NTNU – Trondheim
Norwegian University of
Science and Technology

Evaluating a Game Design for Language Learning

Exploiting Psychological Needs to increase
Motivation for Learning

Malin Aas Berg

Master of Science in Computer Science
Submission date: June 2013
Supervisor: Sobah Petersen, IDI

Norwegian University of Science and Technology
Department of Computer and Information Science

PROBLEM DESCRIPTION

Mobile game for language learning.

Evaluating a game design for learning.
Exploiting psychological needs to increase motivation for learning.

The purpose of this thesis is to demonstrate how a mobile puzzle game can be designed and developed with the purpose of contributing to vocabulary learning. The focus is on evaluating the game design in regard to motivation, mapping the motivational sources in the game design and compare the designed motivational structure with the user experienced motivational structure.

Since the game design is based on psychological needs, the thesis evaluates what the psychological needs does to the game design and especially to user motivation. It also researches whether basing a design on these needs is recommended or not.

Focus is also on evaluating what user-generated content, crowd-sourcing does to a game element, what are the user's opinions towards it, and are there any problems arising when using it.

Assignment given: 15th of January 2013
Supervisor: Sobah Abbas Petersen

ABSTRACT

When students today start their university education, they are faced with a whole new world. In addition to the demanding curriculum which is complex and takes a great amount of time to learn, they are suddenly faced with a world in a different language and with an extended vocabulary. Even when studying in their own countries, students are presumed to know this vocabulary. This situation occurs when students in higher education joins lectures, talks to course aid and studies for their exams. Vocabulary and technical terms which they are introduced with in these situations are fast forgotten. The mobile game presented in this thesis for supporting language learning is motivated by this scenario and is designed to support university students learning subject-specific language effectively.

In order to motivate learners for tedious and boring learning activities, motivation extracted from games was identified, called psychological needs. These needs were used to design a game which was implemented and evaluated with focus on user motivation. The main task for the game was to promote and perform rote learning in a more fun and engaging way. The game was then implemented and evaluated in order to see if it is in fact so that the psychological needs increases motivation for performing learning.

The results show us that as long as there is some automation of the rote learning and that the user can see some form of progress or score on their performance, motivation increases. Seeing as many of the evaluators are students they were very positive towards having a tool to help them automate memorization of simple definitions or words.

The results and research presented indicates that for a puzzle game to increase motivation for rote learning it must utilize as wide a set of psychological needs as possible, and they must be implemented properly. There are many subcategories and different combinations of them that can be utilized in different ways.

SAMMENDRAG

Når elevene i dag starter sin universitetsutdannelse, står de overfor en helt ny verden. I tillegg til et krevende pensum som er komplisert og tar lang tid å lære, står de pluselig overfor en verden i et annet språk og med en utvidet ordforråd. Selv når de studerer i sine egne land, blir elevene antatt å kunne dette vokabularet. Denne situasjonen oppstår når studenter under høyere utdanning sitter i forelesning, snakker med kurs assistenter og studerer på egenhånd til eksamener. Ordforråd og tekniske uttrykk som de er introdusert med i disse situasjonene er raskt glemt.

Mobilspillet som presenteres i denne avhandlingen har som mål å støtte språkopplæring og er motivert av dette scenariet. Det er utformet for å støtte studenter å lære fagspesifikk språk effektivt. For å motivere elever for kjedelige læringsaktiviteter, ble motivasjon fra spill identifisert, kalt psykologiske behov. Disse behovene ble brukt til å designe et spill som ble evaluert med fokus på bruker motivasjon. Den viktigste oppgaven for spillet var å fremme og utføre memorisering på en mer morsom og spennende måte. Spillet ble deretter implementert og evaluert for å se om det faktisk er slik at den psykologiske behov øker motivasjonen for å utføre læring.

Resultatene viser oss at så lenge det er noen form for automatisering av memoriseringen og at brukeren kan se fremgang eller tall på sine prestasjoner, øker motivasjonen. Siden mange av brukerne som evaluerte spillet var studenter, var de var veldig positive til å ha et verktøy for å hjelpe dem å automatisere læring av enkle definisjoner eller ord.

Resultatene og forskningen som presenteres viser at for at et spill skal øke motivasjonen for memorisering må utnytte et så bredt sett av psykologiske behov som mulig, og de må implementeres på en grundig måte. Det er mange underkategorier og forskjellige kombinasjoner av disse som kan utnyttes på forskjellige måter.

PREFACE

This master thesis is the result of a computer science master degree at Norwegian University of Science and Technology. I have quite an extensive gaming background, both core gaming and puzzles have stolen many hours. Because of this I have always been motivated and inspired by information technology, which made me academically choose computer science and game technology.

In addition to gaming I have always enjoyed learning. I believe that the potential of learning and information technology has not been fully utilized, and my goal is therefore to explore this potential and push the limits for how learning can be performed.

I choose this topic because I believe that combining games and information technology with learning provides an easier and more fun way to learn, perhaps even a more efficient one. The task gave me a possibility to test out these assumptions and contribute results to the research area.

I have gained knowledge in both technical and non-technical aspects of learning, mobile development, the android framework, game elements and game evaluation. I gained the experience of performing software development on my own and what work each specified requirement implies. I also learned that development takes time, not only hard work.

June 4, 2013

Malin Aas Berg

To all those who struggle to achieve their learning goals.

ACKNOWLEDGEMENTS

I would like to express my very great appreciation to Sobah Abbas Petersen for her valuable and constructive suggestions during the planning and development of this research work. Her willingness to give her time so generously and encourage me to stretch further has been very much appreciated.

I would like to offer my special thanks to Ines Di Loreto for her invaluable guidance during the early stages of the project, giving me the right questions to ask and showing me where I had misplaced my red thread.

I would also like to extend my thanks to my fellow students and friends for their help in everything from report layout, technical issues and software evaluation.

Finally, I wish to thank my mum, my sisters and the rest of my family for their support and encouragement throughout my study.

CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACRONYMS

IDE Interactive Development Environment

IS Information System

JDK Java Development Kit

GUI Graphical User Interface

SDK Software Development Kit

UGC User-generated content

UML Unified Modelling Language

VM Virtual Machine

XML Extensible Markup Language

Part I

INTRODUCTION

This part introduces the thesis. It consists of the background information, the research questions and the research methodology used.

1 BACKGROUND

This chapter starts with presenting the motivation for conducting this project, why is it an important topic and what is sought to be achieved. Next is a description of the context and the scope the project has been conducted in. Thereafter a simplified project plan is presented followed by a summary of the results and the report outline.

1.1 MOTIVATION

One of society's challenges today is to encourage children and teenagers to choose and complete higher technical education[1][2]. Many of those entering higher education never complete it and in order to increase the number of students completing higher education one must ease the context in which learning is performed.

Today, much of the learning is done in English. Based on official information, about half of all courses in NTNU have lectures offered in English[3][4]. The real percentage is likely to be higher as lectures are often performed in English as long as there is an international student taking the course. This means that both the lecture and the curriculum is in English. Often the assignments and exams can be delivered in Norwegian, but this only causes more problems since much of the domain knowledge has been learned in English. With increased availability of studying abroad, even more courses are likely to be conducted in English in the future.

Learning is performed during our entire lives. Some of it is fun and exciting while other times learning topics are boring and tedious. When you have been introduced to new vocabulary, this knowledge must be revised in order to learn it and retain that knowledge. The learning technique often used in such situations is rote learning, memorizing through repetition, which learners often find both inefficient, boring and tedious.

In my own context I mostly write and communicate domain knowledge through emails in English, while all oral communication is in my mother tongue. If I were not able to translate my domain knowledge in English into my mother tongue, or vice versa, I would not have been able to discuss anything with the benefit of all my experience in both languages. The correlation between the two languages must be one to one in order to communicate my domain knowledge properly in both.

Students are presented with a world in English and have little or no experience with the technical vocabulary in English. It especially leads to problems when the heavy technological lectures are in English. Stu-

dents do not benefit from attending lectures and during independent study, the technical vocabulary and the domain language becomes a barrier.

In a time when the mobile technology is being used everywhere and for practically everything, from buying bus tickets to having fun with your friends, it should not be so difficult learning from the palm of your hand. Earlier research in this area has been focused on applications with an external tutor aiding the students in learning the relevant subjects and languages, but research and prototypes of fully standalone applications are scarce.

In order to motivate the user the focus is turned to games, and more particularly serious games. Technical vocabulary is difficult and strains the mind and in general, learning the vocabulary is a slow process. Rote learning is an activity very few students enjoy or find rewarding. To compensate for this the use of games is introduced and focus is turned to motivating for the task at hand while at the same time significantly contribute to learning.

1.2 CONTEXT

This master thesis was conducted as a continuation on a specialization project which consisted of researching mobile language games and designing a game. The game was designed to suit a specific user group for the purpose of facilitating rote learning. The game has been separated into modules, developed and evaluated in this master thesis.

DURATION The master thesis was conducted as a full semester's workload through 20 weeks.

1.3 PROJECT PLAN

Table 1 contains an overview of the project plan. The first literature review was focused on game mechanics, psychological needs and game development. The second literature review was focused on game evaluation, previous quiz games and finding out if there were could be other reasons behind the results.

Week	Activity
January	
3	Introduction
4	Development
5	Development
February	
6	Research questions and method
7	Revising requirements
8	Separating into modules and development
9	Development
March	
10	Literature review and Development
11	Literature review and Development
12	Literature review and Development
13	Easter
April	
14	Development
15	Testing
16	Evaluation and questionnaires
17	Evaluation
18	Evaluation
May	
19	Literature review
20	Literature review
21 - 23	Thesis writing
June	
24	Delivery

Table 1.: Project plan

1.4 RESULTS

A thorough presentation of the results and the conclusion can be found in Chapter 10 and 11.

Through the results gathered from the evaluation of the puzzle game it was evident that different users are motivated by different game mechanics. The game design did however increase motivation for learning throughout all the different persons the design was evaluated on. There

were several areas for improvement, but the design itself was positively received.

To be able to generate your own content in the game was also positively received by most of the users, this was mostly because the purpose of the game was to learn what the user wanted to learn.

It was evident that exploiting psychological needs is a large contribution to motivation and emotions experienced in games. It was also evident that different users felt different emotions when being presented with the same game design. The users also felt that the design did not utilize all the needs that it was designed with regard to, which was also different from user to user. Those needs were needs that represented stronger emotions, which might require more game mechanics to be implemented.

1.5 REPORT OUTLINE

This section lists the different parts and chapters in the report along with a description of their content.

PART I: INTRODUCTION

CHAPTER 1: BACKGROUND presents the motivation, context, project plan and report outline.

CHAPTER 2: RESEARCH QUESTIONS discusses and lists research questions from the specialization project and this master thesis.

CHAPTER 3: RESEARCH METHOD describes the research methodology having been followed and the development tools utilised.

PART II: PRE STUDY

CHAPTER 4: PROBLEM ELABORATION discusses the problem in regard to it's context and user group, and presents scenarios.

CHAPTER 5: EXISTING WORK gives insight into the related work performed by others in order to present the work which this work have used and is based on.

CHAPTER 6: THEORETICAL BACKGROUND presents the theories related to games, motivation and learning.

PART III: OWN CONTRIBUTION

CHAPTER 7: GAME DESIGN describes the game concept and game design in details.

CHAPTER 8: GAME IMPLEMENTATION describes how the game was implemented.

CHAPTER 9: GAME EVALUATION gives insight into how the game was evaluated.

PART IV: RESULTS

CHAPTER 10: RESULTS presents and discusses the results gathered in this thesis.

CHAPTER 11: EVALUATION AND CONCLUSION evaluates and concludes the thesis based on the evaluation and the results, and proposes areas for further research.

2

RESEARCH QUESTIONS

This chapter contains a summary of the research questions and the results from the specialization project. Thereafter the research questions extracted from those results is presented.

2.1 SPECIALIZATION PROJECT

This section contains the previous research questions and results which this master thesis builds upon.

RESEARCH QUESTIONS Research was conducted on how to incorporate learning into games and make learning easier and motivate the user in different ways. This phenomena is called serious gaming, meaning you bring a serious aspect, i.e learning, into the entertaining environment which is games and gaming.

- What is it that makes users more motivated by games and can this motivation be used in the context of learning technical vocabulary very quickly and for specific subjects?
- What can we learn from other apps and games in order to best suit a mobile game for vocabulary learning?
- How can such a game be designed for learning technical vocabulary and what game mechanics would be best suited in the learning environment?

RESULTS A game design and requirements related to a mobile game for vocabulary learning is delivered, it can be seen in Chapter 7. It is a result of identifying motivational factors in games in order to engage the learner and on existing games and applications which is presented in Appendix A. The game is a simple puzzle game, building on creation and competition. Rote learning is performed by being able to play created puzzles over and over again. The motivation in the puzzle game is based on the theory of human's psychological needs.

A player is motivated through wanting to satisfy psychological needs. These needs can be implemented in different contexts and game mechanics, and there is no distinct combination of the two which seems more likely to work. Game mechanics are not directed at a distinct psychological need but often several different ones which varies with user to user. Different users are likely to want to satisfy different needs through game play. Very competitive personalities will of course be

likely stimulated by the competitive game mechanic, but more nurturing personalities can have other needs which they want stimulated.

The proposed design consists of a game concept based on competition, collaboration and creation. Seeing as the identified user group is composed of users with many different personalities, the design is attempting to be able to satisfy as many different psychological needs as possible. In order to not make the game too complex and difficult to play, it is divided into two phases, where a user does not need to participate in each phase in order to experience a learning environment or satisfy it's needs.

The results are evaluated using user feedback and discussions on the discovered findings. The results from the interviews are summarized below.

- All users identified themselves with the problem and the issues which it caused. They were both newly admitted university students and they were surprised with how much English they were exposed to and that they were expected to understand it.
- It is tiresome to write on the phone so writing has to be kept at a minimum. It was also mentioned that there should be a pc client of some sort available, so that the puzzles could be created there, where it would be faster to write.
- Colors and design is important, maybe users can choose which color the puzzle should be in. Customizable interface.
- User interface must be engaging. Design a user interface with modern touches and that fits the learning environment, feels encouraging and fun.
- The concept is very good and sounds exiting. Especially that it can be used for several learning purposes. Both users are exited about learning being performed in a game environment.
- The multiplayer modes sounded difficult so they should probably be simplified. Maybe one or three questions each every turn, and another realtime mode. It was also expressed that the realtime game mode sounded error prune.
- It was clearly expressed that adding and playing with friends were an important functionality.
- Questions must be fun to answer. It is therefore important that there are several ways to answer a questions, so that the user is not bored.
- The puzzle must be editable for a time after it have been published. In order to fix errors which were not discovered before after publishing.

- Puzzle creation should be versatile so that it can be used for learning other things as well.

2.2 NEXT STEP

This section contains the next step in evaluating the puzzle game and it's elements. Firstly, the research questions and their sub questions are presented, followed by a short overview on how the questions are to be answered.

RESEARCH QUESTIONS

1. What does this game design do to situational learning in relation motivate for memorizing?
    a) Does this game promote rote learning as a more fun and engaging learning activity and help users revise what they have previously learned?
2. What does generating your own content do to this game environment in regard to motivation and learning?
    a) What are students' opinions towards User-generated content (UGC) based games for learning and what must be done in order to make UGC work in a game environment?
    b) What does utilizing UGC in this puzzle do to motivation for learning?
3. What does exploiting the psychological needs implemented in the game design do to motivation?
    a) In which degree does exploiting psychological needs increase motivation for learning?
    b) Which game mechanic and psychological need increases motivation the most?
    c) How is the mapping between psychological needs and game mechanics different from user to user? Are there any commonalities?

EVALUATION PROCEDURE The research questions presented covers several topics related to user motivation and user opinion. It is therefore important that users are a part of both development and evaluation. In order to properly uncover the reasons behind user motivations and user responses, a methodology of interview is approached. Interviews are also performed several times with the same user, in order to give the user more time to evaluate and think about the questions.

Evaluation UGC is done in a more general way. Since many users know what UGC is and what effects it has, a simple questionnaire maps

what they think about it. UGC is also evaluated in the interviews, and a more deep understanding of the opinions are in that way gathered.

In order to map psychological needs to game mechanics, the users are also asked which of the psychological needs they are satisfying by having the specified game mechanic. With this mapping in mind, the users' motivation after having each module available gives the indirect motivation increase from one or several specific psychological needs. This in turn may be different from user to user, and this difference is also mapped by asking follow up questions regarding why this motivation increase or decrease took place.

3

RESEARCH METHOD

This chapter describes the research methodology design science, it's guidelines and the tools utilized for the software development.

3.1 DESIGN SCIENCE

The project was conducted using the behavioural and design science research methods[5]. Behavioural science helps us understand the human computer interaction in the case of interaction between a player and the game. The goal is to figure out if players are engaged and motivated by the game, and evaluate the source of the motivation and if it is consistent from user to user, if not the goal is to find out what differs between the users.

Design science research method is a problem-solving paradigm, which fits perfectly to this project. It's main goal is to create innovations that define the ideas through which the analysis and design can be effectively and efficiently accomplished[5]. This project aims to innovate in mobile learning by developing a game that stimulates users to perform rote learning in a different way. The creation of this innovative product relies on the behavioural theories which are discovered and the design principles which the product is built on.

An important aspect of design science is that it recognizes that it is important for the empirical Information System (IS) research to be implementable. Design science therefore stimulates functional thinking in the direction of implementation and user evaluation.

It is argued that behavioural and design science is inseparable in IS research, and they are both therefore incorporated as research methods in this project. Much of the design part has been completed in the specialization project, but after the evaluation feedback, some changes has been made.

3.1.1 *Guidelines*

This section contains seven guidelines[5] regarding how to perform design science research. Each guideline is explained in relation to how the method has been used in this project and in that way explain how the project has been conducted.

1. Design as an artifact: Developing a product from an already existing design. Producing a game.

2. Problem relevance: Explaining the problem with regard to context and it's importance in the world. The game is evaluated through explaining real life scenarios and by users using the game in real life situations.

3. Design evaluation: Evaluate using feedback from relevant users and comparing the game with already existing products which purpose is the same.

4. Research contributions: Contribute to the rest of the world by publishing this work and making it dependent on other's work. Giving the society a reason for investigating game technology to promote learning. The implemented artifact, the creative development of the artifact, the technical achievement, the methodology used and the results produced.

5. Research rigor: Finding relevant work performed by others to learn and build from their work. Use rigorous methods for defining and implementing the game.

6. Design as a search process: Finding a correct game implementation and concept in regard to theories discovered within the identified problem's environment.

7. Communication of research: Thesis with discussions and evaluations in order to communicate to technology-oriented people and the user group.

3.1.2 *Evaluating the Design*

Evaluation is very important in IS research. The design science research method utilizes several design evaluation methods. The relevant evaluation methods are listed here.

- Observational
  - Observe how the users use and integrate the artifact in their everyday life. Two users used the artifact in an everyday setting and evaluated it as presented in Section 9.2 afterwards.
- Analytical: Presented in Chapter 8.
  - Static analysis: Examine artifact structure for static qualities.
  - Architecture analysis: How well does the artifact fit into an architecture.
  - Framework analysis: Use existing frameworks to evaluate game mechanics and learning objectives[6]. Presented in Section 9.1.

- Experimental: Procedure used on most evaluators, presented in 9.2.
  - Controlled Experiment: Study the artifact in a controlled environment for qualities, usability, functionality and suitability. User feedback was gathered in order to see how the user responded to the game and the use of it in real situations.
  - Simulations: The use of auto generated content to simulate how the game can be used in a real situation.
- Testing
  - Both functional and structural testing in order to ensure that the game functions properly during evaluation by the users and real life situations. Testing performed in the code, the server application have functional tests.
- Descriptive
  - Informed Argument: Using information from relevant research in order to build a convincing argument for the artifact's utility. Discussions use the information gathered through different channels in order to enlighten the different aspects of the problem and the proposed game design. Using when conveying the results presented in Chapter 10.
  - Scenarios: Constructing detailed scenarios around the artifact in order to demonstrate its utility. Presented in Chapter 4.

3.2 DEVELOPMENT TOOLS AND TECHNOLOGY

This section explains the different development tools user for implementing the game, and also the technology used to make it available to users in real life situations.

INTELLIJ INTERACTIVE DEVELOPMENT ENVIRONMENT IntelliJ[7] Interactive Development Environment (IDE) is a Java IDE which offers a wide range of plugins and support for developing both server and client applications. It has built in support for both Android and Tomcat which makes testing and deployment very easy.

UBUNTU VIRTUAL MACHINE A Ubuntu Virtual Machine (VM) was used to host the server application. Having a VM made it easy to ignore unneeded complexity and focus on deploying and debugging the database and the server application.

RESTLET FRAMEWORK The restlet framework[8] is a framework for developing RESTful web applications at both the server and client side. It can also be use in Android applications so it was an easy choice in

order to make a decent server client architecture that functions out of the box with little or no configurations.

ANDROID SOFTWARE DEVELOPMENT KIT Android[9][10] Software Development Kit (SDK) is the SDK for developing application that run on the Android operating system. It has a wide range of examples and is very well documented.

JAVA DEVELOPMENT KIT Java Development Kit (JDK) is the programming kit for developing in Java and must be used for both Android SDK and IntelliJ IDE to function properly.

EXTENSIBLE MARKUP LANGUAGE Extensible Markup Language (XML) is a simple yet powerful markup language. It was used to communicate between the clients and the server, as well as to create the Graphical User Interface (GUI).

Part II

PRE STUDY

This part presents the problem the puzzle game has been design to solve, the theoretical background built into designing the puzzle game, and some of the relevant work performed by others which this work has been built upon.

4

PROBLEM ELABORATION

This chapter contains a thorough explanation of the problem at hand. The problem is described through a context description, scenarios and a user group description.

The descriptions provided in this chapter is reached through real world situations and own experience. The difficulties and arguments pointed out have been reached through feedback and discussions on campus between fellow students and also student assistants.

4.1 CONTEXT

A high degree of learning is often considered to take place at university and other higher education institutions. The students have full responsibility of their own learning and there is also a certain expectation in regard to what the student shall and shall not manage. This is all well and good, but sometimes other factors make learning and especially the learning curve harder and steeper than what should be expected. This is when the environment in which the learning takes place is also of unknown character and must be learned. The most important of these environment factors is the language. How the learning is communicated and that the listeners understand it?

When the newly admitted student at higher education studies complex curriculum at a different language than the student is comfortable with, it causes frustration. The language is most often English, which the student is somehow familiar with, can communicate through, but is not comfortable studying with. It is the higher education with more technical terms, advanced mechanics and domain language that the student's English is not advanced enough to comprehend.

