Part III

Appendices

Appendices

Appendix A

Questionaire

This appendix contains the questionaire as presented to the participants.

Questionare:

Name :_____

E-mail :_____

Age :_____

Gender :_____

Studies :_____

		Strongly disagrees				Strongly agrees
1	I found the system unnecessarily complex.	1	2	3	4	5
2	I thought the system was easy to use.	1	2	3	4	5
3	I think that I would need the support of a instructor person to be able to use this system.	1	2	3	4	5
4	I found the various functions in this system were well integrated.	1	2	3	4	5
5	I thought there was too much inconsistency in this system.	1	2	3	4	5
6	I would imagine that most people would learn to use this system very quickly.	1	2	3	4	5
7	I found the system very cumbersome to use.	1	2	3	4	5
8	I felt very confident using the system.	1	2	3	4	5
9	I needed to learn a lot of things before I could get going with this system.	1	2	3	4	5
10	The interface was easy to understand	1	2	3	4	5
11	The buttons was grouped naturally in order for you to complete tasks	1	2	3	4	5
12	The icons was easy to understand and consistent throughout the game	1	2	3	4	5
13	It was easy to navigate in order to find information	1	2	3	4	5
14	I checked my score regulary	1	2	3	4	5
15	It was easy to keep track of progress	1	2	3	4	5

16	It was easy to check your own score	1	2	3	4	5
17	It was easy to look up different and understand different data/statistics during play	1	2	3	4	5
18	Tasks were being complex to perform due to a lot of navigation	1	2	3	4	5
19	There was a lot of navigation in order to look up needed information	1	2	3	4	5
20	The stats and progressbars in the game help guide you to perform better at the game	1	2	3	4	5
21	The progressbars and stats were motivating to observe	1	2	3	4	5
22	The game helped you performing the correct actions when playing	1	2	3	4	5
23	You considered different ways of completing the game	1	2	3	4	5
24	The quizes in the game made me study the content more	1	2	3	4	5
25	You find it interesting to try the game again in order try to achieve a higher score	1	2	3	4	5
26	You can think of other strategies that might give a higher score	1	2	3	4	5
27	The game motivated me to research before taking actions as opposed to trying/failing	1	2	3	4	5
28	The information presented in the game were overwhelming	1	2	3	4	5
29	Your actions induced a logical response from the game	1	2	3	4	5
30	Your actions greatly affected the outcome of the game	1	2	3	4	5
31	You recieved sufficient feedback on the impact of your actions	1	2	3	4	5
32	The game provides content that stimulates my attention	1	2	3	4	5
33	The mapping of developers to deliverables required me to understand the content in the game.	1	2	3	4	5
34	I am not burdened with tasks that seem unrelated	1	2	3	4	5
35	Overall goals were presented in the beginning of the game	1	2	3	4	5
36	Overall game goals were presented clearly	1	2	3	4	5
37	I receive feedback on my progress in the game	1	2	3	4	5

38	I enjoy the game without feeling bored or anxious	1	2	3	4	5
39	The game provided new challenges with an appropriate pacing	1	2	3	4	5
40	The game provides «hints» that help me overcome the challenges	1	2	3	4	5
41	My skill gradually improves through the course of overcoming challenges	1	2	3	4	5
42	I am encouraged by the improvement of my skills	1	2	3	4	5
43	I think this is a good way to learn new content	1	2	3	4	5
44	I feel that I can use different strategies freely	1	2	3	4	5
45	I remember the content from the game afterwards	1	2	3	4	5
46	The game does not allow players to make erros to a degree that they cannot progress in the game	1	2	3	4	5
47	I learned some of the content I did not already know, from the quizing.	1	2	3	4	5
48	I can become involved in the game	1	2	3	4	5
49	I feel competitive toward other classmates	1	2	3	4	5
50	I compare my scores towards other continiously while playing	1	2	3	4	5
51	The game increases my knowledge	1	2	3	4	5
52	I try to apply the knowledge in the game	1	2	3	4	5
53	The game motivates the player to integrate the knowledge taught	1	2	3	4	5
54	I want to know more about the knowledge taught.	1	2	3	4	5
55	The intro given by the instructor were helpful	1	2	3	4	5
56	The intro contained the most important aspects of the game	1	2	3	4	5
57	I am an experience gamer	1	2	3	4	5