The most important part the problem is to understand technical terms and technical mechanics. These expressions often come in regard to a context, and in a different context, they mean something else. A term must therefore be learned in the context it is relevant in, and because of it's complex nature it must be repeated in order be stored in long term memory. The more knowledge is repeated the longer it is remembered. Repetition is therefore the most efficient way to do language learning, but as it sounds it is also not very engaging or exiting. Because of this students rarely repeat their newly learned terms, and they are forgotten after a couple days. When exams come, the essential basic technical terms making up their newly learned technical domain language, which they are to work in for many years, is forgotten and is not easily learned in a couple days.

4.2 SCENARIOS

This section describes different scenarios where the problem and the need explained occurs. This provides a better understanding of the context and the problem and displays situational learning. Future situations are also described in order to better visualise where and how the game can be used.

4.2.1 *Need Scenarios*

This section describes scenarios explaining how and where the need for an easy way to learn technical expressions occurs. These scenarios have been reached through real life experience of students including myself.

4.2.1.1 *NS#1*

A student arrives at his calculus class. This is one not many students are taking, meaning there is a more relaxed environment and the lecturer is easy to talk to. This lecture however, a couple exchange students had also started taking the course, meaning the lecturer switched over to English. During the lecture the student is lost several times during explanations. Words which he does not understand is noted in his notebook, but he knows he will not look them up nor is it likely that he will learn them in any way. Even though the lectures are likely to continue being in English.

4.2.1.2 *NS#2*

During exercise aid a student studying physics is aided by a very skilled exchange student. During the explanation both students recognize the difficulty discussing physics in English and understanding what the other person is trying to communicate.

4.2.1.3 *NS#3*

A student is studying for his exam in chemistry. His curriculum is in English while his notes from earlier in the semester is in his mother tongue. He soon realizes that studying was proving more difficult and he felt that there was almost no progress. If only he had learned those words when he first heard them, then he would not have struggled so much at the end of the semester.

4.2.2 *Future Scenarios*

This section contains future scenarios when the game designed in this project is available. These scenarios have been reached through own insight and analysis of the use of mobile apps and games.

4.2.2.1 *FS#1*

While riding the bus to a lecture, a student is struck with the memory of his calculus lecture being in English, and how little he got out of it because of the language barrier. He then opens the game on his phone, finds a relevant topic, and plays through it. He even plays through it several times and though he did not understand everything it all feels a bit more familiar now than it did earlier. During the lecture he uses the game to collect the different words he does not understand so he can revise them later through the game. He is even looking forward to the bus ride home, when he will be able to organize his learning through the game.

4.2.2.2 *FS#2*

During exercise aid a student studying physics is aided by fellow student. They struggle with the curriculum and do not feel that the student assistant only speaking English is of much help because of the difficult technical expressions. Between themselves they write down all the words they find which they do not understand, inside the game. They then create a game and decide to see who can get the best score until the next exercise aid.

4.2.2.3 *FS#3*

Before starting to study for his exam in chemistry, a student finds himself playing with his phone. Studying proved more difficult because the curriculum was in English, and even though he must study he postpones it because it is more fun to play games on his phone. After having played games where chemistry is the topic for quite a while, his motivation for studying for the exam is increased, and he feels it will be a lot easier to read the chemistry curriculum now than it was before.

4.3 USER GROUP

As presented in the previous sections the targeted user group is students in higher education studying science and technology. This consists of both males and females in the ages of 19 to 28. While this might sound as a concrete user group at first glance, this group covers a large range of different people and personalities. Within different programmes one might find stereotypes, but in general one can not rely on a particular stereotype.

Complementary to the student user group there is a user group consisting of professors and lecturers. If the students do better or even can do better in their courses because of the game, the lecturer is likely to want to provide content for the game, if possible, and maybe even suggest “homework” in the form of playing particular puzzles. If the

lecturer knows he is going to use a lot of new vocabulary the next lecture, it would increase the participation level in the class if the students understand the expressions beforehand.

A secondary user group is students on lower educations but that also studies complex curriculum, physics, mathematics and chemistry, in English. This user group is not that large.

5

EXISTING WORK

This chapter presents relevant work performed by others. This includes a framework for evaluating educational games and some existing games and applications for learning.

5.1 EVALUATING A GAME FOR LEARNING

Evaluating a game which's purpose is learning, is different than evaluating a game which's purpose is pure entertainment. This is because a learning game demands a degree of measurable results in relation to the learning objectives the game claims to provide to the user.

In order to properly evaluate the puzzle game a framework for analysing and designing educational games have been used. The framework proposes a specification of three aspects of the game in order to identify learning objectives and game mechanics. The framework is built on existing components: a method for precisely specifying educational objectives, a framework relating a game's mechanics, dynamics and aesthetics with each other, and principles for instructional design grounded in empirical research in the learning sciences[6].

A problem with using this framework to evaluate the puzzle game is that the game does not have any clear learning objectives in the form that the framework specifies. The learning objective of the puzzle game is to aid in using a learning method, not learning the user something in particular. Because of this, other forms of evaluation have been used as well, including interview of the users, questionnaires and technical testing.

5.1.1 *Framework*

The next three paragraphs explains each component of the framework[6] in detail. The results of the framework is presented in Chapter 9.

COMPONENT 1: LEARNING OBJECTIVES This component consists of specifying the learning objectives of game. This is done by answering three questions:

1. What knowledge or skills do student/players need to have before starting the game?
2. What knowledge or skills can student/players reasonably be expected to learn from the game?

3. What knowledge and skills might they learn that go beyond what they actually encountered in the game?

Answering these questions and specifying the educational goals makes it easier to evaluate if the game is truly educationally effective. To answer the questions it is advised that a written specification is provided, examples of tasks are described and categorizing the different knowledge, skills and tasks.

COMPONENT 2: MDA FRAMEWORK This component is a framework in itself which's goal is to aid the analyst to think about games in terms of three dependent layers.

- The *Mechanics* are the basic components out of which the game is built: the materials, rules, explicit goals, basic moves and control options.
- The *Dynamics are the behaviours that result when applying the game's mechanics with player input* during game play.
- The *Aesthetics* capture the subjective experience of the player, the emotional response or pleasure that the game is designed to evoke. The aesthetics taxonomy is comprised of eight elements: Sensation, fantasy, narrative, challenge, fellowship, discovery, expression and submission.

This component allows the designer to articulate aesthetic goals and make reasonable choices at the mechanical level to support the aesthetic outcome.

COMPONENT 3: INSTRUCTIONAL PRINCIPLES This component comprises of using research-based principles for instructional design. There are many such collections[11][12] and they are becoming an increasingly popular way to summarize and communicate results in the learning science.

A key assumption behind using the results in the learning sciences is that the instructional design principles can be carried over to the design of educational games, and can help games become more effective, educationally.

5.2 EXISTING GAMES AND APPLICATIONS

This section contains a quick review of some of the more relevant existing games and applications learning. This includes three mobile applications/games and two games available on the web. For more existing games which have been evaluated see Appendix A.

Figure 1.: Memrise logo

5.2.1 *LectureQuiz*

LectureQuiz[13] is a quiz game for use in lectures. The lecturer prepares the quiz and when it is played in the lecture later on, the students interact with their smart phones in order to answer the quiz. A score is achieved by answering fast and correct and at the end of the quiz the score board is presented. Since it is the lecturer which makes the quiz, it can be used for learning any sort of information, including vocabulary and language.

Feedback and experience with LectureQuiz indicates that the students enjoyed it very much and they felt they learned more when they were tested at the end of the lecture. Knowing that they would do a round of LectureQuiz also motivated them further in meeting up for lectures and listening to the lecturer[14]. The game does however occupy a lot of lecture time which there often no room for.

LectureQuiz has been evaluated and tested by many students, and the results are gathered from user feedback.

5.2.2 *Memrise*

Memrise[15] is a computer game played on the web where the user learns words with the help of different definitions, mnemonics and pronunciations Anyone can add anything, which makes this a gamed based on UGC. The main game mechanic used for motivating the player is that the words learned is visualised as plants. First they are seeds, and the more the words are repeated and practised the more the plants grow, until at the end they can be put in the long term memory, visualised as the garden. There is also a delay between when you have repeated a word enough many times until you can move it to the garden. This makes sure that the user does not do everything at the same day, which would reduce the duration of what he has learned. Once the words have been placed in the garden they have to be revised every few days in order to not fade.

The learning itself is performed by using both sound, typing and quizzes. If what you guess or what you type is not correct the game will take you back to that word faster, and show a different definition or mnemonic. It also recognizes when an answer is almost correct by giving points for trying. This motivates the user to try instead of leaving it unanswered, which in turn enables the user to think and learn.

Figure 2.: Duolingo logo

Memrise have also implemented a leaderboard. It enables the users to try harder for other reasons than the learning itself, which then just becomes a by-product. All in all it is a very good serious casual game which because of the plant abstraction changes language learning into a fun activity, and the user is motivated from wanting to fill up the garden.

5.2.3 *Duolingo*

Duolingo[16] is like memrise a computer game played on the web. It focuses on learning more than just words, but sentences, how words can be connected, how they are related, and sentence structures. It is harder to start using it if the user does not know many words. This is because it starts off with a lot of writing, listening and saying, which are all difficult in the start. If the user however has learned a bit of the language at school many years ago, Duolingo is very easy to get into and the learning curve is steep but manageable.

Duolingo motivates the user by visualizing the learning in a skill tree, with each "node" in the tree having both requirements and a curriculum. The user's profile page is also filled with different types of progress bars and skill points which motivates the user further. A vocabulary page contains all the words the user have seen, and in which memory these words are likely to be stored at any moment, new word, short-term, mid-term or long-term memory. This enables the user to see which words he knows the least and does the most errors with, and he can also choose to only practice on the weakest words. When starting a practice round the user can also choose to do it timed, which enables a competitive aspect, even though the competition is just against the clock.

Figure 3.: Lingobee logo

Duolingo is a social learning environment. The user can follow and be followed like in the social network Twitter[1]. The user also has a stream where he can post statuses and communicate with others in the language he is learning.

5.2.4 *Lingobee*

The SIMOLA project[17], short for Situated Mobile Language Learning, develops a crowd-sourced information system for situated language learning. Much research and results achieved in this project has been used for this master thesis.

Lingobee[18] is developed by SIMOLA and is a system based on UGC, crowd-sourcing. The main purpose of Lingobee is to aid vocabulary learners and it promotes a social environment. Lingobee was evaluated by users taking foreign language classes, both a pre-intervention and a post-intervention questionnaires were conducted.

The social environment in Lingobee promotes learning but also recognizes the latest trend of social networking[19]. Because of this it can develop to be a very powerful application when it's community grows.

Research on types of applications like Lingobee showed that when the content is user-generated the application can be used for much more than what was intended. The benefit of UGC is that it is only the user himself which sets the limits of what the content can be[20][21]. It is also a source for the user to achieve self-expression, which is a powerful game mechanic[22]. On the other hand other users can become annoyed or frustrated by users not using Lingobee for what it was made for.

Lingobee was evaluated through questionnaires, both before usage and after, in classes for learning language. The evaluation had a wide focus, everything from the usage of mobile phones in general, what functions they used, how often, where and if they had any suggestions for improvements.

1 https://twitter.com/

5.2.5 *Quizfun*

Quizfun is like LectureQuiz a quiz based game. It is however not committed to the environment of a lecture, but can be used anywhere and anytime. It's purpose was to increase student's interactive participation in learning. The study found that using mobile games for educational purposes increased the enthusiasm of students and engaged them in the learning activity. It was also found that those activities would then provide better understanding of the learning[23]. The evaluation showed that using small simple games in a learning environment can have huge impacts on both the learning and the students' motivation.

QuizFun was evaluated by several users, and research found high interactivity among students and found that students became more enthusiastic in participating in learning activity. Students experienced higher enthusiasm towards the learning process and learning activities, and the learning activities provided better understanding of the information.

6

THEORETICAL BACKGROUND

This chapter presents the theoretical background for the game design. This consists of the work done in the specialization project, as well as a more thorough description of psychological needs, user-generated content, and gamification. All this information is used vigorously throughout the development and the evaluation of the puzzle game.

6.1 SPECIALIZATION PROJECT

This section presents a summary of the theoretical information gathered during the specialization project. This consists of a review of game mechanics and how they are used in existing applications and games, an description of social environments in games and an explanation of the terms serious and casual games.

6.1.1 *Game Mechanics and Functionality*

This section describes strengths and weaknesses with some of the functionalities identified in existing games during the specialization project.

As is shown in the list below, a lot of the element's strengths and weaknesses are based in user's feelings and opinions. This is related to the psychological needs explained in Section 6.2. Different people with different personalities have different psychological needs and require different approaches in order to be motivated[24], some likes to compete while others likes to collaborate[22].

Besides the emotional aspect behind responses to game mechanics, some elements are "in the wind" at the moment. With the increased popularity of MMORPG, Facebook games[25] and socializing through mobiles, a social environment seems to be a must if an application is compete. Affection and power needs are a larger part of social gaming, but not many mobile games have been implemented to exploit the power needs. This might be because the need requires a larger and more dedicated social environment, referred to as a community, which is harder to implement and manage on the mobile platform.

The review performed on existing games and applications to identify popular game mechanics is presented in Appendix A. Sources for the information in the following list is gathered from this review, using user feedback and user comments on Google Play[26].

User-generated content

- Strengths: Enables multiple purpose and customization, the user feels closer to his content and can learn from other content in order to generate better content himself[27].
- Weaknesses: Feedback from the use of Lingobee(Section 5.2.4) made clear that the start of an app with user-generated content, is very slow, and users might leave the app instead of contributing.

Competition

- Strengths: Very motivating and engaging to competitive players.
- Weaknesses: With multi player competition wireless communication is required, which may include spending money on mobile data.

Social environment

- Strengths: Being able to play with friends and make new friends is essential to playfulness and entertainment. It makes the environment a motivational factor in the game context and also a drive for returning to the application later on[25].
- Weaknesses: Feedback after the use of Lingobee made clear that the social environment can feel threatening. Even though functions for social interaction are there, if there is no reason to interact with other people, interaction will not happen[28].

Collaboration

- Strengths: Encourages the use of the social environment and gives it a purpose. Increases quality on content because several users are able to review it[29].
- Weaknesses: Difficult to implement on a mobile device, wireless communication is required, which may include spending money on mobile data.

Quality assurance

- Strengths: Essential in a UGC and social environment. Users must be able to convey what is good and what is bad. A large community is very good at evaluating information, i.e Wikipedia.
- Weaknesses: Some users might be threatened by rating, not wanting to share in fear of being rejected. However, when people are able to reject, one of the psychological power needs comes into play.

Progress

- Strengths: Being able to see progress is a great source for motivation.
- Weaknesses: If the road is long, small steps might feel insignificant because the progress bar is designed incorrectly.

Easy to learn/Good usability

- Strengths: Essential to a casual game. Users do not want to spent time on other things than playing the game and learning. Can also boost learning and make it more engaging[30].
- Weaknesses: Can sometimes be hard to implement because of different types of users with different backgrounds, in addition to there being several different mobile phones.

Puzzles

- Strengths: As seen in several existing games, small simple puzzles can make great entertainment if coupled with one or more game mechanics.
- Weaknesses: Users might also find puzzles very boring, depending on their personality and how te game is implemented.

Word list

- Strengths: Note it or you forget it. Having a note function available can be essential for the user to remember what was just said. In the Lingobee study many used notebooks for vocabulary learning.
- Weaknesses: If the list is not connected to any other function it is likely to not be used and forgotten.

Multiple usages/Multi-purpose

- Strengths: If the game because of it's user generated content approach, can be used for multiple purposes it is likely to maintain a larger user pool.
- Weaknesses: If the different purposes are not separated clearly enough users will get annoyed and frustrated when faced with uninteresting content. This was experienced with Lingobee when users added content in different languages than was expected.

6.1.2 *Social Environment*

A social environment is an environment where it is possible for different users to interact with each other in one way or another. A social environment is not the same as a multiplayer game/environment. A multiplayer game contains a social environment, but this is not necessarily true the other way around.

A social environment in a game can be created in several ways. The social aspect can be included in the game dynamics itself, having cooperation or competition as the main game mechanic or include a chat function, or a highscore table outside the main part of the game. Both methods have proven to work well and increases the enthusiasm of the users in regard to the game[25]. Learning with friends have always been more motivating and fun than the opposite, collaboration helps to bring out aspects and understandings which no user alone would have

figured out, helping others gives the user satisfaction and in that way increases motivation towards the activity[24].

In addition to reasons and methods mentioned in the other game sections, a game today is highly unlikely to be single player. Players expect to be able to play and interact with their friends. This is mostly because of the technological development. The internet is everywhere and a user can be reached through several mediums. Social networks have taken social environments to a whole new level. People are expected to be online and share aspects of their life, and if a game is not suited for this activity it is likely to not be as popular[31].

One of the weaknesses with a social environment is that it can be left unused. If there is no obvious reason for the interaction, i.e what the interaction should be about, the social environment is likely to not be used[28]. In a game design it is therefore very important that the purpose of the social environment is clear.

6.1.3 *Serious Games*

A serious game is a game where education in various forms is the primary goal, and entertainment and fun becomes a secondary goal[32]. Serious games seek to increase the efficiency of learning and increase the motivation for performing educational tasks[33].

Serious games and gamification is two terms often used interchangeably. In this report serious games refer to applications that from the start has been designed and defined as games, and learning thereafter. Gamification is the use of specific game mechanics in an already existing application in order to enhance the experience from using the application[34]. In this context one can understand why the two terms can be used on the same application development. Language learning and vocabulary learning is not easy to gamify. If you make word games or puzzles the words must often already be known by the user in order for the user not to feel the game is too challenging. Other non game mechanics must be in place first in order to learn the user the relevant words, and thereafter a game can be used to store the word and expressions in the long term memory of the user, using repetition, visualization, abstractions, and emotions to enhance the learning and make it easier to remember.

Several practical examples of serious games for language learning exist through the web platform. Some of these are explained in Section 5.2.

6.1.4 *Casual Games*

Casual games have lately increased their popularity because of the trend and spread of games on Facebook[1]. These are games which require little user investment, is simple to learn and can be started, stopped and resumed as the user wants[35]. They do not require a lot of information from the user in order to be played and users regard casual social games as a social environment in their own[31].

The success of Facebook games are likely linked to the blending of the social and the game aspect. The engagement in "fictional" social actions, the use of asynchronous actions, and the combination of public and private actions within the game are three aspects of particular importance[25].

Social casual games is a special combination of both the social environment and the casual game. Since it is a casual game, it is not likely to bring users because of the game story. However, because of the presence of the social environment the 'emotional sphere' where the user and the user's friends live, becomes a lever that pulls users back to the application[25]. The social environment is key to the success of the game, but the social environment is nothing without the user's friends that inhabit it. In the end it is the users that create entertainment and playfulness in a casual social game.

6.1.5 *Mobile Games*

In order to encompass the benefits of the mobile platform into a game, there are some guidelines which should be followed. This list summarizes some of the feedback received by other mobile games.

- Must be playable offline
- Simple yet modern layout and design
- Customizable to fit the user's needs
- Import/export of content
- Easy to learn interface
- Social environment

6.2 PSYCHOLOGICAL NEEDS

In order to motivate the user in a game, there are several psychological needs that are based in human desires which can be exploited[24]. These needs are categorized in six, materialistic needs, power needs, affection needs, ambition needs, information needs, and sensual needs. The sensual need is related to physical stimuli and is therefore not very relevant in an application setting.

1 http://facebook.com

There are several categories of psychogenic needs, which are basic needs in personality. The different aspects of each need is described in the list below[24][35] which represent a framework for identifying what motivates a player in a game context.

- Power needs
  - Aggression: Attacking or ridiculing others.
  - Blame avoidance: Following the rules and avoiding blame.
  - Defence: Obeying and cooperating with others.
  - Dominance: Controlling others.
  - Defendance: Defending one-self after failure.
  - Counteraction: Overcome defeat or failure.
- Materialistic needs
  - Acquisition: Obtaining things.
  - Construction: Creating things.
  - Order: Making things neat and organized.
  - Retention: Keeping things.
- Ambition needs
  - Achievement: Success, accomplishment and overcoming obstacles.
  - Exhibition: Shocking or thrilling other people.
  - Recognition: Displaying achievements and gaining social status.
  - Autonomy: Independence and resistance.
  - Harmavoidance: Escaping from a dangerous situation.
  - Infavoidance: Refrain from attempting something beyond one's power.
- Information needs
  - Cognizance: Seeking knowledge and asking questions.
  - Exposure: Educating others.
  - Understanding: Analysing experience and arrive at generalizations that are comprehensive and verifiable.
- Affection needs
  - Affiliation: Spending time with other people.
  - Nurturance: Taking care of another person.
  - Play: Having fun with others.
  - Rejection: Rejecting other people.
  - Succorance: Being helped or protected by others.
  - Abasement: Confessing and apologizing.
- Sensual need
  - Play: To play games, to laugh, joke and be merry.
  - Sentience: To enjoy sensuous impressions

One can see that these needs are closely related to what games use to motivate and engage the user, and what emotions can be experienced by the user in a game situation. Different game mechanics together with contexts can utilize different needs to motivate the user, this in turn can work differently from user to user. While one user likes achievements because he wants to accomplish something in the game, another might want it so he can receive recognition and fame for what he has done.

From the ambition needs it is also concluded that the user wants to be challenged, without challenge there is nothing to achieve, but with too hard challenges the user has nothing to achieve and motivation goes down. Keeping the right level of each need can prove difficult, as it varies from person to person. A good understanding of the user group and a clear definition of the people in the user group can make it easier to adapt the game difficulty. Another solution can be to let the users themselves decide which difficulty level they want, which includes adding this functionality. It is however also difficult to know where the borders between each level lies.

In the context of serious gaming, gaming for education, motivation is of great importance. These needs are therefore essential if a game for contributing to learning is to succeed in regard to motivation.

6.3 USER-GENERATED CONTENT

As one of the main purposes of the puzzle game is to help the user memorize whatever he needs to remember, the user must be able to add his own content. This implies the UGC aspect of gaming, which comes with both benefits as well as limitations.

The focus in the puzzle game is motivation. The benefit for the contributor is that he then has his own content as a puzzle which he can play. This incentive is behind motivating the users to generate content, but it is likely that not all users will be motivated enough by this.

There are two different incentives, implicit and explicit. The implicit incentives are not based on anything tangible and one of the most common ones is the social incentive. The user feels good because he is part of a community which he shares content to[36]. The explicit incentives refer to tangible rewards. This includes financial payment, entry into various contents, coupons etc. Direct explicit incentives are easily understandable because they have immediate value regardless of the community size. Both incentives strive to encourage user participation. The latter is more costly to implement and the social incentive requires a community of considerate size.

There are some legal issues with using UGC. Many companies has therefore come together to agree on principles regarding copyright and intellectual property[37].

One of the advantages being evaluated in relation to the puzzle game is motivation. It is interesting to see if UGC increases motivation for creating and playing puzzles. Results are summarized in Section 7.4.

UGC is being used for very many different purposes and has been widely known for conveying quality and knowledge. However, no matter the purpose, in order to benefit from quality there must be some form of quality assurance. This is especially true for learning purposes, where the users must trust the content they are to learn. The puzzle game is no exception, quality assurance is done by being able to rate each puzzle, where a low rated puzzle is likely to be deleted.

6.4 GAMIFICATION

This section contains relevant information about gamification as a means to create a serious game.

Earlier gamification was defined as adding game mechanics to an already existing application in order to spice it up a bit. Lately, however, gamification is being defined as the use of game thinking and game mechanics in a non-game context in order to engage users and solve problems[22]. Gamification is used in applications and processes to improve user engagement, data quality, timeliness, and learning. Gamification has grown beyond just integrating game mechanics, and now encompasses all aspects of gaming and it is encouraged to redesign the underlying application in order to make it more suitable as a game. This includes implementation of the elements presented in the next section.

Gamification seeks to leverage people's natural desires, specified as psychological needs. In a more general term people's natural desires are competition, achievement, status, self-expression, altruism and closure. This fits perfectly in to the purpose of the puzzle game, and as the game's main goal is learning, creating the game design is the act of gamifying learning.

6.4.1 *Goals, Rules and Things that Make a Game*

This section shortly explains some of the elements that together creates a game.

GOALS AND RULES are the most basic parts of a game. The player is motivated to play the game by waning to complete a goal. It is goals which separates a game from casual play. Rules are what restricts how the goal can be achieved. They define how the game is played[22][38].

CONFLICT, COMPETITION AND COOPERATION are three elements which games involve. A conflict is in this case a challenge from a meaningful opponent. Often good game design includes elements of all these three[22], and together they create an engaging game play environment.

TIME AND REWARD STRUCTURES are elements which generates a different type of motivation in the player. Introducing a timer makes the player focus on the task at hand and generates a pressure to perform. Reward structures generates an extrinsic motivation in the player. This being to collect badges, receive a high score, or show off on the list of scores[22].

FEEDBACK in games is almost constant. It is the information the player receives about how the status in the game is, it being his score, his progress, the time passed or the success of himself or his fellow players. There are several aspects of feedback that designers strive for, i.e tactile, inviting, repeatable, continuous, balanced and fresh[22][38].

GAME LEVELS with UGC is a complicated element. It moves control of the game level from the designers to the players, as it is the players themselves which generates the content and decides how difficult the content shall be.

CURVE OF INTEREST is the "graph" showing how the player interest or motivation increases or decreases during the flow of the game. It is important that the curve of interest keeps the player interested and continuing to play.

AESTHETICS - art, beauty and visual elements can lift the game experience from good to great.

REPLAY OR DO OVER is an important element of games which makes failure acceptable. This is especially important in a game which promotes or contributes to learning. Failure is important in games because winning a game without experiencing failure or a do over is often a dissatisfying experience for the player[22].

6.4.2 *Gamification Theories of Learning and Instruction*

This section introduces some theories of gamification of learning and instruction and presents how they impact game design.

INTRINSIC AND EXTRINSIC MOTIVATION [22] is the two types motivation is separated into. Intrinsic motivation is when someone performs an activity for it's own sake, for the enjoyment it provides, the learning or the feelings it evokes. Intrinsic motivation often leads to a greater depth of learning. Extrinsic motivated behaviour is, on the other hand, behaviour performed in order to obtain rewards or avoid punishment. The behaviour is performed in order to earn something that is not directly related to the activity.

It is important that both types of motivation is evident in a learning game. In an educational game the intrinsic motivation is most important in regard to contribute the most to learning. The puzzle game expects intrinsic motivation towards the task to be low, but tries to increase this by having the activity performed in a game. The design also utilizes extrinsic motivation in order to motivate further towards learning. In the evaluation of the puzzle game, motivation is evaluated as a general term, meaning intrinsic and extrinsic motivation is less separated. It is however evident that motivation received from the information need is intrinsic motivation whereas most of the other psychological needs are extrinsic.

MOST MOTIVATIONAL MODELS describe both intrinsic and extrinsic motivation and they all conclude with one or more aspects which impacts gamification of learning. The motivational models presented in Table 2[22] are those models which have been counselled when designing the puzzle game. The impact they have on gamification is also presented.

6.4.3 *Types of Play and Players*

There are three aspects of play that games use. These are *competition*, *cooperation* and *self-expression*. Self-expression is giving the player a possibility to exercise their creativity, in creation of something. When designing a game, elements from all these three should be included in order to encourage the most engagement and activity with the gamified content[22][38].

Every person is different, and in the same sense every player is different. Ignoring the small differences one can say that there are several player types. Some players are very competitive, others are more interested in social aspects, and still some enjoys achieving goals the most. A popular classification called Bartle's player types is presented in Table 3[22][38].

This theory about player types backs up the fact that different people enjoys and are motivated by different game mechanics. It is therefore interesting to see how different people in the user group specified in Section 4.3 are motivated (differently) by elements in the puzzle game.

Since the description of Bartle's player types is closely related to psychological needs, Table 4 maps the player types to the psychological needs presented in Section 6.2. The only psychological need not directly covered as the main need for a player type is the materialistic needs, which is the main contributor behind the self-expression game mechanic.

Theory	Impact on gamification
Flow	Continually adapt to keep the learner at constant state of interest. System adapts to the right challenge level for the learner, not too difficult and not too easy
Operant conditioning	Provide appropriate rewards, points and badges on a variable basis to maintain learners' interest
Malone's theory of intrinsic motivating instruction	Include elements of challenge, fantasy and curiosity
Lepper's design principles for intrinsic motivation	Include elements on learner control, challenge, curiosity, and contextualization
The taxonomy of intrinsic motivations for learning	Include internal and external motivational elements such as challenge, curiosity, control, fantasy, cooperation, competition and recognition
Self-determination theory	Provide the learner with the opportunities for autonomy, a feeling of competence, and relatedness with others
Distributed practice	Play out over time to provide spaced repetition of the content within the game
Episodic memory	Evoke learners' emotions to more richly encode the lessons from the game in memory

Table 2.: Theories and their impact on gamification

Type	Description
Achiever	Wants achievement, recognition, status, accomplish goals, only engages in activities which can be used to progress towards a goal, everything they do is a mean to get close to achievements and rewards.
Explorer	Wants to learn everything there is to know about the game environment, learn all the nooks and crannies, experience all surprises (easter eggs) that are hidden in the game, enjoys discovering new things about the game that others don't know.
Socializer	Wants relationships with other players, likes to organize players, enjoy connecting to people through the game environment, the game is only a means to connect with others, like to greet new players nd establish groups.
Killer	Wants to defeat others by killing them any way possible, causing as much disruption and havoc as possible, imposes their ideas or will on to other players and sees their impact on other players as more important than their engagement with the game.

Table 3.: Bartle's player types

Type	Psychological needs
Achiever	Most Ambition needs and the Power need: Counteraction
Explorer	Most Information needs and most Materialistic needs
Socializer	All Affection needs and the Information need: Exposure
Killer	Most Power needs and the Affection need: Rejection

Table 4.: Bartle's player types and psychological needs

Part III

THE GAME

This part contains own contributions in the form of the game design, it's implementation and information about how it has been evaluated.

7

GAME DESIGN

This chapter describes the game design. Firstly, the game concept is presented, thereafter a summary of functionality that the game implements is listed. Lastly, the game play and how the game is to motivate is presented.

7.1 GAME CONCEPT

The concept is based on competition, collaboration and creation. These are all the three elements mentioned in Section 6.4.3. There are two phases in the game, one for collaboration and creation, and one for competing in playing. Users can choose to only create or only to compete if they like to. In that way the game is adapted to a wide set of player types, those who like to create and cooperate, and those who like to compete, see Section 6.4.3. In addition, for single player mode highscores are saved, both for the player and others to see, which appeals to the achiever player type.

The main part of the game are the puzzles, or quizzes. This is what is being created and played. It is a collection of question sets, along with a puzzle name and a category.

The first phase is the collaboration and creation phase. A puzzle can be created using more players. Each of the players in the team are given the edit possibility, which means they can all take part in creating the puzzle.

The second phase is where the puzzles are played. Each user-made puzzle is given a category during creation, which makes them easier to browse. The puzzles themselves are played by answering questions, where the question can be a definition, a synonym or a normal formulated question. The answer is the term relevant to the question which is answered through the input method specified during creation. The time the user spends answering the puzzle is also saved, so there is two values, a time and a score indicating how correct all the answers were answered.

The game is a serious game, but the complexity and the learning curve for learning to play the game, is low so for it to be categorized as a casual game as well. Since the main concepts are competition and collaboration, the game also promotes a social environment.

7.2 FUNCTIONALITY

As explained in the previous section, the main game mechanics are competition, collaboration and creation. In order to glue the two different game phases and the different game mechanics together, some small additions are added. Among other things the puzzles are rateable, single player mode can be played offline, and a personal word list is available for use.

The different game mechanics are described in Table 5, and how they are implemented is also described. The additional functions are listed in Table 6.

Game mechanic	**Description**
Collaboration	Multiple players can together create a puzzle.
Creation/Self-expression	The puzzles are created by the users.
Competition	The puzzles are both played and created through competition. The best puzzles are showed in a list, and the scores of each user on one puzzle is displayed in a highscore list.
Game modes	The puzzles can be played as single player or different types of multiplayer.
Time	The playing of a puzzle is timed in order to pressure the user to answer as fast as possible.
Reward structures	Players are given a score and a time on their played puzzles, and a rating and times played on their created puzzles.
Feedback	Each puzzle can be rated which is how it can achieve a spot in the best liked puzzles list. In addition, after the user has played through a puzzle he gets to see information about each question set he answered.
Aesthetics	A simple design is used, with clean colors and the use of black and white.
Replay	The puzzles can be played as many times as the user wants, only the highest score is saved.
Game levels	Since the content is UGC based, there are likely to be several game levels available between each puzzle.

Table 5.: Game mechanics and their implementation in the game

Using design principles and routines learned in User-Interface design[39] courses and developing an architecture as learned in Software architecture[40] course aided both development and interface design. Getting feedback

Functionality	Description
User-generated content	The puzzles are generated by the users themselves.
Word list	Each user can store words in a word list which can be used during puzzle creation.

Table 6.: Additional functions

and having real users test the game also made it easier to focus on what the users felt was important.

7.3 GAME PLAY

The game play is described through state diagrams. Figure 4 describes the creation and collaborative phase where the puzzles are made. Because a puzzle can contain several questions and users can participate at different times, the puzzle can be temporarily saved and published at a later point. This makes it easier to collaborate and the puzzle quality is expected to be better if creation is done iteratively by many people.

Figure 5 describes the actions when the puzzle is played. How the questions are answered is based on the puzzle mode. If it is a single player mode it is straight forward, but in a multiplayer mode there are two types, time based and turn based. A player can also choose between playing against a friend or letting the system choose who to play against.

Because of the time constraint the entire game design has not been implemented. The parts of the state diagrams which are in grey have not been implemented in time for evaluation, but are nonetheless included in the evaluation through discussion and interviews.

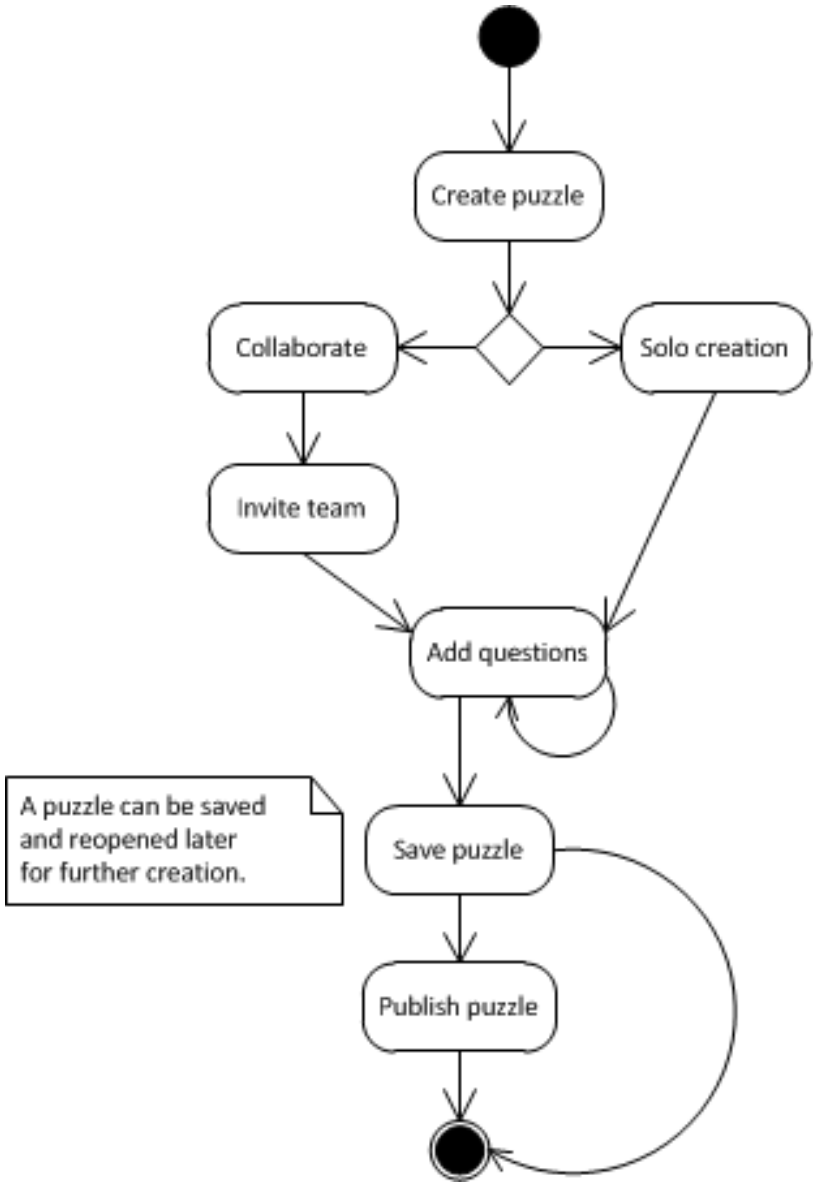

Figure 4.: Game play during the creation phase

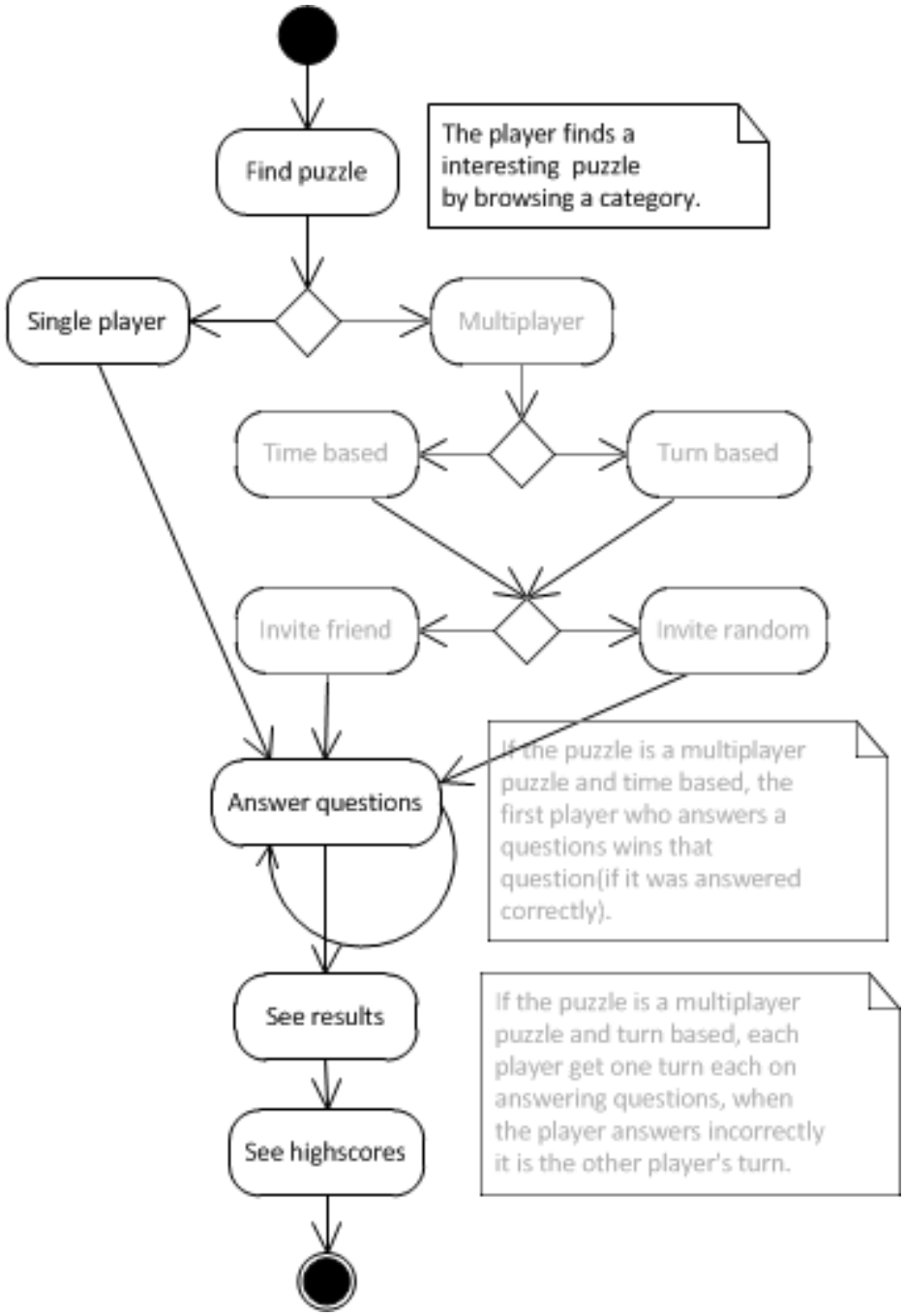

Figure 5.: Game play during the competitive phase

7.4 MOTIVATION

The most important part of the puzzle game is to motivate it's user to perform rote learning. In order to achieve this goal the theory of psychological needs, see Section 6.2, are incorporated as a part of the chosen game mechanics and functions.

7.4.1 *Creation and collaboration phase*

In the game users are motivated to contribute by making puzzles and satisfying the psychological needs listed below. The list reflects what is possible for a user to feel during the creation phase, which not necessarily every user experiences. The list also shows incentives to participate in the social environment, which is a large part of the collaboration.

- Power needs
  - Defence: Obeying and cooperating with others when creating puzzles. The social environment encourages discussions regarding the puzzle being made.
- Materialistic needs
  - Construction: Creating a challenging puzzle.
  - Order: Making things neat and organized. Making the puzzle easy to understand and correctly structured.
- Ambition needs
  - Achievement: Success, accomplishment and overcoming obstacles. Creating a popular puzzle earns success.
  - Recognition: Displaying achievements and gaining social status. Creating a popular puzzle earns the creators a place on the most popular puzzles list. Other puzzles they have made then becomes more easily recognized.
- Information needs
  - Exposure: Educating others through making a challenging and good puzzle.
  - Understanding: Analysing experience and arrive at best possible puzzle that is comprehensive and verifiable.
- Affection needs
  - Affiliation: Spending time with other people when collaborating and in the social environment.
  - Play: Having fun with others during discussions in the creation of the puzzles.

7.4.2 *Competition phase*

During the competition and play phase the users are encouraged to play the puzzles through the set of psychological needs presented in the list below. As in the previous list the needs identified are all those that are possible for a user to experience, but no user is likely to experience all of them since every user is different.

- Power needs
  - Aggression: Attacking or ridiculing others. Through a competitive environment.
  - Counteraction: Overcome defeat or failure after loosing a puzzle.
- Ambition needs
  - Achievement: Success, accomplishment and overcoming obstacles.
  - Exhibition: Shocking or thrilling other people.
  - Recognition: Displaying achievements and gaining social status.
- Information needs
  - Cognizance: Seeking knowledge and asking questions.
- Affection needs
  - Affiliation: Spending time with other people.
  - Play: Having fun with others.

The needs in the competition phase are different from those in the creation phase. This shows that the game encourages different types of people to participate, which in turn realizes the requirement that the game should encourage a wide range of different users, students, to participate. Both the creation and the competition phase contributes to rote learning, though through different methods.

7.4.3 *Implementing Psychological Needs*

This section presents the connection of game mechanics presented in Section 7.2 and the psychological needs presented in the previous subsections.

This is the expected mapping between needs and game mechanics, which needs which are truly experienced by the users is presented in Chapter 10.

Game mechanic	Psychological needs
Collaboration	Affection and Ambition needs
Creation/Self-expression	Materialistic and Information needs
Competition	Power and Ambition needs
Time	Ambition needs
Reward structures	Ambition and Information needs
Feedback	Information needs
Replay	Ambition needs
Game levels	Information, Materialistic and Ambition needs

Table 7.: Mapping between game mechanics and psychological needs

7.4.4 *Curve of interest*

As one of the basic elements in a game mentioned in Section 6.4.1, the curve of interest must keep the player in the game throughout game play. A curve of interest might be different from user to user, and it is therefore created when performing the evaluation of the game. The motivational curves can be seen in the two first paragraphs in Section 10.3. As shown the different users have different curves.

8

GAME IMPLEMENTATION

This chapter presents notes on the implementation of the game. Firstly, the requirement specifications are listed, followed by a presentation of the architecture and lastly, images from the game and a discussion in the implementation is presented.

Because of restrictions regarding time not all of the game mechanics and requirements have been implemented. The parts presented in grey or written in italic are parts which has not been implemented.

8.1 FUNCTIONAL REQUIREMENTS

This section contains functional requirements extracted from the game design. The italic requirements have not been implemented, but nonetheless evaluated in the interviews and questionnaires, see Chapter 9.

Table 8 lists the functional requirements.

ID	Description	Priority
F1	*The user is able to save words in an internal word list*	*Medium*
F2.1	The user can create a puzzle by providing puzzle name and category, questions and answers	High
F2.2	The user can create a puzzle together with other users	High
F2.3	The puzzle can be saved and reopened later	High
F2.4	When the puzzle is published it is open for play by users	High
F2.5	*After a puzzle have been published it is open for editing for 7 more days, editing means no additions can be made*	*Medium*
F2.6	Only the person or group of persons that made the puzzle can edit it	High
F2.7	The puzzle author can choose how a question is to be answered, written, multiple choice types, drop-down	High
F2.8	*The user can use words saved in the word list when creating a puzzle*	*Medium*
F2.9	The puzzle has a category *and two key words*	Medium
F3.1	The user can have a friend list	Low
F3.2	The user can add friends by user name	Low

F4.1	The user can rate a puzzle	High
F4.2	If a puzzle has received 15 ratings, have been published for at least 2 weeks and is below a threshold it is deleted	Medium
F5.1	A puzzle can be played solo *or against an opponent*	High
F5.2	*If a puzzle is to be played against an opponent it can be time or turn based*	*Medium*
F5.2	*A puzzle can be played against a friend or a random person*	*Medium*
F6.1	The user receives a score and a time after having answered a puzzle	High
F6.2	The score is based on how correct the answers were using Longest common subsequence	Medium
F7.1	The server stores the ongoing creation of puzzles that are done collaboratively	High
F7.2	The server stores the puzzles which have been published	High
F7.3	The user can browse for a specific puzzle on the server	High
F7.4	The server maintains a highscore list for each puzzle, best users	Medium
F7.5	*The server maintains a most played list for each user*	*Medium*
F8	When a puzzle has been fetched from the server it can be played offline in single player mode	High

Table 8.: Functional requirements

8.2 NON-FUNCTIONAL AND GAME REQUIREMENTS

This section contains the non-functional requirements and the game requirements. The non-functional requirements regards attributes like usability, availability, performance and maintainability. Game requirements are special requirements directed to the game experience. These requirements regard attributes like playfulness, fun, emotions, engagement and motivation.

Table 9 lists the non-functional requirements and Table 10 lists the game requirements.

ID	Description	Priority
N1	The game must be easy to learn	High
N2	The puzzles must be easy to create	Medium
N3	Interaction with the game must be logical	High
N4	The user interface must be modern *and colorful*	High

Table 9.: Non-Functional requirements

ID	Description	Priority
G1	*The puzzles must be fun to play*	*High*
G2	The cooperation when creating the puzzles must be easy to conduct	Medium
G3	The competition must be fair	High
G4	*The user must be able to compete with others*	*High*
G5	The user must be able to collaborate with others	Medium
G6	The game must be engaging	High

Table 10.: Game requirements

8.3 QUALITY REQUIREMENTS

The game design has certain requirements in regard to quality. As discovered through the analysis of existing mobile apps and games, see Appendix A, technical issues and user interface have a large impact on how the users evaluate the applications. Non-functional requirements are focussed on usability and the main quality requirements therefore becomes availability, usability and modifiability.

High availability means the game does not crash or halt because of technical errors. This in turn means that the development and the testing of the game must be thorough, and in order to easily fix technical issues the code should be as modifiable as possible. This is where the modifiability quality comes to play. High modifiability means the code is separated into logical components and modules so that dependencies are easily followed and fixes are less likely to cause errors at other places in the code. It also means that code conventions regarding variable and method names, as well as code comments, are followed.

High usability means the game is easy to learn and easy to interact with. This includes a good user interface and a good interaction model. Functions and game play are logical in regard to what the user expects. Since usability is evaluated from the user's eyes, development has been performed with user involvement and user feedback.

Table 11 contains a short overview of what measures are to be taken in order to increase the quality in regard to the different attributes.

ID	Description	Attribute
QA1	Low amount of dependencies	Availability
QA2	*Error log to be sent to developer*	*Availability*
QM1	Clear separation of code in modules and packages	Modifiability
QM2	Use of interfaces and generalizations where possible	Modifiability
QU1	In game tutorial	Usability
QU2	Simple user interface design	Usability
QU3	Support multiple screen resolutions	Usability

Table 11.: Quality requirements

8.4 ARCHITECTURE

This section presents the architectural[40] drivers, tactics, and patterns used and implemented.

8.4.1 *Architectural Drivers*

This section presents the architectural drivers.

8.4.1.1 *Technical Constraints*

This section contains the architectural drivers derived from the constraints related to components and technology used in this project.

- Android Operating system
- Android phones: Different hardware and screen sizes
- Touch screens: User interface design must be designed with focus on input methods and how to most easily navigate.
- Java programming
- Server framework (Restlet) and database setup (MySQL)

8.4.1.2 *Business Constraints*

This section contains the business constraints related to the game development. The business constraints promotes focus on usability and easy modifiable architecture.

- Time available: Constraint on how much time is available to do development before user evaluation must start. Means the most basic functions are implemented first, so the game can be evaluated even though not everything is implemented.
- Platform for development: If only Android is to be supported this enables a more free development process.

- Inexperienced developer: Little experience with Android programming, but decent experience with Java programming.
- User group: How reachable and willing to perform usability tests the user group is has a large impact on number of testers and evaluators.

8.4.2 *Architectural Tactics*

This section contains the architectural tactics and thoughts on how to achieve the different qualities.

- Availability
  - Keep as few processes and threads as possible in order to avoid complex data flow that can reduce availability and in worst case make the application crash. Gather all methods that communicate with the server in one method, the IntentService. Android then automatically handles threads.
  - Make sure race conditions does not happen. This is also mostly handled by Android objects.
  - In order to increase availability in the eyes of the user, the user must always be informed about what the system is doing, so that he knows that it is working. Means that progress dialogs and bars are implemented.
  - Reduce what is sent through the net, so that it takes less time to send/respond and in that way increase availability.
- Modifiability
  - Localize modifications: When a modification has to be made it should only be made in one or two places. This is often not possible if at the same time as few dependencies as possible is requested. A tradeoff between the two has to be found.
  - Prevent ripple effects: When a modification is made, it shall not create effects that make other parts of the system fail or work incorrectly. This means that proper code conventions are to be used so the developer understands what each method does.
- Performance
  - Multithreading is practically a must on Android when having to communicate with a server. Android applications are easily made so update tasks are run in the background.
  - Network latency also affects performance, and network traffic should therefore be kept to a minimum. XML is used as the communication medium, it is text based and should not cause too much network to be used.

8.4.3 *Architectural Patterns*

In this section the architectural patterns are described. The primary quality attribute for this implementation is usability. Second quality attribute is modifiability. Architectural patterns has been chosen to support these qualities.

8.4.3.1 *Layered*

A layered architectural pattern divides the parts of the system into different levels of abstraction. Each level cannot use procedures in the levels above it, but any of the levels below. This architecture is a call-and-return type which means that higher level layers call lower level procedures which simply returns a value.

Programming an Android application means the user interface is created in XML files, whereas the logic managing each screen is is Android Activity java classes. Communication with the server is done in an IntentService object, also communication with the local database is through a Content/SQLiteOpenHelper object. Each of the parts of the layer have specific permissions regarding who they can communicate to. This means that the natural way to design an Android application is through realizing the layered architectural pattern.

8.4.3.2 *Client Server*

The smart phones running the game connects to the server through a client server set up. This means one server is servicing several clients. This set up is however prone to scalability issues. To prevent this the server must be stateless. This means all information regarding the state of the puzzles(whether they are published or not) must be saved in the database and not stored locally on the server.

8.5 ARCHITECTURAL 4+1 VIEW MODEL

This section contains the 4+1 view model[41][42] for presenting the puzzle game architecture. This consists of logical, development, process and physical views, followed by the use case.

The logical view is represented by one or more Unified Modelling Language (UML) sequence diagrams showing the internal logic when a function is requested by an actor, in this case the user of the smart phone. The development view is presented as a UML class diagram and shows the composition of the applications using packages. It also represents the layered architecture pattern. The process view is presented as a UML activity diagram, showing how data flows internally in the clients and between client and the server. The physical view is a simple UML deployment diagram showing how the client server architecture pattern is realized and also the communication protocols used.

8.5.1 *Logical View*

One of the more interesting logical views is when a created puzzle is published, shown in Figure 6. The user clicks the publish button which asynchronously communicates with the server. The server stores the publish date and responds to the client that the publishing was successful, only then does the client update his local database with the publish date.

If the puzzle to be published was not created collaboratively the entire puzzle would be sent to the server to be saved. A puzzle created through collaboration is stored at the server each time a collaborator adds question sets.

The layered architectural pattern is partly visible in this view. The layout XML files are not shown, but they are fetched by the CreateActivity, and it is clear that only UpdaterService can communicate with the server.

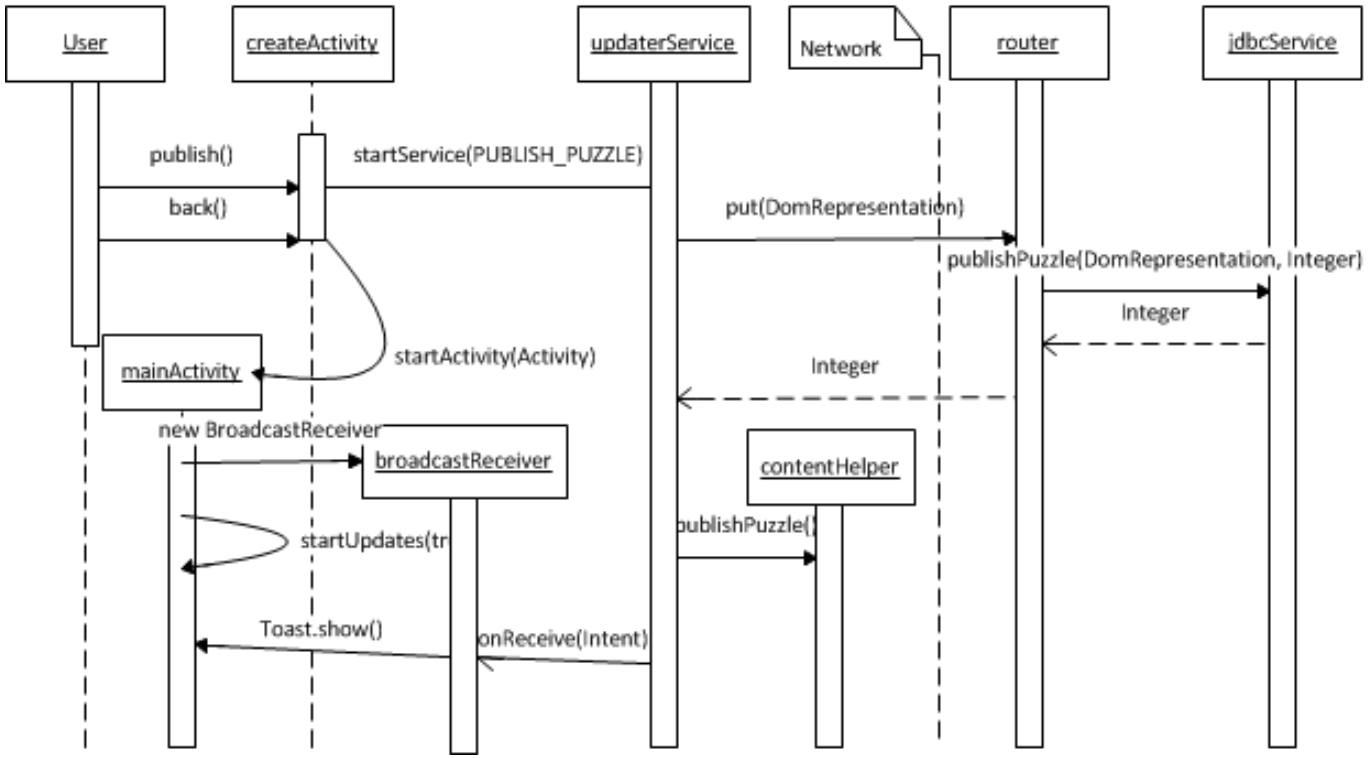

Figure 6.: Logical View

8.5.2 *Development View*

Figure 7 shows the class/package diagram generated from the Android application project. The application is built up by two packages, one main package where all the activities reside. Activities are classes which belong to a specific screen and it is recommended that each screen has one activity. The other package is a helper package containing classes that manages network communication, list adapters, XML generators and database communication.

It is the UpdaterService class which manages network communication. Each activity requiring to send or receive information from the server requests this feature from the UpdaterService. The class performs it's functions in a separate thread and broadcasts results once it is finished. Each Activity which listens to this broadcast has an internal BroadcastReceiver object which filters out those messages relevant to that particular class, see Figure 6. In this way communication with the server is performed in the background and the user is not disturbed by it. When the user have to wait for server feedback he is presented with a ProgressDialog, so that he understands the application is still functioning as it should and that it is not possible to continue until an answer from the server has arrived.

What is hard to see from the development view, but is very important, is how Android activities are created and initialized at runtime by other activities. In the diagram it seems e.g that PlayActivity does not require any information from local or external services, but this is not the case. However the activity which sends the user to PlayActivity also sends information required to initialize it. In this case MainPlayActivity fetches the question sets which are to be played and sends it to PlayActivity once the user clicks start, see Figure 13. This technique is used throughout the application and is a common way for activities to communicate information in Android.

The same is not true e.g for QuestionSetActivity, where it explicitly uses local storage to save what is created and check whether something old has been changed.

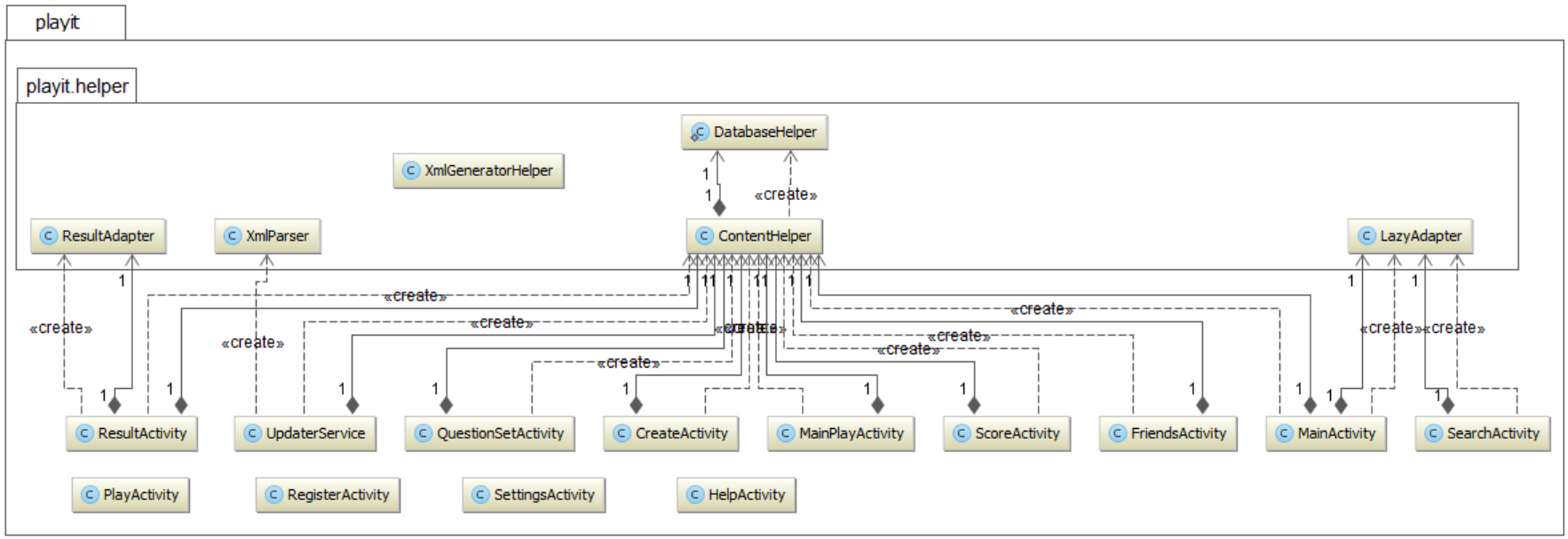

Figure 7.: Development View

8.5.3 *Process View*

The process view displays how data flows in the application and is here conveyed using an activity diagram shown in Figure 8. The importance of a process view in this case is that an Android application uses background tasks for many of it's core functions and it is exiting to model how this works.

Figure 8 displays the data flow when the user first searches for a puzzle to play, and thereafter plays it. If the client does not have an internet connection, the puzzle can only be played if it has previously been stored locally. After having played the puzzle other functions are communicated to the server including updating rating, times played and scores. In those cases the server does not return any information of value to the client, only an indicator of whether the update was complete or not. If a rating did not go through, the rating is not saved locally either, meaning the user can rate again. A score is likewise not updated if the old score on that puzzle achieved by the same user was better.

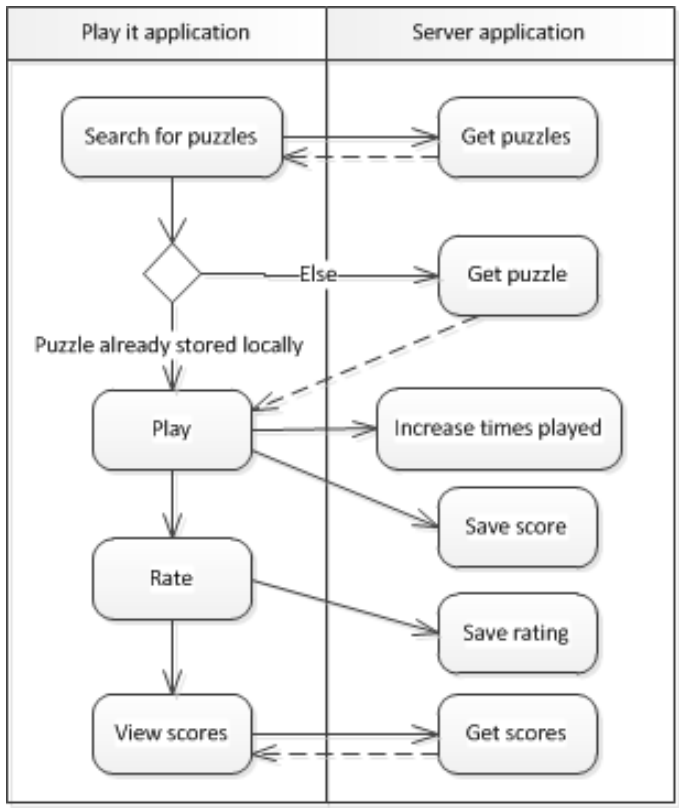

Figure 8.: Process View

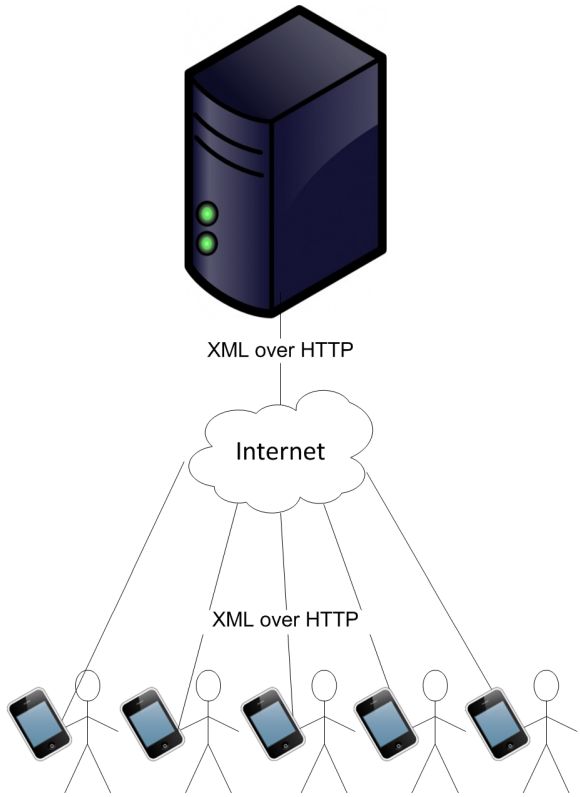

Figure 9.: Physical View

8.5.4 *Physical View*

The physical view shown in Figure 9 models how the client server architectural model is implemented. This consists of the Android smart phones which are the clients, and the Ubuntu VM which is the container of the server application.

8.5.5 *Use Case*

Figure 10 shows the game's use case with the main functions and activity flow. The middle use case is the server, which controls storing and fetching of puzzles, as well as maintaining metadata regarding each puzzle. The social environment is created by adding friends and acquaintances, or people that have made puzzles that the player likes.

The use cases create and play puzzle both have several internal functions which for clarity are not shown in the figure. The parts of the use case which is drawn in grey have not been implemented, but is nonetheless evaluated as a part of the game design.

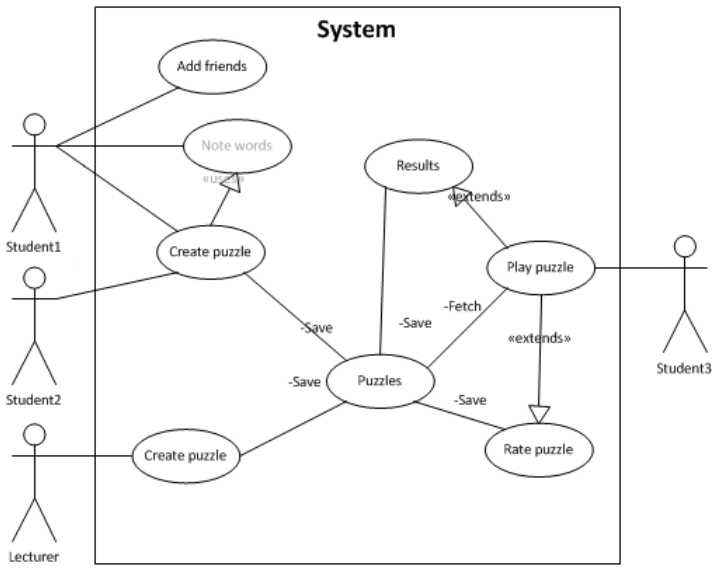

Figure 10.: Use case

8.6 INTERACTION AND GRAPHICAL USER INTERFACE

The application is organized in a simple way. The first screen the user sees when he is already logged in is a screen with three tabs. Each tab corresponds to a set of puzzles, created, played, or requests. Figure 11 shows the first screen along with the available options menu, the screens which some of the options leads to is presented in Figure 14.

Figure 12 shows the creation procedure. Firstly, the puzzle name and category is specified, thereafter question sets are added. When question sets have been added the publish puzzle functions is revealed.

Figure 13 shows the screens when playing the puzzle. The first screen informs the player about the puzzle, who made it, when was it published, what rating does it have and how many times have it been played. Each question with it's corresponding input method is then presented one after another, followed by a review page where the user can see what the questions were, what he answered, if he used a hint, what the achieved score was and what was the correct answer. In this page the user can also rate the puzzle if he has not already done so, and see scores from everyone who has played the puzzle, see Figure 14.

Figure 14 shows the rate dialog, the highscore page, the search page and the help page. Highscores can be filtered on only your friends, making it easier to compare your score with those you want to. Searching is performed by providing a category. The help page has three tabs, one general, one tab for the creating and one for playing the puzzles.

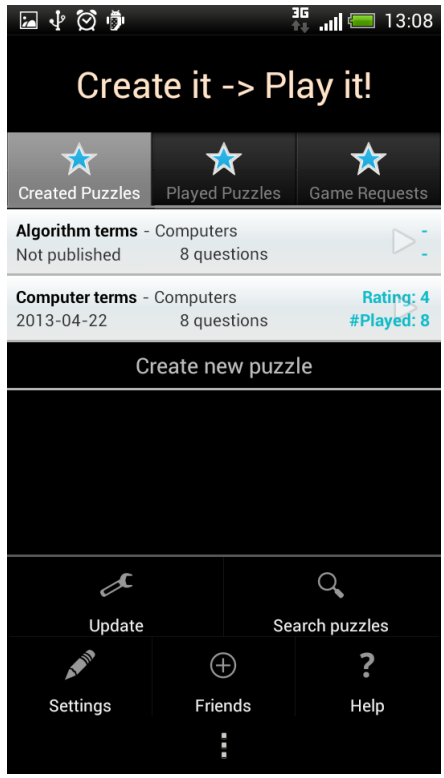

Figure 11.: Main screen and options menu

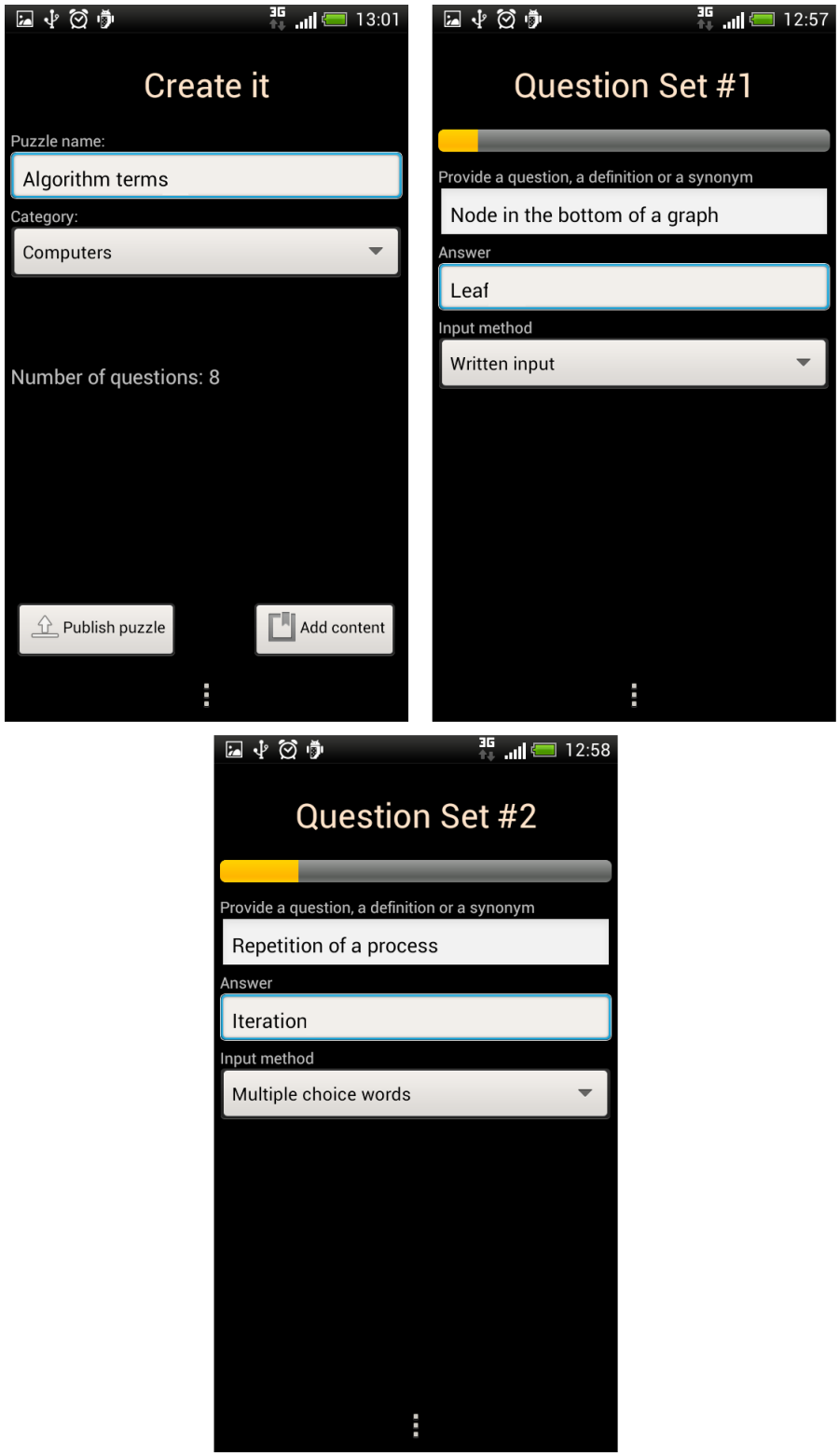

Figure 12.: How to create puzzles

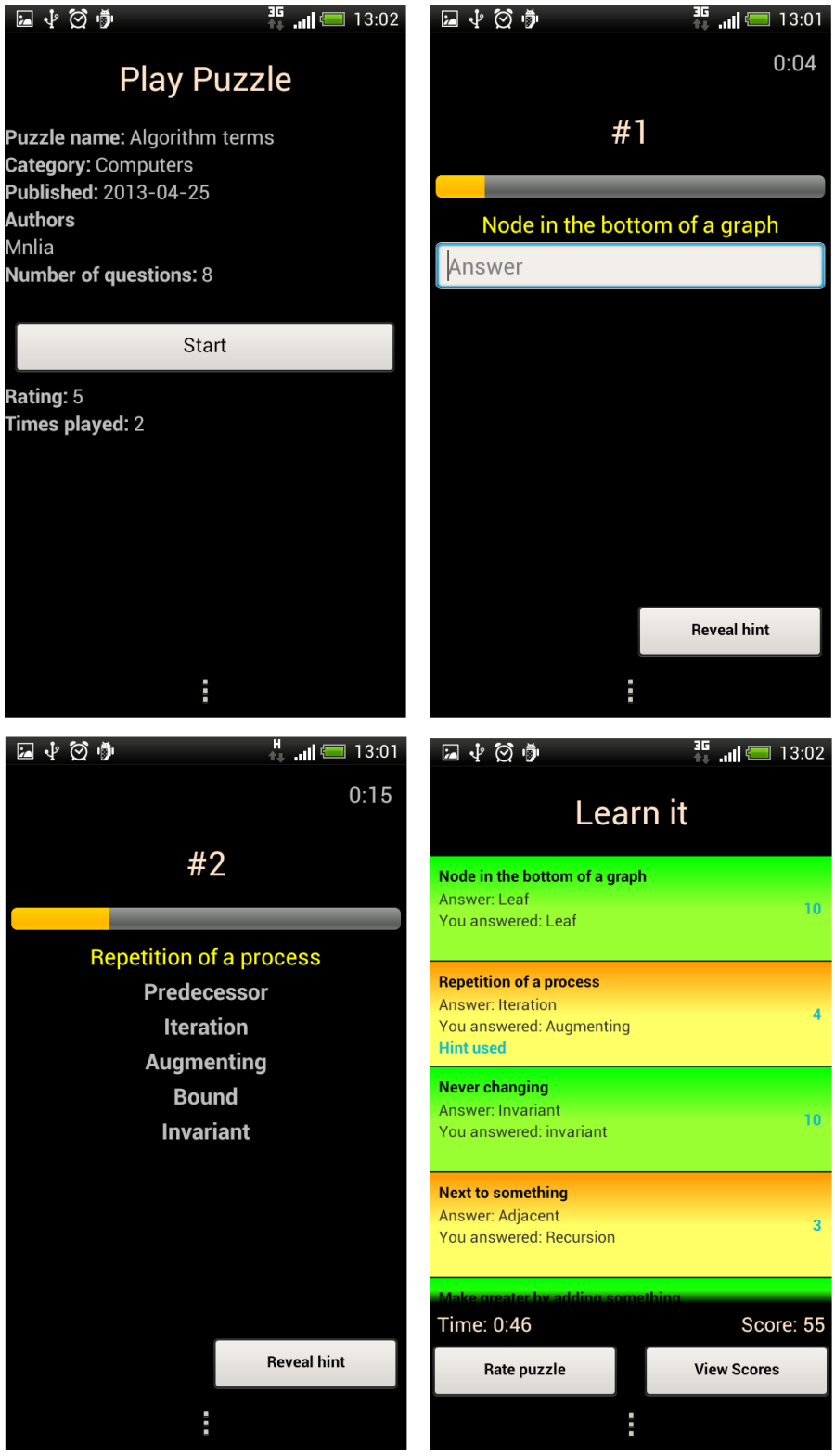

Figure 13.: Interaction when playing the puzzle

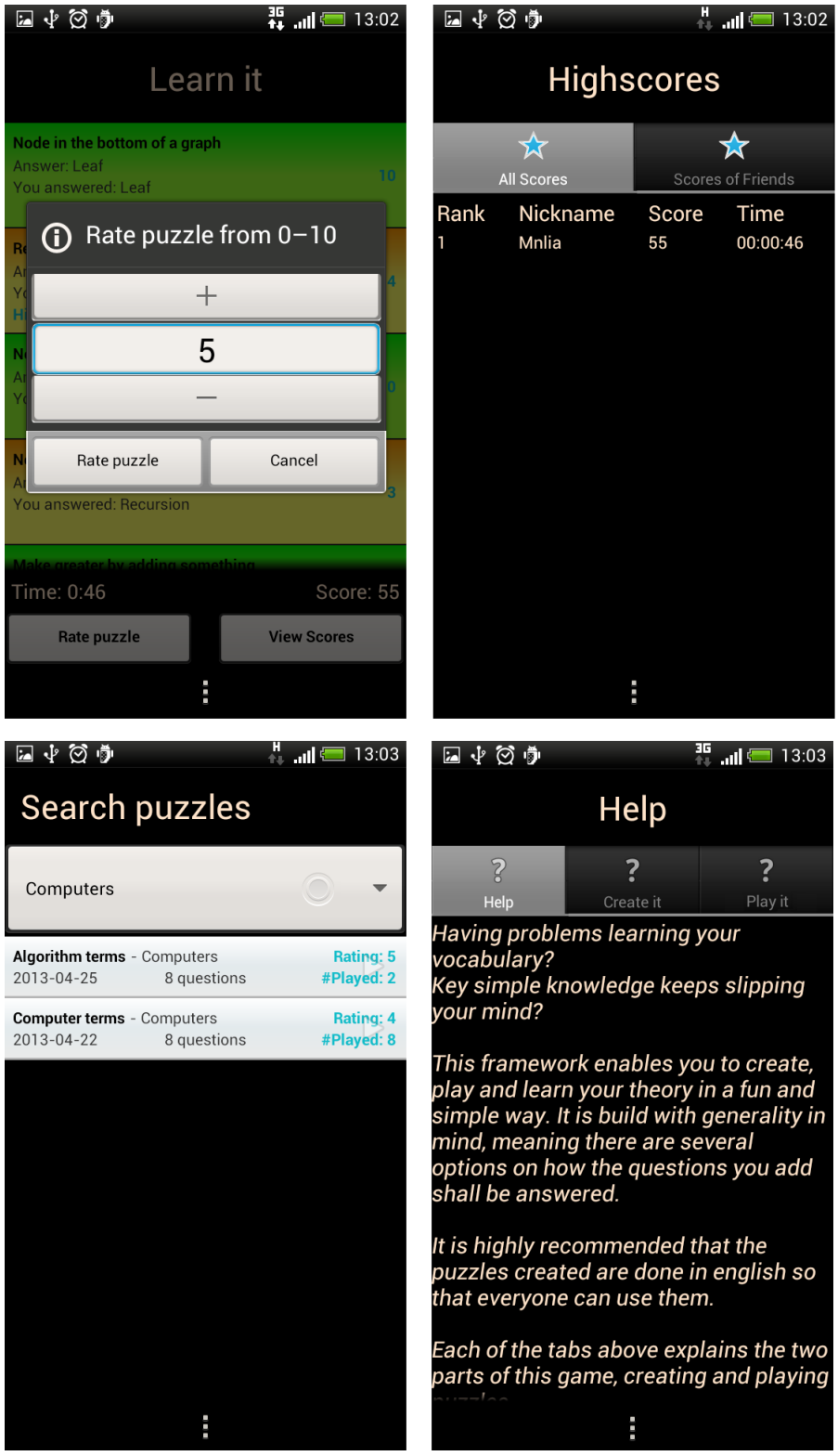

Figure 14.: Rating, highscore, search and help screens

8.7 DISCUSSION

As seen it is only the client's architecture which has been presented. This is because it is the only application of importance when it comes to evaluation and discussion game mechanics, psychological needs and how they have been implemented.

The server application is basically a stateless database connector. The only thing it does is to parse and save incoming information, retrieve requested information, parse it to XML and send it back to the client.

When it comes to the game there are some functions presented in Chapter 7 that have not been implemented. This has also been laid out in this chapter as those parts presented in grey or written in italic. The impact of this is that the evaluation of the game is conducted a little different. Both the implemented game and the concept must be evaluated. The functions not implemented are word list, game requests, input methods, and most played/popular puzzles list. In addition to that the collaboration feature has been evaluated as if it was not implemented, this is because evaluating collaboration takes more time and effort from the users and the project than was available.

Disregarding the functions that have not been implemented, the implementation itself is not as robust as one would like regarding having the application used in real world setting and on an everyday basis. The simplicity of the server application also has it's drawbacks when it comes to performance and robustness. It is likely it would not have managed a high number of simultaneous users.

Because of these drawbacks in the implementation the evaluation must take care when letting users test the application and make sure every functionality is working as expected in that scenario. With technical errors making users frustrated and irritated the evaluation results can suffer.

9 GAME EVALUATION

This chapter presents the methods used for and some of the results achieved, when evaluating the game design. The design was first evaluated in the specialization project, and the results from that is summarized in Section 2.1. After that the design was revised and implementation started. After a working prototype was built two users got to test it out and game feedback on flow in the application and general design. Then the implementation was finished as much as possible followed by the framework analysis and user evaluations as presented in this chapter.

Firstly, the results from the use of the framework presented in Section 5.1 is listed, followed by a discussion on the results and the method. Thereafter the interviews performed on users of the game are presented and categorized in the same way as the research questions in Section 2.2. Lastly, a discussion on how the game design and psychological needs have been evaluated is presented.

9.1 COMPONENT ANALYSIS

This section contains the results from using the framework explained in Section 5.1. Each paragraph explains one of the three parts an educational game must consist of[6]. The evaluation is performed with the problem description presented in Chapter 4 in mind, and the scenarios elaborated on there. Use of the game is performed as in those scenarios and the respective user type is described in Section 4.3.

The main goals with using this framework is firstly, to get a thorough understanding of how learning contributions are achieved through the game, and secondly, to answer some of the research questions which are not directly connected to user motivation, but connected to learning contributions. This means research question number one and it's sub questions.

COMPONENT 1: LEARNING OBJECTIVES

1. What knowledge or skills do student/players need to have before starting the game?

Need to be familiar with the topic he wants to revise and the words he finds difficult. Only having heard them in a lecture or from fellow students is enough.

2. What knowledge or skills can student/players reasonably be expected to learn from the game?

Students are expected to memorize the words and vocabulary they set out to learn. They are also expected to learn how to define words, how to most easily recognize the meaning of words and how to organize words.

3. What knowledge and skills might they learn that go beyond what they actually encountered in the game?

Students might find it easier to use the learned vocabulary and be better at communicating in the learned vocabulary. They might also be more engaged in lectures and get more out of the lectures themselves because they understand a greater part of what the lecturer is trying to convey to his students.

COMPONENT 2: MDA Since this component is focussed on the game itself, the evaluation is only used on the challenge phase, when the puzzles are being played.

- Mechanics

The basic components that are being used in the challenge phase are a timer, hint function, input methods which has specific ways of being used, score achievement, and highscore list.

- Dynamics

The dynamics resulting from applying the basic components mentioned are time pressure and achieving a score.

- Aesthetics

The aesthetics which are likely to arise are challenge and fellowship.

COMPONENT 3: INSTRUCTIONAL PRINCIPLES This component consists of connecting research-based principles[12] for instructional design, to the learning aspect of the game. This is most definitely the most unfamiliar component regarding this thesis seeing as focus is game technology first and learning second.

Learning principles has been retrieved on two topics: Process of remembering[1] and Practice at retrieval[2].

The learning revised through this puzzle game is first learned in a specific situation, e.g in a lecture, while studying alone, or when asking someone for help. This situations enables the learner to perform

1 http://www.psyc.memphis.edu/learning/principles/lp8.shtml
2 http://www.psyc.memphis.edu/learning/principles/lp3.shtml

memory retrieval more easily by remembering the situation where the learning occurred. By choosing those topics that the learner finds most important he will learn to recall those elements which are important, and revision will not lead to selective "forgetting". Though, in order to know which topics which are important, the learner must retrieve curriculum and key notes from the lecturer and other reliable sources.

The other key learning principle is practice at retrieval. This is the key activity which the puzzle game performs. Together with the situational learning, the revision through the game is attempting to transform rote learning into meaningful learning by making the learner think about the situation where he was first introduced with the knowledge. In addition the retrieval is performed repeatedly, perhaps in varied context because of it being available on a mobile device, which enables the learner to strengthen his access to this information.

9.1.1 *Discussion*

Based on what this framework was made to evaluate and which games it was made with thought of, this game design might not be best evaluated by this framework. It did however increase insight into the game mechanics and the learning principles which the game utilizes, and in which degree and how it utilizes them.

The way the framework has been used here did not always include the creation phase. In itself the creation phase is not a game or a game mechanic, but together with the play phase it is likely to effect both play, learning and motivation. Since the framework did not always include this part it is important to thoroughly evaluate the effect it has on learning and motivation through the questionnaire and interviews.

9.2 INTERVIEWS

This section presents the evaluation procedure and some results for evaluating the game design and game implementation through interviews. The interviews were conducted as a side note from the questionnaire and much information which the questionnaire did not catch was brought up during the interview.

The interviews was the main evaluation method for understanding how the psychological needs and the game mechanics mapped together for each of the users. The main goal was to understand how and in what way the user felt the game mechanic exploited different needs and how they affected motivation. After having mapped this, it was interesting to see if there was any personal commonalities between the users that could explain why they felt they were having different needs exploited on different elements, or any other differences.

The results of the interviews and the second questionnaire(Q2) is presented in Section 10.3.

9.2.1 *Game Design*

The game design was evaluated through use of the puzzle game. Every user went through an description of the scenarios and how the user identified himself in the scenario was discussed, whether it was a likely scenario or not, and if not how it would be changed to fit the user.

Questions one through 20(Q2) in the second questionnaire presented in Appendix B, regarded the game design. Firstly, attitudes towards the game itself, the scenarios and the designed game mechanics were evaluated. Thereafter the user' opinions towards the design in it's whole and psychological needs was identified.

Questions 21 through 24(Q2) evaluated what the users thought about using games for learning and learning activities in general.

9.2.2 *User-Generated Content*

Questions 25 through 27(Q2) regarded the use of UGC in games, and in particular the presented game design. With this topic the users were interested in how it would work in regard to quality assurance and content distribution, and discussions arose.

9.2.3 *Psychological Needs*

Psychological needs and their mapping on game mechanics is a difficult topic to evaluate. Aspects of user needs were picked up during the entire evaluation and especially when having to evaluate if their motivation would increase/decrease on given game mechanic. In those cases users would often explain or be asked to explain, in which way the game mechanic would increase motivation, and in which way it would not.

Users were also asked which need they felt were appropriately connected to each game mechanic, but as users were unfamiliar with psychological needs and found it hard to express where the motivation came from, they at several occasions gave mixed and almost contradicting answers.

9.3 DISCUSSION

The evaluation procedure is both based on user feedback and opinions, as well as using a technical framework for educational games. The research questions indicates a more subjective evaluation is needed. They are mostly concerned with what the users feel and think about different aspects of the game, games for learning and UGC.

This means that the interviews and the questionnaires are more likely to answer the research questions than the component analysis, but the

component analysis sheds light on how learning is performed in the game, what can be expected as a direct learning result and what can be a bi-effect learning wise.

One of the weaknesses with this evaluation approach is that it might require a lot of users to participate, in order to thoroughly get the game design evaluated. Since the evaluation is performed as an interview this requires a lot of time and might not be possible within the time available. In order to not make that too large a weakness a general questionnaire regarding the more general research questions is also used, in order to get a more general view on what the user group thinks and feels about the topic in question. The results from all these evaluation activities are presented in Chapter 10.

The reason for choosing this type of evaluation is based on how similar games and applications have been evaluated, as presented in Chapter 5. Those application achieved results by using users as their main resource and also used questionnaires or a form of question-answer approach to achieve insight in user opinions.

Part IV

RESULTS

This part presents the results, the evaluation and the conclusion of the thesis.

10 RESULTS

This chapter presents the results from both the evaluation framework, the two questionnaires and the interviews. Firstly, the evaluation framework results are presented. Thereafter the results from the questionnaire regarding general use of games and opinions towards games and UGC for learning are presented(Q1), followed by the results from the interviews and the corresponding questionnaire(Q2). Lastly, a discussion on the results in relation to research questions is presented.

10.1 FRAMEWORK

While performing the component analysis as presented in Section 9.1, it was clear that the learning contribution the puzzle game attempts to facilitate is hard to specify. This is probably because it is based on UGC, and the learning material is different from user to user. Despite of this difficulty performing the analysis, the learning aspects and learning principles which the game is based on was identified. This being memorizing previously learned knowledge by using repetition of a quiz.

The other aspect of the component analysis was that the MDA framework which attempted to analyse which game mechanics lead to game dynamics and game aesthetics. This was also difficult because the game mechanics used in the puzzle game were both simple and few.

Lastly, it was clear that the puzzle game utilizes research-based learning principles which facilitates how to remember and how to learn to retrieve remembered knowledge. These principles are in accordance to what are the learning goals of the game.

10.2 QUESTIONNAIRE

This section contains the results from the questionnaire regarding motivation towards the presented scenario, student opinions towards learning, learning methods and UGC in game contexts.

The questionnaire is presented in Appendix B. The results presented here have been merged with the results from the questionnaire used in the interviews where the questions were the same.

Some of the results are not discussed here but are presented in Appendix C.1. Those are results from questions where only information was gathered, the result was as expected, or it was only confirming what was already know.

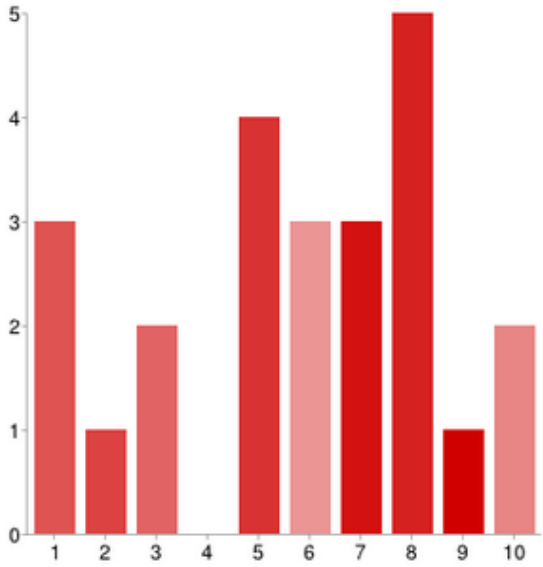

Figure 15.: Q1: 3: What is your motivation for memorizing the words as explained in the scenario?

FIGURE 15 shows how the users responded on motivation towards the scenarios that was explained in the questionnaire. The users of this questionnaire was only given a written presentation of the scenarios and it is clear that there is no obvious "correct" response to this question.

The motivation experienced from just reading about the scenario is intrinsic motivation, see Section 6.4.2. The responders are motivated solely by the activity at hand. The difference in responses is probably because of the difference in the responders' personality, background and learning experiences. This conforms with the assumptions that different users are motivated in different ways and that the psychological needs which motivates one learner does not necessarily motivate a different one.

It is evident that many of the users did not have low motivation towards learning after having experienced like in the scenarios.

FIGURE 16 is the responses gained from what element the users thought would increase their motivation the most. Here users could only pick one alternative, and the diagram therefore shows which element should be implemented first when thinking about motivation in regard to learning.

The alternatives are extracted from the psychological needs, where each one corresponds to a more specific game mechanic. As expected the information need scored high, but what is interesting to see is that the ambition need also had the same amount or votes. This indicates that a lot of the users are motivated by feeling a sense of accomplish-

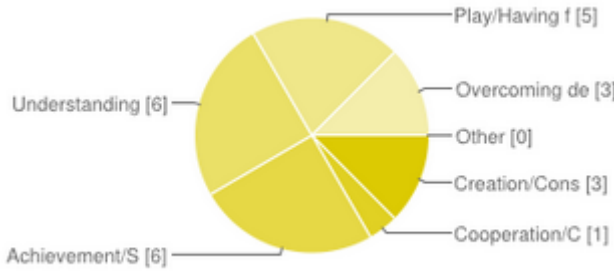

Figure 16.: Q1: 4: Which of these elements do you think will increase your motivation the most?

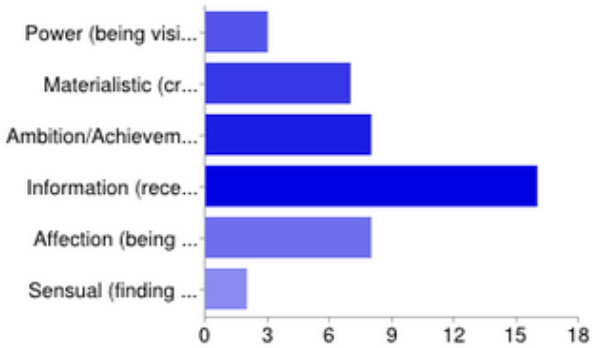

Figure 17.: Q1: 7: Which of these aspects do you feel the most attraction to?(maximum 2)

ment, being able to measure how well they are doing and receive recognition for their work. Another aspect which scored high is having fun, which is essential in a game, followed by overcoming defeat and creation/construction.

What is also interesting is the fact that cooperation/collaboration received so few votes. This might indicate that cooperation does not increase motivation alone, and one or more other elements must be included in order to increase motivation.

FIGURE 17 shows how the responses were when the users were asked for the need they felt the most attraction towards. This is also in regard to the scenario they have been presented with, and because of that it is clear that the information need is high. The other important needs which are often used in games, materialistic, ambition and affection, are all on the same level. These three has also been used in the puzzle game.

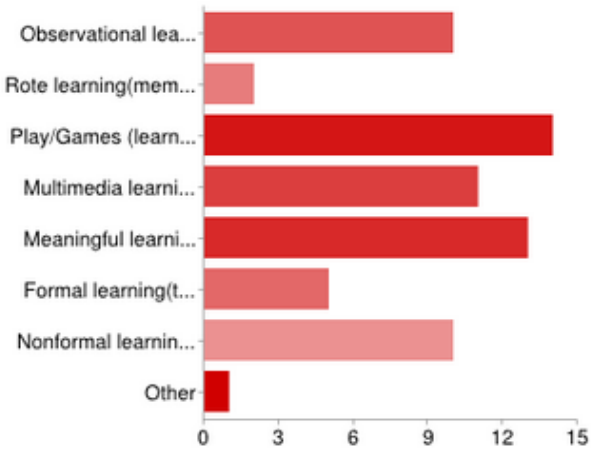

Figure 18.: Q1: 11 & Q2: 24 Which learning method(s) do you enjoy the most?(maximum 3)

FIGURE 18 AND FIGURE 19 assess how the users felt about different learning activities. As expected rote learning scored low on what the users enjoyed most, and high on what users enjoyed least. The other learning activity of importance in this project is meaningful and nonformal learning, which both scored high in what users enjoyed most and low on what users enjoyed least. This means that learning knowledge that would be learned by rote learning, as a combination of meaningful learning and through play/games is a good way to engage learners and make them in a larger degree enjoy and be motivated for learning.

FIGURE 20 shows which learning method the users experiences as most efficient. It is very clear that meaningful learning tops any other learning activity when it comes to what the users finds most efficient. Meaningful learning is learning by understanding where the knowledge fits into already known information.

The results from this diagram combined with the two previous diagrams indicates that making learning meaningful benefits learners in many ways, both when it comes to enjoyment, motivation and efficiency. The puzzle game attempts to make memorization of situated learning, which is meaningful learning as described in the scenarios, in to a more fun and engaging activity.

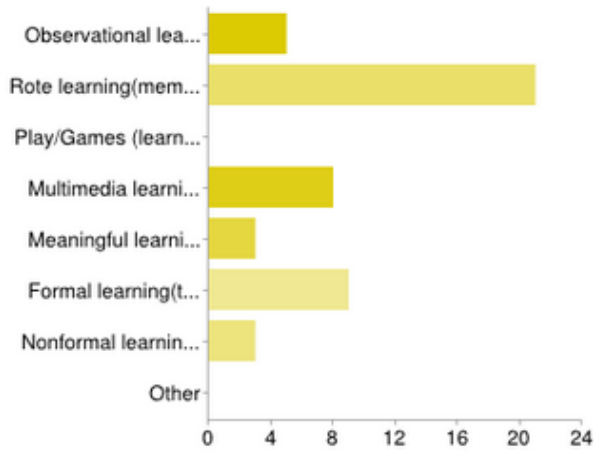

Figure 19.: Q1: 12 & Q2: 25 Which learning method(s) do you enjoy the least?(maximum 3)

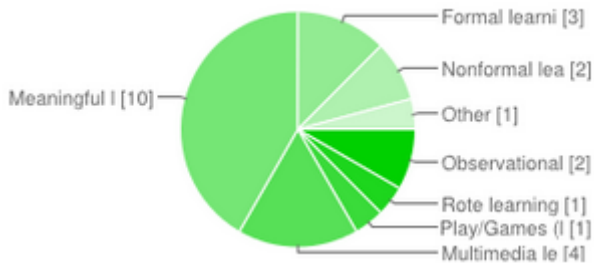

Figure 20.: Q1: 12: Which learning method do you think/feel is the most efficient?

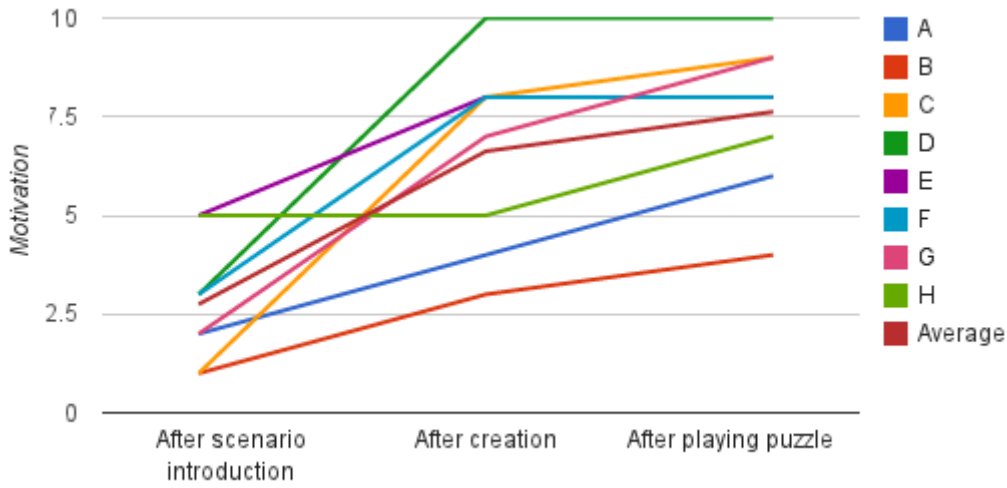

Figure 21.: Q2: 3, 4 and 8: Motivation

10.3 INTERVIEWS

This section presents the results from the interviews and the questionnaire regarding evaluation of the puzzle game. Results from discussing the different questions are also presented along with each diagram.

FIGURE 21 displays how user motivation changed while being introduced to the puzzle game. The first number indicates motivation after the scenario had been introduced and discussed. The second number is considering motivation after having created a puzzle. The last number indicates motivation after the user had used all the functions in the puzzle game, the last being playing the puzzle and seeing the result screen, high score and rating function.

Some users liked the creation the most, and motivation sky rocketed after that part, but others felt less of an increase after creation, and more after playing the puzzle. This can be because of the users having different preferences when it comes to game mechanics. It is also evident that users did not feel any increase in motivation when being able to play in relation to only being able to create. This was discussed and the users felt that only creation would help them learn the knowledge in enough degree for them. The creation would create a situation which the user would remember when faced with the knowledge he memorized by creating a puzzle.

The first value indicates intrinsic motivation. The users are motivated only by the activity itself. The other two values are extrinsic motivation in addition to the already specified intrinsic motivation. Users are motivated by the game mechanics in the way of fulfilling psychological needs.

FIGURE 22 shows how user motivation was negatively or positively effected by each of the different elements that were introduced. Most of these elements have not been implemented in the puzzle game, but the game design includes them and it was interesting to see what the elements would do to motivation.

During the evaluation the users also said they experienced that evaluating game mechanics in regard to motivation felt like evaluation in regard to what they found the most exiting and engaging, which through discussions was concluded as that is how games work. Users were motivated by elements which they found interesting, engaging or fun.

As is seen in the diagram, some elements all the users evaluated as an increase to motivation, while other, like sound, every evaluated as something that would not affect motivation, or affect motivation negatively. It was discussed and every user agreed that as long as it would be possible to turn off the sound it would not matter to them if it was implemented or not.

It was also interesting to see that one user did not like the challenge function. The possibility for one player to challenge another player to beat his score. He felt that the function would not fit in a learning environment and he would rather like to expand the high score or have achievement functions instead. It can also be explained by the fact that this player was one that enjoys collaboration more than conflict and challenge in game environments.

The overall average score for all elements which was evaluated, with exception of sound, is positive, which indicates that implementing all elements would further increase motivation. The importance of how these elements fit together was also discussed, and since the implementation finds place on a mobile device, the importance of interaction design was pointed out.

As with the previous diagram, Figure 22 also shows extrinsic motivation. This time it is whether the extrinsic motivation increases or decreases with each game mechanic. The different types of motivation is not separated in the questionnaire because where the motivation comes from is of little importance, only when it increases/decreases.

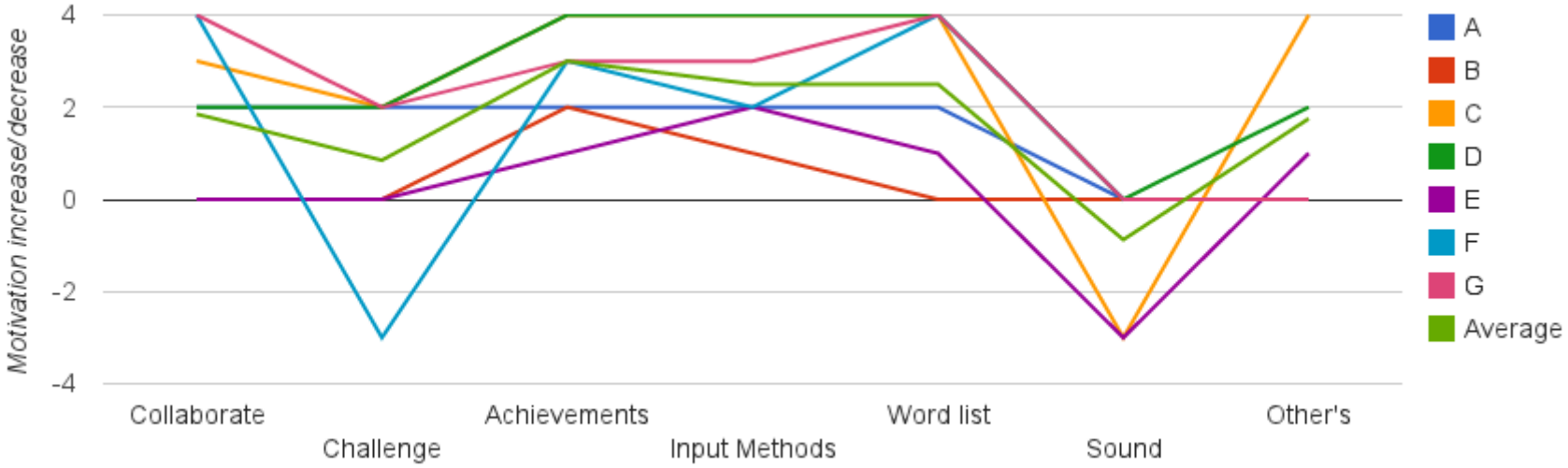

Figure 22.: Q2: 10 - 16: Motivation

FIGURE 23 displays the results after asking the users about which elements they felt increased their motivation the most. The alternatives are extracted from the psychological needs, each alternative though, are utilized in several needs.

During evaluation it was discussed which element they though fit with what part of the game design. Achievement/Recognition most felt was appropriate to both creation and play. This was because the authors of the puzzles was published so that others could see, and the puzzles could be rated. Some users felt that this function alone was not enough to feel recognition, and it would be more prominent if users could comment the puzzle, or if there was a number on how many users had rated the puzzle. The more information available a stronger sense of recognition would be possible.

The understanding/seeking knowledge alternative caused most frustration, the users did not see how the element would be implemented in a game, but they still understood the feeling it represented. It mostly received votes based on the scenario and the fact that the purpose of the game was learning. Users felt that the puzzle game should utilize a different element for main motivation.

The play/having fun alternative was also rooted in several psychological needs. The users felt this alternative was vague, but also thought it defined what they found attractive and motivating in games. Doing something that they found new, automatic, or easy, something where they did not have to strain the mind too much.

The alternative overcoming defeat/attacking players referred to the competitive environment which the game attempts to implement. Some users felt that the alternative had an aggressive and hostile undertone, but the competitive environment in itself was motivation and engaging. Other users felt that the game design did not utilize competitiveness in enough degree as for them to feel it was complete. This feedback was received from users which had experience with core games where competition is a very large part of the game play, which can explain why they felt the game design lacked in competitiveness.

The last alternative did not get any votes. It was indicated that the users did not feel that collaboration would be the main reason for them to user the game. It was discussed that it might have been more interesting if the different authors could chat while collaborating.

FIGURE 24 displays what psychological needs the users felt they recognized in the game design. These needs were explained before the users answered, see Section 6.2. The power need is not shown because it did not receive any votes.

What we can read from this is that the most recognizable psychological need was the information need. The second largest recognizable need was the materialistic need, which is also expected as the creation phase is a lot about materialism and organizing. This is expected see-

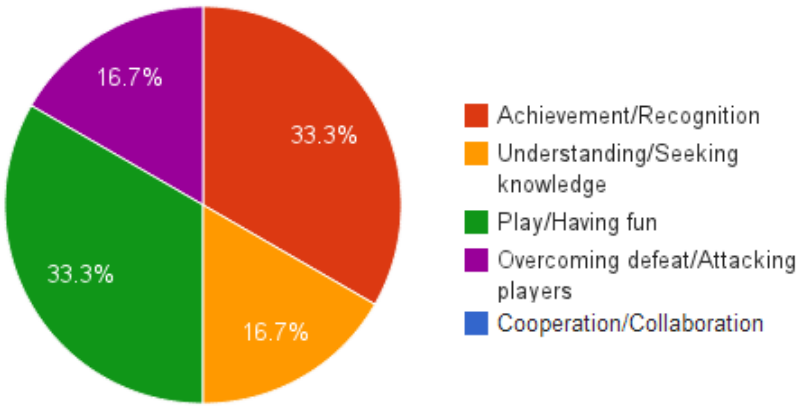

Figure 23.: Q2: 17: Which of the elements of the application and those mentioned above increases your motivation the most?

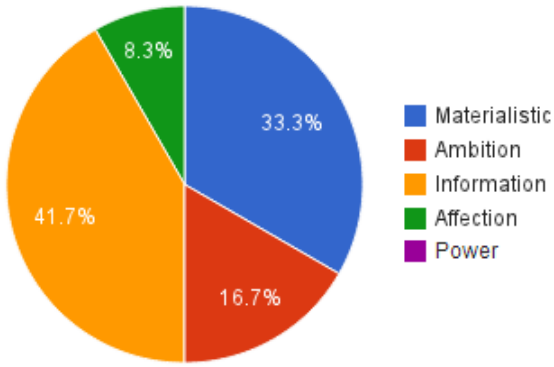

Figure 24.: Q2: 20: Which of these aspects do you recognize in the game?(You are welcome to search the application)

ing as the design is based on learning scenarios. Another interesting point is that ambition was recognized, seeing as feedback from earlier in the evaluation indicated that what was designed was not enough to support the ambition need.

The power need was not recognized at all. This is also in accordance with earlier feedback about the competition environment not being competitive enough, and that it should be other ways to evaluate and communicate in the game.

The affection is closely related to collaboration and cooperation, and it's few votes is in accordance with the fact that cooperation/collaboration was not introduced in the run-through of the game. It was also discussed that the affection need required more functions than just collaborating because it felt like it should have generated a stronger emotion.

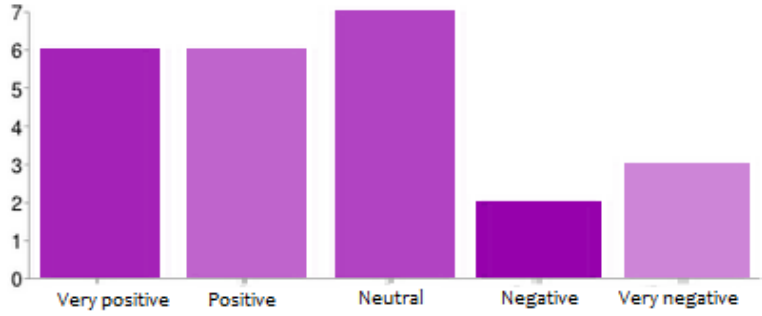

Figure 25.: Q1: 13 & Q2: 25 What is your opinion towards using user-generated content for learning?

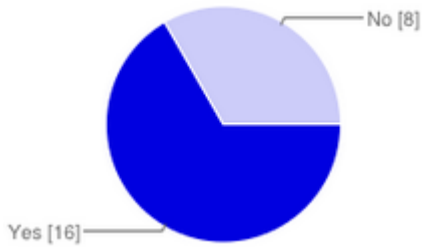

Figure 26.: Q1: 14 & Q2: 26: Does generating and sharing your own content increase your motivation for using an application or a game?

10.4 USER-GENERATED CONTENT

Since both questionnaires asked the learners about UGC the results from both are combined and presented here.

FIGURE 25 AND FIGURE 26 indicates what users feel about using UGC for learning. This is an interesting topic because learning is often affected by how much the learners trust the information they learn. If the information is generated by users in the same position as the learner, the learner might feel that he is learning something that is not guaranteed to be 100% accurate.

As seen the users does no agree on their opinion towards UGC in a learning environment and it is therefore important that the content has some form of quality assurance. It is also interesting to see that using UGC in a game context is likely to increase user's motivation to use that game.

FIGURE 27 indicates whether the users were worried about the quality of the UGC in a learning environment. Everyone in the game evaluation group felt that it would not be a problem as long as some strict qual-

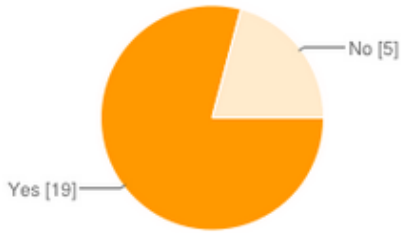

Figure 27.: Q1: 15 & Q2: 27 Are you worried about the quality of the information in a user-generated environment?

ity assurance method was implemented. The one presented in the game design would suffice, deleting low rated puzzles after a set amount of ratings, as long as the authors of the puzzle would be able to play it locally.

The users also expressed that they did not feel that the consequences of using UGC were that severe when the users would create their own puzzles for then to use those puzzles themselves. Each user would then be very interested in creating a puzzle with as high quality as possible because it would benefit that user the most, both in regard to learning and recognition from other users.

10.5 DISCUSSION

This section contains a short discussion of the results in relation to answering the research questions.

1. What does this game design do to situational learning in relation motivate for memorizing?

Motivation has been the main concern throughout the evaluation. Figure 21 and 22 shows how the different aspects of the game design increase or decrease motivation. From these results one can discuss whether there is any right answer to which element increase motivation and which decrease motivation because there are somewhat contradicting results. Some users liked the different elements more than others, and some even disliked some elements. In general however, the users were very positive towards the design, and they could visualize it being used for it's purpose while giving the learners the motivation to perform the memorizing

2. What does generating your own content do to this game environment in regard to motivation and learning?

Since the users themselves were the main users of their content, it was evident that the quality of the content would be as high as possible. Though humans are not infallible, and it was therefore important that

measures to assure quality were implemented. It was also important that this measure would be strict, so as no cheating would be possible.

It was evident that using a single form of feedback to the authors would not be enough. The rating system should at least have an indicator to how many people had rated the puzzle. This would give more information and cause the rating to be more or less valid, many or few ratings, according to what were the actual status of the puzzle.

3. What does exploiting the psychological needs implemented in the game design do to motivation?

Psychological needs seems to be able to describe what the users find motivating in games, and makes them able to pin out what they feel is most motivation in regard to games. It is however more difficult for the users to explain which game mechanic for them that corresponds to which psychological need. They could however, explain which psychological need which was evident in the puzzle game, and on that base a discussion about which psychological need corresponds to which game mechanic can be conducted.

10.6 PSYCHOLOGICAL NEEDS

This section contains an overview of the psychological needs identified by the users in the puzzle game. This is presented in order to answer the third research question, and further evaluate if the designed set of psychological needs presented in Section 7.4, is the same as what the users experienced from using and evaluating the puzzle game.

To make it simple the needs that are in italic are those that have not at all been recognized by the users, while the rest have in some way been identified. The last subsection presents a short discussion on the findings in these lists.

10.6.1 *Creation phase*

- *Power needs*
  - *Defence: Obeying and cooperating with others when creating the puzzles. The social environment encourages discussions regarding the puzzle being made.*
- Materialistic needs
  - Construction: Creating a challenging puzzle.
  - Order: Making things neat and organized.
- Ambition needs
  - Achievement: Success, accomplishment and overcoming obstacles.
  - Recognition: Displaying achievements and gaining social status.

- Information needs
  - Exposure: Educating others through making a challenging and good puzzle.
  - Understanding: Analysing experience and arrive at best possible puzzle that is comprehensive and verifiable.
- Affection needs
  - *Affiliation: Spending time with other people when collaboration and in the social environment.*
  - Play: Having fun with others when creating puzzles.

10.6.2 *Competition phase*

- *Power needs*
  - *Aggression: Attacking or ridiculing others. Through a competitive environment.*
  - *Counteraction: Overcome defeat or failure after loosing a puzzle.*
- Ambition needs
  - Achievement: Success, accomplishment and overcoming obstacles.
  - *Exhibition: Shocking or thrilling other people.*
  - Recognition: Displaying achievements and gaining social status.
- Information needs
  - Cognizance: Seeking knowledge and asking questions.
- Affection needs
  - *Affiliation: Spending time with other people.*
  - Play: Having fun with others.

10.6.3 *Implementing Psychological Needs*

This section presents the differences experienced in the results between what was expected and presented in 7.4.3 and the results gathered from the users. The experienced mapping is presented in Table 12 and the difference between the two mappings is that the power needs and affection needs are lacking in the experienced mapping.

Since the users found it difficult to assess which need was implemented where, this mapping is mostly based on what likely has been experienced. It is also suggested that collaboration and replay did not contribute to the ambition need.

Game mechanic	**Psychological needs**
Collaboration	Ambition needs
Creation/Self-expression	Materialistic and Information needs
Competition	Ambition needs
Time	Ambition needs
Reward structures	Ambition and Information needs
Feedback	Information needs
Replay	Ambition needs
Game levels	Information, Materialistic and Ambition needs

Table 12.: Mapping between game mechanics and psychological needs

10.6.4 *Discussion*

As expected from the feedback during the evaluation, none of the power needs have properly been designed or implemented. All the evaluators expressed that the power need was not felt in any part of the game. The same goes for one of the ambition subcategories and one affection subcategory. The latter can be explained by the fact that the evaluators did not properly experience the collaboration.

These results can be explained by what one of the users said. The power need is mostly implemented through a competitive environment, and it was evident that competition requires more from a game to utilize the power needs. This might be because through the power need the users feel stronger emotions which they are not used to feeling, therefore it is harder to make that feeling appear.

11

EVALUATION AND CONCLUSION

This chapter evaluates and concludes the thesis. Firstly, the research method is evaluated, followed by a summary of strengths and weaknesses. Thereafter, a summary of the results in regard to answering the research questions is presented, followed by thoughts about future research. Lastly, the conclusion is presented.

11.1 RESEARCH METHOD

The research method used when completing this thesis and the pre project is that of design science presented in Chapter 3. The design and development of the artifact was performed as presented in the methodology, whereas evaluation used interviews and questionnaires, as well as using real users to both evaluate and help design.

Evaluating with users gave the artifact, the game design, a more realistic approach, in that sense that the scenarios were not just to simulate, but a real world application taken from real world learners. The evaluation also proved more difficult because the developed artifact was a game, and result and research shows that different users are likely to experience the same game differently.

In addition to evaluating in a larger degree with users, the methodology had little regard to what separated designing a game artifact in relation to designing a standard IS artifact. As presented in Chapter 6 there are several more complex aspects with games that is non existing in standard applications. The fact that the design science methodology was not made for game development in particular did not cause any large problems as this fact was evident from the start, and was taken care of by researching game development from other sources.

The methodology proved a great asset to completing the thesis, both development and evaluation procedures have benefited from using the design science methodology.

11.2 STRENGTHS AND WEAKNESSES

This section contains a description of strengths and weaknesses in the project. This includes among other things strengths and weaknesses in the game design, the implementation, the results, the evaluation and the general completion of the project.

11.2.1 *Strengths*

The greatest strength in the project was it's cause. Researching the use of games for making learning easier and more motivating is a just cause, and gives the researcher both an extrinsic and intrinsic motivation in addition to that of completing a master thesis. Making research functional using real world scenarios is highly encouraged. This is because it has the possibility of giving back to the society by both having high impact results and producing something useful.

Completing this research by actually implementing the game design so it works in the real world is a great achievement. The results and the evaluation is much more solid with regard to it being performed on a real artifact and not just evaluating the theoretic design alone.

The thesis is focused on how users are motivated. This is a multi purpose area, where the results found can contribute to motivating people in different settings and for other activities. In a world where users are constantly getting instant feedback from technological gadgets and the like, it is important to also have the users motivated for learning, which not always gives instant feedback.

In general the master thesis had a very wide scope, both implementation, evaluation and theoretic analysis of those. Despite this a lot of information and results are presented, and the evaluation has managed to shed light on all aspects of the thesis, both design, game theory, implementation and evaluation of games in general.

11.2.2 *Weaknesses*

One of the greatest weaknesses this thesis had, is that the research approach and the research questions, was of a very wide scope, which caused the thesis to grow more than it should. Based on this the results can be lacking in regard to depth, and it would have been better if a narrower scope had been adapted in order to get more detailed results. On the other hand this approach was appropriate because the main reason behind the thesis was to implement and evaluate a game design which was developed with many aspects in mind, therefore many aspects had to be approached.

Another weakness was that the evaluation should have had more evaluators. As it stands in this report there might be too few users which have evaluated in order to properly conclude what users in general think and feel about the game design. The conclusion is only based on this set of results, and it is evident that because of the amount of evaluators a different and larger set of users might give different results. It is also a question whether the selected users is representative for the user group. This is believed to be accurate, as the users are very different, but all are students in higher education.

A technical weakness in the project is the server implementation. It has not been presented in any detail in the report in order to reduce the scope, but also because it is not of any significant achievement or is significant to the game design or the evaluation of such. As long as the server application was functioning properly there was nothing to evaluate.

Another weakness was that the game design was not completely realized in the implementation. This was mostly caused by time shortage and lack of experience with how much time an implementation of such size would take. Nevertheless the complete game design was evaluated, and since this weakness was evident from early on it was reduced as much as possible.

11.3 ANSWERING RESEARCH QUESTIONS

This section presents a summary of the results in regard to answer the research questions.

1. What does this game design do to situational learning in relation motivate for memorizing?
    a) Does this game promote rote learning as a more fun and engaging learning activity and help users revise what they have previously learned?

The game design motivated every user it was tested on. Those least motivated by the scenario got one of the highest increases in motivation when introduced to the game. Users were particularly interested in the game as a aid to memorize anything. The users did not feel the game design was directly exiting, but it increased the motivation and automation of the activity, which they felt made the activity more fun and engaging.

The motivation of each user increased and decreased differently with each game mechanic, which shows that the different users the game design was evaluated on belongs to different player types.

2. What does generating your own content do to this game environment in regard to motivation and learning?
    a) What are students' opinions towards UGC based games for learning and what must be done in order to make UGC work in a game environment?
    b) What does utilizing UGC in this puzzle do to motivation for learning?

Some users found generating their own content to be give a motivational increase, but this was mostly because they felt that the task and scenario demanded that the user would be able to. The users did however point out that there would have to be some form of automatic

quality assurance, and some felt that the rating function and automatic deletion of badly rated puzzles was not enough.

3. What does exploiting the psychological needs implemented in the game design do to motivation?
    a) In which degree does exploiting psychological needs increase motivation for learning?
    b) Which game mechanic and psychological need increases motivation the most?
    c) How is the mapping between psychological needs and game mechanics different from user to user? Are there any commonalities?

Psychological needs were hard to identify by the users, but it was evident that many of the needs that the design was based on was identified by the evaluators. There was however some needs which were not identified, and users said that there had to be more game mechanics to support those needs.

Users were very clear about the fact that the psychological needs were a source of motivation, but found it difficult to specify which. One of the elements that users identified as very interesting was the creation element, which corresponds to the materialistic need. Earlier it was identified to be the element least used in mobile games, which might be because of the mobile device and it's capacity. Based on the results here it is therefore encouraged to in a larger degree use the self-expression game mechanic in mobile games.

Between users there were several differences in what they experienced in the game. It was evident that users which were more familiar with core games found the ambition and affection needs not to be properly utilized. This might be because in core games these needs are exploited in a much deeper sense and cause stronger emotions.

11.4 FURTHER RESEARCH

There is much more research that should be conducted in the area of combining motivation, learning and games, in order to fully harvest the potential of games in learning situations. Frequently the need for higher education in society because of the growth in the technological sector, is mentioned, and one way to help is to give students a motivation beyond that which learning gives on it's own.

Other problems in other parts of society, with different user groups, must have their situations seen and the potential for an application or a game to help their learning problems must be evaluated. This requires use of different sets of psychological needs and other game designs for sure. It might also be more important with a story line in those settings, and it is also pointed out that the story line in itself can be motivating.

It is also proposed to focus on the use of psychological needs in other contexts. In example to create a better workday and work environment for businesses where the employees suffer from lack of engagement and motivation for their work. This could increase both efficiency and reduce sick days which would both effect the employees life and the business positively.

Games can be used to increase the potential and the motivation for learning in any age, and it is interesting to see if there is a difference in the effect of learned knowledge when learned in a motivated engaging learning method vs a standard formal learning method. Children and adults with difficulties functioning in the world can use games to keep them focused and productive in both learning and work environments. Games can reveal resources and an inner drive and enthusiasm in people that they did not know they had in the first place.

I encourage other students to take up my work, finish developing the game and further evaluate psychological needs as a source of motivation.

11.5 CONCLUSION

Games have been identified as an efficient means for learning[22] and it is something that has been attempted to be utilized in this puzzle game. It is evident that this has succeeded. Users became more motivated for both performing learning in general using the puzzle game, and performing the task presented in the scenarios. Utilizing crowd-sourcing enabled the users to customize the game for their own needs and learn what they were interested in learning. The game mechanics exploited psychological needs in order to motivate the users and make the learning more fun and engaging.

Basing game design on psychological needs works, but be aware of expecting every to be utilized on every user, as this is likely not going to occur. The complexity of games has a wide range, and some psychological needs are more evident in a more complex game.

The quality of the implemented puzzle game was not ready for full scale use. In order for that to happen, a better server application should be implemented, and the client application should have a security layer as well as a more robust game experience, being able to pause and restart at any moment of the application.

Learning should use more technology, not only to motivate the learners, but also to make learning easier, more efficient, and available whenever and wherever. The technology is evolving and learning should evolve with it.

BIBLIOGRAPHY

[1] Nard Schreurs Computerworld. Desperat jakt på teknostudenter. Online magazine, November 2012. URL http://www.idg.no/computerworld/article260448.ece. (Cited on page 3.)

[2] Caroline Drefvelin Teknisk Ukeblad. Profil: Kunnskapsminister kristin halvorsen – jeg tror vi er et folk av matteangst. Online magazine, May 2012. http://www.tu.no/jobb/2012/05/12/-jeg-tror-vi-er-et-folk-av-matteangst. (Cited on page 3.)

[3] Norwegian University of Science and Technology. Courses which offer lectures in english. Online, December 2012. URL http://www.ntnu.no/web/studier/emnesok. (Cited on page 3.)

[4] NTNU International Section. Percentage of technological courses in english. November 2012. (Cited on page 3.)

[5] A. R. Hevner, S. T. March, J. Park, and S. Ram. Design science in information systems research. *MIS Quarterly: Management Information Systems*, 28(1):75–105, 2004. Cited By (since 1996): 1190. (Cited on page 13.)

[6] V. Aleven, E. Myers, M. Easterday, and A. Ogan. Toward a framework for the analysis and design of educational games. In *DIGITEL 2010 - The 3rd IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning*, pages 69–76, 2010. Cited By (since 1996): 4. (Cited on pages 14, 23, and 69.)

[7] JetBrains. Intellij idea : Best java ide to do more high-quality code in less time. Online, November 2012. URL http://www.jetbrains.com/idea/. (Cited on page 15.)

[8] Restet Community. Restlet framework - restful web api framework for java, 2013. URL http://restlet.org/. (Cited on page 15.)

[9] Open Handset Alliance. Android operating system, 2013. URL http://developer.android.com/index.html. (Cited on page 16.)

[10] Lauren Darcey. *Sams teach yourself Android application development in 24 hours*. Sams Pub, Indianapolis, Ind, 2010. ISBN 9780321673350. (Cited on page 16.)

[11] LearnLab Pittsburgh Science of Learning Center. Instructional principles and hypotheses, March 2013. URL http://learnlab.org/research/wiki/index.php/InstructionalPrinciples. (Cited on page 24.)

[12] Department of Psychology The University of Memphis. Principles of learning, March 2013. URL http://www.psyc.memphis.edu/learning/principles/. (Cited on pages 24 and 70.)

[13] A. I. Wang, T. Øfsdahl, and O. K. Mørch-Storstein. Lecture quiz - a mobile game concept for lectures. (Cited on page 25.)

[14] A. I. Wang, T. Øfsdahl, and O. K. Mørch-Storstein. An evaluation of a mobile game concept for lectures. In *Software Engineering Education Conference, Proceedings*, pages 197–204, 2008. (Cited on page 25.)

[15] Memrise team. Memrise - the fun way to learn anything. . URL http://www.memrise.com/about/. (Cited on page 25.)

[16] Duolingo team. Duolingo. . URL http://duolingo.com/. (Cited on page 26.)

[17] SIMOLA. Situated mobile language learning, June 2012. URL http://itrg.brighton.ac.uk/simola.org/. (Cited on page 27.)

[18] SIMOLA project. Lingobee. URL http://itrg.brighton.ac.uk/simola.org/lingobee/index.php. (Cited on page 27.)

[19] E. Procter-Legg, A. Cacchione, and S. A. Petersen. Lingobee and social media: Mobile language learners as social networkers. CELDA 2012, Madrid, Spain, September 2012. (Cited on page 27.)

[20] S. A. Petersen, J. Sell, and J Watts. Let the students lead the way: an exploratory study of mobile language learning in a classroom. Workshop MLCW@E-TEL, Saarbrucken, Germany, October 2011. (Cited on page 27.)

[21] S. A. Petersen, E. Procter-Legg, and A. Cacchione. Lingobee - creative mobile language learning. Workshop MLCW@E-TEL, Saarbrucken, Germany, September 2012. (Cited on page 27.)

[22] Karl Kapp. *The gamification of learning and instruction : game-based methods and strategies for training and education*. Pfeiffer, San Francisco, CA, 2012. ISBN 9781118096345. (Cited on pages 27, 29, 36, 37, 38, and 97.)

[23] M. I. T. C. Perera, K. Lokuge, H. Mudunkotuwa, N. Premarathne, and M. Kularathna. Quizfun: Mobile based quiz game for learning. In *International Workshop on Technology for Education, T4E'09*, pages 95–96, 2009. (Cited on page 28.)

[24] B. Borstan. Player motivations: A psychological perspective. *ACM Computers in Entertainment*, 7(2):32, 2009. (Cited on pages 29, 32, 33, and 34.)

[25] I. Di Loreto and Goucich A. Facebook games: between social and personal aspects. *International Journal of Computer Information Systems and Industrial Management Applications.*, 3, 2011. (Cited on pages 29, 30, 31, and 33.)

[26] Google and the Android Community. Google play. URL https://play.google.com/store. (Cited on pages 29 and 109.)

[27] J. Park and M. Van Der Schaar. A game theoretic analysis of incentives in content production and sharing over peer-to-peer networks. *IEEE Journal on Selected Topics in Signal Processing*, 4(4):704–717, 2010. Cited By (since 1996):11. (Cited on page 30.)

[28] K. Jegers and M. Wiberg. Pervasive gaming in the everyday world. *IEEE Pervasive Computing*, 5(1):78–85, 2006. Cited By (since 1996): 16. (Cited on pages 30 and 32.)

[29] Edward F. Gehringer, Maria Droujkova, Abhishek Gummadi, and Maveeth Nallapeta. Work in progress - game mechanics and social networking for co-production of course materials. pages American Society for Engineering Society, ASEE; IEEE; IEEE Computer Society; ATM; San Antonio College, SAC –, 2009. URL http://dx.doi.org/10.1109/FIE.2009.5350564. (Cited on page 30.)

[30] F. Fotouhi-Ghazvini, R. A. Earnshaw, D. Robison, A. Moeini, and P. S. Excell. User interface design within a mobile educational game. In *Proceedings of the 4th International Conference on Internet Technologies and Applications, ITA 11*, pages 111–118, 2011. (Cited on page 31.)

[31] I. Di Loreto, Goucich A., and L. Pierre-Alain. Facebook games: The point where tribes and casual games meet. *International Conference Game and Entertainment Technologies (GET2010), Spain*, March 2011. (Cited on pages 32 and 33.)

[32] Chen S. L. Michael, D. R. Serious games: Games that educate, train, and inform. *Muska ans Lipman/Premier-Trade*, 2005. (Cited on page 32.)

[33] V. Janarthanan. Serious video games: Games for education and health. In *Proceedings of the 9th International Conference on Information Technology, ITNG 2012*, pages 875–878, 2012. (Cited on page 32.)

[34] K. M. Kapp. Games, gamification, and the quest for learner engagement. *T and D*, 66(6):64–68, 2012. (Cited on page 32.)

[35] Ines Di Loreto. Social games. TDT4245 - Cooperation Technology lecture, October 2012. (Cited on pages 33 and 34.)

[36] J. Krumm, N. Davies, and C. Narayanaswami. User-generated content. *Pervasive Computing, IEEE*, 7(4):10–11, 2008. ISSN 1536-1268. doi: 10.1109/MPRV.2008.85. (Cited on page 35.)

[37] User-generated content principles. Online, February 2013. URL http://www.ugcprinciples.com/. (Cited on page 35.)

[38] Katie Salen. *Rules of play : game design fundamentals*. MIT Press, Cambridge, Mass, 2003. ISBN 9780262240451. (Cited on pages 36, 37, and 38.)

[39] Y. Rogers, H. Sharp, and J. Preece. *Interaction design : beyond human-computer interaction*. Wiley, Chichester, West Sussex, U.K, 3rd edition, 2011. ISBN 9780470665763. (Cited on page 44.)

[40] L. Bass, P. Clements, and R Kazman. *Software architecture in practice*. Addison-Wesley, Boston, 2nd edition, 2003. ISBN 0321154959. (Cited on pages 44 and 54.)

[41] Phillippe Kruchten. Architectural blueprints - the 4+1 view model of software architecture. *IEEE Software*, 12(6):42–50, November 1995. (Cited on page 56.)

[42] Mikko Kontio. Architectural manifesto: Designing software architectures, part 5. February 2005. URL http://www.scribd.com/doc/84656947/Architectural-manifesto-Designing-software-architectures-Part-5. (Cited on page 56.)

[43] A. Kukulska-Hulme. Will mobile learning change language learning? *ReCALL*, 21(2):157–165, 2009. Cited By (since 1996): 13.

[44] M. Rico, J. E. Agudo, H. Sánchez, and A. Curado. Language learning in the palm of your hand. In *Proceedings - 2nd IEEE International Conference on Digital Game and Intelligent Toy Enhanced Learning, DIGITEL 2008*, pages 113–115, 2008.

[45] M. Li, H. Ogata, B. Hou, and N. Uosaki. Scroll: System for capturing and reminding of ubiqitous learning log. In *Proceedings 2012 17th IEEE International Conference on Wireless, Mobile and Ubiquitous Technology in Education, WMUTE 2012*, pages 328–330, 2012.

[46] H. Ogata, C. Yin, R. G. Paredes J., N. A. Saito, Y. Yano, Y. Oishi, and T. Ueda. Supporting mobile language learning outside classrooms. In *Proceedings - Sixth International Conference on Advanced Learning Technologies, ICALT 2006*, volume 2006, pages 928–932, 2006. Cited By (since 1996): 9.

[47] S. Petersen, J. Markiewicz, and S. Bjørnebekk. Personalized and contextualized language learning: Choose when, where and what. *World Scientific*.

[48] S. . Cehan and D. . Cehan. *Computer games and English language learning*, volume 7558 LNCS of *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*. 2012.

[49] How many languages are there in the world. October 2012. URL http://1howmany.com/how-many-languages-in-the-world.

[50] How much of an average lifetime is spent in school. october 2012. URL http://www.kgbanswers.com/how-much-of-an-average-americans-life-is-spent-in-school/19651803.

[51] S. Deterding, K. O'Hara, M. Sicart, D. Dixon, and L. Nacke. Gamification: Using game design elements in non-gaming contexts. In *Conference on Human Factors in Computing Systems - Proceedings*, pages 2425–2428, 2011. Cited By (since 1996): 8.

[52] J. Vassileva. Motivating participation in social computing applications: A user modelling perspective. *User Modelling and User-Adapted Interaction*, 22(1-2):177–201, 2012. Cited By (since 1996): 1.

[53] H. . Hsieh, C. . Chen, and C. . Hong. Context-aware ubiquitous english learning in a campus environment. In *Proceedings - The 7th IEEE International Conference on Advanced Learning Technologies, ICALT 2007*, pages 351–353, 2007. Cited By (since 1996): 4.

[54] G. Stockwell. Vocabulary on the move: Investigating an intelligent mobile phone-based vocabulary tutor. *Computer Assisted Language Learning*, 20(4):365–383, 2007. Cited By (since 1996): 24.

[55] M. F. Young, S. Slota, A. B. Cutter, G. Jalette, G. Mullin, B. Lai, Z. Simeoni, M. Tran, and M. Yukhymenko. Our princess is in another castle: A review of trends in serious gaming for education. *Review of Educational Research*, 82(1):61–89, 2012. Cited By (since 1996): 2.

[56] M. Poppendieck and M. A. Cusumano. Lean software development: A tutorial. *IEEE Software*, 29(5):26–32, 2012.

[57] D. Callele, E. Neufeld, and K Schneider. Requirements engineering and the creative process in the video game industry. In *13th IEEE International Conference on Requirements Engineering (RE'05)*, pages 240–252, 2005.

[58] M Fowler. *UML distilled : a brief guide to the standard object modeling language*. Addison-Wesley, Boston, 3rd edition, 2004. ISBN 0321193687.

Part V

APPENDICES

A

GAME MECHANICS IN EXISTING GAMES

This chapter presents the review of game mechanics used in existing games and applications which was performed during the specialization project.

Table 13 presents a set of review notes from the existing applications and games for language learning. Thereafter a short overview on which different functionality and game mechanics each game utilizes, is listed in Table 14.

SUMMARY Wordfeud is by far the most popular game, but it also does not have a strong focus on learning. It is difficult to assess if Duolingo and Memrise have a big user pool, but from the energy having been spent developing them, and the fact that they are free, they should have a considerate amount. words rumble and 50 languages are also quite popular. Memrise have listed numbers of users per course, and there are several courses with a user pool ranging from five to sixty-five thousand.

Looking at the tables and assessing which functionality works is not a straight forward task. Other aspects also interfere with users' opinions, user-interface design and technical completeness(number of errors) is two of them. These aspects have therefore also been included in the tables.

Looking at the game mechanics used it is very little collaboration, and competition seems more popular. There is neither many social environments. The games with the best user score are often those with the fewest technical issues. Using learning in itself as a motivation does not work for the games identified.

Name	Description	Strengths	Weaknesses	Motivation	Popularity
Lingobee	Write down expressions and words you don't understand in order to be able to look them up at a later stage	Can easily fit your needs	Self built, might be slow and take a lot of work in the start	Learn a language, words and expressions	
Ankidroid	Learn anything and everything by using flash cards	Has a big repository, very good feedback, logic and theory, based on research that flash cards work	As with paper flashcards it is about self discipline and using it the right way	Learn something, compete against yourself	100 000+
Free rice	Game for expanding your English vocabulary/learn synonyms	Easy and fast to use, fast to learn, intuitive	Screen does not adapt to the size of your device, game mechanics are not fully utilized	Money to charity, levels	10 000+
50 languages	Comprehensive app for learning languages, vocabulary, phrases, flash cards	Comprehensive, only need one app, quiz with score	Boring way of learning, like going to school, only on your own, no competition/-motivation	Learn a language	1 000 000+
TS English talk game	Game for learning a language based on translating sentences	Colorful, fun, competitive, addicting	Only to learn english, does not have many native languages to choose from	Learn a language, entertainment	50 000+
Hangman-basic	Game for guessing English words, can translate words if google translate app is installed	Entertaining, good graphics	Not challenging, simple, less understanding and more guessing, small repository	Pass time	5000+

Word learner	Learning from list of word definitions and repetition by using mini games combined with a test	Can change difficulty, several minigames	Minigames can fast become too little challenging	Learn a language, pass time	5000+
Wordfeud	Competitive mobile scrabble game	Competitive, social, entertaining, good usability	Must have a decent vocabulary in the first place	Competitive, social	10 000 000+
Flash cards free	Create your own flash cards	Self made, personal, easily fit your own need	A lot of effort to create cards, does not always work	Learn something	1000+
Tourist language learn and speak	Contains useful expressions when travelling to another country	Comprehensive, sorted by subject, has pronunciation, easy to use	Does not support all countries/languages	Travelling in a new country	1 000 000+
Words Rumble	Find all the words in a grid	Good graphics, fun, competitive, addictive		Fun, challenging	500 000+
Memrise	Learn a language from scratch	Skill growth is visualized, based on repetition without getting boring	Only words?	Growing a garden of words	
Duolingo	Learn a language and at the same time translate the web	Skill is visualized in a skill tree, easy to see what you have learned	A lot of writing	Filling the skill tree	

Table 13.: Review summary

Name	Social?	Competitive?	Collaboration?	Motivation?	Popular?	Game?	Mobile?	Good GUI	Tech. issues	User's score[26]
Lingobee	Yes	No	Yes	Learning	Not yet	No	Yes	Yes	Some	-
Ankidroid	No	No	Yes	Learning	Yes	No	Yes	Yes	No	4,5
Free rice	No	Yes	No	Charity	No	Yes	Yes	No	Yes	4,0
50 languages	No	No	No	Learning	Yes!	No	Yes	No	No	4,7
TS English talk game	No	Yes	No	Fun	No	Yes	Yes	Yes	Some	3,9
Hangman	Yes	No	No	Fun?	No	Yes	Yes	Yes	No	4,3
Word learner	No	No	No	Repetition learning	No	Yes	Yes	No	Many	-
Wordfeud	Yes	Yes	No	Competition	Yes!!!	Yes	Yes	Yes	No	4,5
Flash cards free	No	No	No	Repetition learning	No	No	Yes	No	No	-
Tourist language	No	No	No	Learning	Yes!	No	Yes	Yes	No	4,5
Words Rumble	Yes	Yes	No	Competition	Yes!	Yes	Yes	Yes	Many	3,5
Memrise	Yes	No	No	Learning	Yes	Yes	No	Yes	Some	-
Duolingo	Yes	No	No	Learning	Yes!	Yes	No(widget)	Yes	No	-

Table 14.: Functionality overview

B

QUESTIONNAIRES

This chapter contains the two questionnaires which have been used to evaluate the puzzle game. Both questionnaires presented here were used when implementation had ended.

The questionnaires have also been made electronic in order to evaluate over the internet. This has enabled the feedback from students whom does not have Norwegian as their mother tongue.

The scenarios and the questions presented in the questionnaires have been discovered to be error prune. The evaluation has therefore also been performed vocally in order to remove errors in how the questionnaire presented the scenarios and how they should be interpreted.

The results from these questionnaires is listed in Section 10.2 and 10.3, and also some in Appendix C.

Throughout the report Q1 indicates the general questionnaire listed first here, Q2 indicates the puzzle game evaluation questionnaire listed second here.

Questionnaire about motivation for rote learning

About You

First, a couple facts about yourself.

1. **Are you currently a student?** □ Yes □ No
2. **How old are you?**

   □ <17
   □ 18-20
   □ 21-23
   □ 24-26
   □ >27

Scenarios

This section describes three scenarios you should visualize when thinking about learning, in particular rote learning, which is the procedure of repeating an activity to memorize something.

Scenario #1: You are beginning a course in algorithms and data structures, and to your frustration the lecture is performed in English. During the lecture you encounter several words which you do not understand and you write them down. You do not fully understand what the lecturer is talking about, and you feel it is likely to be the case the next lecture too, if you do not learn these technical terms. The lecturer is also likely to bring up new words the next lecture.

After the lecture you buy the course textbook, which to your frustration is also in English. It is clear you have to memorize the technical terms found in this book, and used in the lecture even though you understand their use and definition in Norwegian.

Scenario #2: During exercise aid you are aided by a very skilled exchange student. During the explanation you both recognize the difficulty discussing algorithms in English and understanding what the other person is trying to communicate.

Scenario #3: You are studying for your exam. Your curriculum is in English while your notes from earlier in the semester are in Norwegian. You soon realizes that studying prove very difficult because you have trouble connecting your notes with the text book, and you feel that there is almost no progress.

Task: Learn technical English vocabulary for your course in algorithms.

Game Elements

This section focuses on motivation and game elements.

3. **What is your motivation for memorizing the words as explained in the scenario**:
   Very negative □ —□ —□ —□ —□ —□ —□ —□ —□ —□ Very positive

4. **Which of these elements do you think will increase your motivation the most?**
   - □ Creation/Construction
   - □ Cooperation/Collaboration
   - □ Achievement/Success/Recognition
   - □ Understanding/Learning/Seeking knowledge
   - □ Play/Having fun
   - □ Overcoming defeat/Attacking players/Competitive environment
   - □ Other: _____

5. **Do you feel that using one or more of the elements above will benefit your learning and make learning easier for you?**
   □ Yes □ No, because: _____

6. **Which game elements do you think must be implemented for you to be satisfactory motivated to perform the task explained in the start of this questionnaire?(choose as many as nessesary)**

   - □ Creation/Construction
   - □ Cooperation/Collaboration
   - □ Achievement/Success/Recognition
   - □ Understanding/Learning/Seeking knowledge
   - □ Play/Having fun
   - □ Overcoming defeat/Attacking players/Competitive environment
   - □ Other: _____

7. **Which of these aspects do you feel the most attraction to?(choose maximum 2)**
   - □ Power (being visible to others)
   - □ Materialistic (creating and possessing something)
   - □ Ambition/Achievement (receiving recognition)
   - □ Information (receiving information and knowledge)
   - □ Affection (being in the company of others)
   - □ Sensual (finding satisfaction in stimuli and experiences)

Learning

In this section I would like some input on using games for learning and learning in general.

8. **What is your opinion towards using games for learning?**
   - ☐ Very positive
   - ☐ Positive
   - ☐ Neutral
   - ☐ Negative
   - ☐ Very negative

9. **What do you have the most trouble learning?**_____

10. **Which learning method(s) do you enjoy the most?(choose maximum 3)**
    - ☐ Rote learning(memorization/learning by repetition)
    - ☐ Observational learning(learning by trying to imitate someone/something else)
    - ☐ Play/Games (learning where the main goal is not knowledge or learning)
    - ☐ Multimedia learning(auditory and visual stimuli to learn information)
    - ☐ Meaningful learning(fully understanding how it relates to other knowledge)
    - ☐ Formal learning(teacher-student relationship, such as in a school system)
    - ☐ Nonformal learning(learning by coming together with people with similar interests)
    - ☐ Other: _____

11. **Which learning method(s) do you enjoy the least?(choose maximum 3)**
    - ☐ Rote learning(memorization/learning by repetition)
    - ☐ Observational learning(learning by trying to imitate someone/something else)
    - ☐ Play/Games (learning where the main goal is not knowledge or learning)
    - ☐ Multimedia learning(auditory and visual stimuli to learn information)
    - ☐ Meaningful learning(fully understanding how it relates to other knowledge)
    - ☐ Formal learning(teacher-student relationship, such as in a school system)
    - ☐ Nonformal learning(learning by coming together with people with similar interests)
    - ☐ Other: _____

12. **Which learning method do you think/feel is the most efficient?**
    - ☐ Rote learning(memorization/learning by repetition)
    - ☐ Observational learning(learning by trying to imitate someone/something else)
    - ☐ Play/Games (learning where the main goal is not knowledge or learning)
    - ☐ Multimedia learning(auditory and visual stimuli to learn information)
    - ☐ Meaningful learning(fully understanding how it relates to other knowledge)
    - ☐ Formal learning(teacher-student relationship, such as in a school system)
    - ☐ Nonformal learning(learning by coming together with people with similar interests)
    - ☐ Other: _____

User-Generated Content

This section focuses on content and especially content which is generated by users.

13. **What is your opinion towards using user-generated content for learning?**
    - ☐ Very positive
    - ☐ Positive
    - ☐ Neutral
    - ☐ Negative
    - ☐ Very negative
14. **Does generating and sharing your own content increase your motivation for using an application or a game?**
    ☐ Yes ☐ No, because: _____
15. **Are you worried about the quality of the information in a user-generated environment?**
    ☐ Yes, because: _____
    ☐ No
16. **Do you have any tips toward quality assurance in a user-generated content environtment?**

_____

_____

_____

Other Comments

_____

_____

_____

_____

Evaluation form for the Play It application

About You

First, a couple facts about yourself. This information will not be made public.

1. **Your name**: _____
2. **Are you currently a student?** □ Yes □ No

Scenarios

This section describes the three scenarios you should visualize when evaluating the application and your motivation. Your motivation is rated between 1 and 10, where 1 is very negative motivation, 5 neutral motivation and 10 very positive motivation. Negative motivation is the feeling of not wanting to perform that task.

Scenario #1: You are beginning a course in algorithms and data structures, and to your frustration the lecture is performed in English. During the lecture you encounter several words which you do not understand and you write them down. You do not fully understand what the lecturer is talking about, and you feel it is likely to be the case the next lecture too, if you do not learn these technical terms. The lecturer is also likely to bring up new words the next lecture.

After the lecture you buy the course textbook, which to your frustration is also in English. It is clear you have to memorize the technical terms found in this book, and used in the lecture even though you understand their use and definition in Norwegian.

Scenario #2: During exercise aid you are aided by a very skilled exchange student. During the explanation you both recognize the difficulty discussing algorithms in English and understanding what the other person is trying to communicate.

Scenario #3: You are studying for your exam. Your curriculum is in English while your notes from earlier in the semester are in Norwegian. You soon realize that studying prove very difficult because you have trouble connecting your notes with the text book, and you feel that there is almost no progress.

Task: Learn technical English vocabulary for your course in algorithms.

Application

3. **What is your motivation for memorizing the words as explained in the scenario**:
   Very negative □ —□ —□ —□ —□ —□ —□ —□ —□ —□ Very positive

You will now create a puzzle using the application in order to memorize 5 of the words in Table 1.

4. **What is your motivation for memorizing after having created the puzzle**:
   Very negative □ —□ —□ —□ —□ —□ —□ —□ —□ —□ Very positive
5. **Did you encounter any problems or difficulties creating the puzzle? Please explain**

   _____

   _____

Word	Definition
Adjacent	Next to something
Augmenting	Make greater by adding something
Bound	A territorial limit, a boundary
Invariant	Never changing
Iteration	Repetition of a process
Leaf	Node in the bottom of a tree graph
Recursion	Repeating a procedure inside itself
Predecessor	A thing followed or replaced by another

Table 1: Words and their definitions

You will now publish and play your created puzzle.

6. **What did you score**: _____
7. **How fast did you complete the puzzle**: _____
8. **What is your motivation for memorizing after having played the puzzle**:
   Very negative □ —□ —□ —□ —□ —□ —□ —□ —□ —□ Very positive
9. **Did you encounter any problems or difficulties playing the puzzle? Please explain**

   _____

   _____

Game Elements

This section explains different game elements which can be added on top of the application you have just tested. Each question asks you to give your motivation if that game element was added to the application.

How much does your motivation increase or decrease for memorizing the words as explained in the scenario if you could

10. **Collaborate with friends to create puzzles**:
    Decrease a lot □ —□ —□ —□ —□ —□ —□ —□ —□ Increase a lot
11. **Challenge friends to beat your score/time on a puzzle**:
    Decrease a lot □ —□ —□ —□ —□ —□ —□ —□ —□ Increase a lot
12. **Achieve a better score from completing the puzzle without errors**:
    Decrease a lot □ —□ —□ —□ —□ —□ —□ —□ —□ Increase a lot
13. **Play the puzzle using different input methods, rearranging letters, clicking a grid etc** :
    Decrease a lot □ —□ —□ —□ —□ —□ —□ —□ —□ Increase a lot
14. **Create puzzles using a built in word list where you previously have saved your words**:
    Decrease a lot □ —□ —□ —□ —□ —□ —□ —□ —□ Increase a lot
15. **Create and play with sound effects**:
    Decrease a lot □ —□ —□ —□ —□ —□ —□ —□ —□ Increase a lot
16. **Play other people's puzzles**:
    Decrease a lot □ —□ —□ —□ —□ —□ —□ —□ —□ Increase a lot

17. **Which of the elements of the application and those mentioned above increased your motivation the most?**
    - ☐ Creation/Construction
    - ☐ Cooperation/Collaboration
    - ☐ Achievement/Success/Recognition
    - ☐ Understanding/Learning/Seeking knowledge
    - ☐ Play/Having fun
    - ☐ Overcoming defeat/Attacking players/Competitive environment
    - ☐ Other: _____
18. **Do you feel that these game elements and this game design will benefit your learning and make learning easier for you?**
    ☐ Yes ☐ No, because: _____
19. **In which degree do you think this application will be helpful for memorizing?**
    - ☐ Very helpful
    - ☐ Helpful
    - ☐ Neither
    - ☐ Unhelpful
    - ☐ Very unhelpful
20. **Which of these aspects do you recognize in the game?(You are welcome to search the application)**
    - ☐ Power (being visible to others)
    - ☐ Materialistic (creating and possessing something)
    - ☐ Ambition/Achievement (receiving recognition)
    - ☐ Information (receiving information and knowledge)
    - ☐ Affection (being in the company of others)
    - ☐ Sensual (finding satisfaction in stimuli and experiences)

Games for Learning

In this section I would like some input on using games for learning and learning in general.

21. **What is your opinion towards using games for learning?**
    - ☐ Very positive
    - ☐ Positive
    - ☐ Neutral
    - ☐ Negative
    - ☐ Very negative
22. **What do you have the most trouble learning?**_____
23. **Which learning method(s) do you enjoy the most?(choose maximum 3)**
    - ☐ Rote learning(memorization/learning by repetition)
    - ☐ Observational learning(learning by trying to imitate someone/something else)
    - ☐ Play/Games (learning where the main goal is not knowledge or learning)
    - ☐ Multimedia learning(auditory and visual stimuli to learn information)

- ☐ Meaningful learning(fully understanding how it relates to other knowledge)
- ☐ Formal learning(teacher-student relationship, such as in a school system)
- ☐ Nonformal learning(learning by coming together with people with similar interests)
- ☐ Other: _____

24. Which learning method(s) do you enjoy the least?(choose maximum 3)

- ☐ Rote learning(memorization/learning by repetition)
- ☐ Observational learning(learning by trying to imitate someone/something else)
- ☐ Play/Games (learning where the main goal is not knowledge or learning)
- ☐ Multimedia learning(auditory and visual stimuli to learn information)
- ☐ Meaningful learning(fully understanding how it relates to other knowledge)
- ☐ Formal learning(teacher-student relationship, such as in a school system)
- ☐ Nonformal learning(learning by coming together with people with similar interests)
- ☐ Other: _____

User-Generated Content

This section focuses on the content in the application. Method for quality assurance: The created puzzles can be rated, and if a puzzle has a low rating after many plays it will be deleted.

25. What is your opinion towards using user-generated content for learning?

- ☐ Very positive
- ☐ Positive
- ☐ Neutral
- ☐ Negative
- ☐ Very negative

26. Does generating your own content increase your motivation?

☐ Yes ☐ No, because: _____

27. Are you worried about the quality of the information if there is a quality assurance method as explained above?

- ☐ Yes, because: _____
- ☐ No

Other Comments

In this section I ask you to provide any information you may have regarding the use and experience of the application, or of the evaluation.

Feedback regarding the application:

_____

_____

_____

Feedback on completing the evaluation:

_____

_____

_____

C

RESULTS

This chapter lists some of the results from the evaluation and the completed questionnaires. The first section presents supplementary results from the first questionnaire which ascertained student opinions regarding motivation towards the presented scenario, opinions towards learning, learning methods and UGC in game contexts.

The next sections present supplementary results from both questionnaires where the results were only basic information, as expected, or only confirming what was already know.

C.1 QUESTIONNAIRE 1

FIGURE 28 shows the distribution of students and non-students answering the questionnaire.

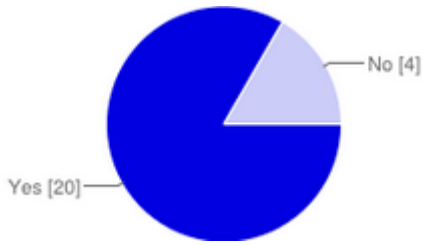

Figure 28.: Q1: 1: Are you currently a student?

FIGURE 29 shows how the age distribution among the responders of the first questionnaire was.

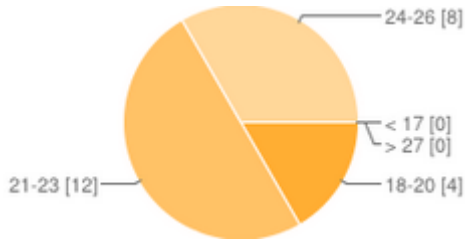

Figure 29.: Q1: 2: How old are you?

FIGURE 30 shows the responders' opinion towards using elements extracted from the psychological needs for learning.

Figure 30.: Q1: 5: Do you feel that using one or more of the elements above will benefit your learning and make learning easier for you?

FIGURE 31 indicates what the users felt would sufficiently increase their motivation regarding the explained scenario, so that the motivation for performing the learning activity would be positive.

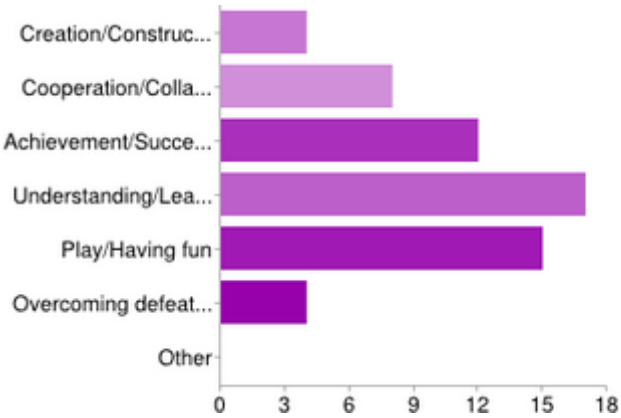

Figure 31.: Q1: 6: Which game mechanics do you think must be implemented for you to be satisfactory motivated to perform the task explained in the start of this questionnaire?(as many as necessary)

C.2 QUESTIONNAIRE 2

FIGURE 32 shows how the users of the puzzle game felt about using the game for learning(positive or negative), and if it would benefit learning and make learning easier for them.

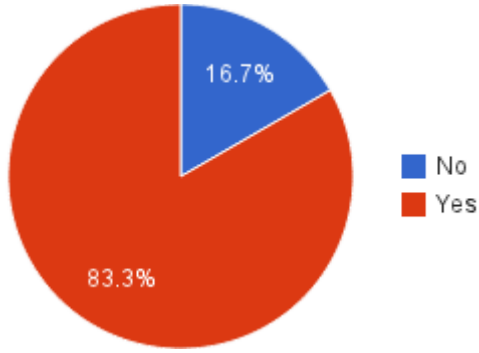

Figure 32.: Q2: 26: Do you feel that these game mechanics and this game design benefits your learning and make learning easier for you?

FIGURE 33 shows in which degree the users of the puzzle game found the application helpful for memorizing.

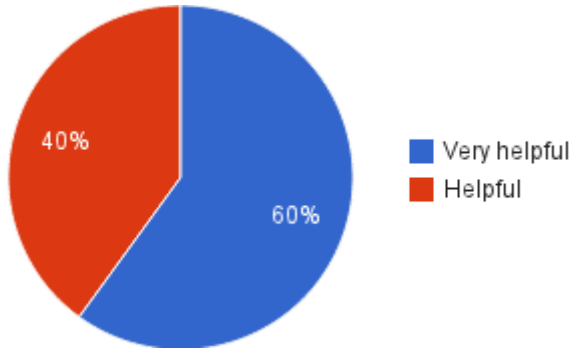

Figure 33.: Q2: 27: In which degree do you think this application is helpful for memorizing?

C.3 BOTH

Results from questions which were asked in both questionnaires.

FIGURE 34 shows how the respondents of both the first and the second questionnaire felt about using games for learning. This is almost unanimously positive, which indicates that there is more to gain from using games for learning, i.e learners would be more motivated for learning.

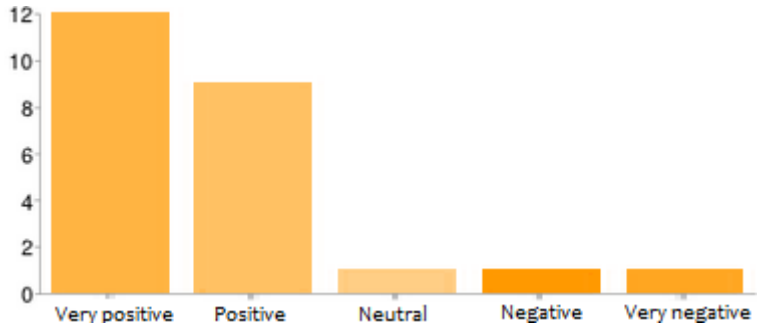

Figure 34.: Q1: 8 & Q2: 21 What is your opinion towards using games for learning?