# **AALBORG UNIVERSITY COPENHAGEN**

Semester: 4<sup>th</sup> semester Medialogy Master

#### Title:

Investigating how Singular Game Elements Can Improve the Overall Quality of a Game Application for Smartphones



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Project Period:		Abstract:		
Start date: End date: Semester Th	May 10 <sup>th</sup> 2012 November 30 <sup>th</sup> 2012 neme: Master's thesis	This project started with a thought that the board game Khet would be great as an Android application. An existing implementation has however received only		
Supervisor:	Lars Reng	mediocre feedback from its users. As such it was desired to implement a new Khet application for android focusing only on few needed elements in the game, but		
Project grou	<b>p no.:</b> N/A	polishing it using a user centered iterative approach.		
Member:		When the application was implemented to a playable state a set of user tests were conducted. The participants would grant feedback according to which elements of the		
	Johnny Myhre Mikkelsen	application they thought needed more work. Through iterations the product was improved.		
Copies:	3	Finally a final test with more users were performed. The results showed that the elements that had received the most feedback during user test had indeed improved, but the application as a whole would still benefit from		
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## FORMALITIES

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### **Reader's Guide**

This report assumes that the reader will have the basic knowledge of at least a tenth semester Medialogy student. A general knowledge of games and game development is also advised. Furthermore, it might be beneficial to have a general understanding Unity3D in order to understand parts of the implementation. Several game titles will be mentioned throughout this report without reference. If the reader stumbles upon a title that is unknown it is advised to read a description of that game, or possibly view a couple of videos on a game review website such as www.gametrailers.com.

The report is separated into chapters, which are referred to by x ("x" referring to the relevant chapter number e.g. 1, 2, 3 and so forth). Sections within the chapters are referred to by x.x, sub-sections by x.x.x, and sub-sub-sections by x.x.x.

A list of figures and tables can be found under the main bibliography before the appendix. Cross-references to previous/future sections in this report will be marked as (section x.x title) where "x.x" is the section number and "title" is the headline of the section. Source references are denoted as [x], where x is a number corresponding to the placement of the reference in the bibliography. Finally it should be mentioned that this readers guide is based on the reader's guide from a prior report [1].

# **1.0 INTRODUCTION**

The purpose of this report is to investigate the effect of involving users in the process of finding and developing key elements for mobile applications.

This project could be considered a case study where the board game *Khet* will serve as a foundation for development of a mobile game for Android. Through analysis of currently successful games and user tests throughout the project the intention is to develop a Khet application to a playable state that should aid in the game becoming a success on Google Play if nursed.

### **1.1 MOTIVATION**

A few years ago I got introduced to the board game *Khet*. Khet is a turn based game where the goal is to beat a certain piece controlled by the opponent, equivalent to the king in chess. I only played the game a couple of times before I decided that I had to get this game for myself, so I went out and bought it. Now I have owned this game for a couple of years and I still find it to be a great game. This is why I got inspired to actually implement it as an app for Android devices.

Recently there has been a release of a Khet application for Android on Google Play, but it did not receive the best of user ratings and recommendations. I bought the app to get my own impression of the game, because I believed that if the app was anything like the board game it seemed strange to me that it would receive mediocre scores from the users.

Having read the recommendations and tried the game myself I thought that it seemed to me that the game was better than the reviews and comments suggested. Still there is of course room for improvement. But most importantly it spawned an interesting question:

### What makes the difference between a great success and a failure for a game on Google Play?

Answering this question in itself would be rather difficult, but it is however a problem area that is interesting to look further into. A complete list of what would make a game a success is most likely not possible to create as it would differ from game to game. But if narrowing the field down to a single game it might be possible to discover some guidelines that will push the application in the direction of success rather than failure. Especially because this approach would allow for a user centered progression in the development, ideally resulting in less time used for development of features that does not contribute much to the games success. And diminishing time waste on inessential features grants the luxury of having more time for developing the features that users suggest would improve the game. Thus the initial idea is to through involve users throughout the development in order to constantly improve the game from the user's perspective, rather than from a game designer's perspective.

This reasoning along with an urge to produce a game for the smartphone platform is what will serve as my motivation for carrying out this project and writing my master thesis on the topic. Hence the above question will serve as the initiating problem in order to conduct

a meaningful analysis and construct a final problem statement. But prior to any analysis it might be beneficial to briefly introduce the perspective of the report, since it could have influence on choices throughout.

### **1.2 PERSPECTIVE**

In order to better understand this report and the perspective of it, it is deemed relevant to briefly introduce myself; the author. Since my childhood I have had a great interest in video games, along with a dream of one day getting to work in the industry. My profile on the Medialogy education is *Games - Technical*, meaning that I've specialized throughout my master semesters in the technical aspects of game development (primarily C# programming, the Unity3D engine and artificial intelligence).

# 2.0 BACKGROUND

With the introduction, perspective and motivation behind this report in place the next step is to consider the problem at hand, namely how to increase the chances of success for a game on Google Play. It has been decided to investigate this through a case study of sorts, by implementing Khet for Android and using the application to be developed to test what users prefer in terms of features, at least for this type of game. As such it is found relevant at this point to introduce Khet since it is not the most well known board game. And considering that the existing Khet mobile application has not achieved great success it seems safe to assume that it is relatively unknown as well.

### **2.1 KHET – THE BOARD GAME**

Khet is a two player zero-sum turn based game with perfect information published by Innovation Toys, LLC [1]. Each player has four different types of pieces that are placed on the playing board in a symmetrical fashion. The initial placement of pieces on the board is referred to as a *starting configuration* (see Figure 2 for a picture of a game set up with the classic starting configuration).

The main piece is called a *Pharaoh* and the goal of the game is to eliminate the opponent's Pharaoh by directing a laser to hit it. Any piece hit on a non-mirror side must be removed from the game. Beside the Pharaoh, each player has a number of *Obelisk*, *Pyramid* and *Djed* pieces. An Obelisk has no mirrors thus serving as a blocker. Pyramids have one mirror and Djed pieces have only mirror sides rendering it un-killable. Each player begins with a total of 14 pieces on the board divided as 1 Pharaoh, 2 Djeds, 4 Obelisks and 7 Pyramids. The following illustration shows what the original Khet pieces look like:



Figure 1 - Illustration of the four different types of pieces [1].

A turn in the game consists of two simple steps. First the player must move or rotate a piece of his color and subsequently the player must fire his laser. All pieces can be moved one field up, down, left, right or diagonal and a rotation must be exactly 90 degrees. An Obelisk have the ability to move on top of another Obelisk and the Djed piece has the ability to swap positions with any Pyramid or Obelisk as long as that piece is placed on a neighboring field of the Djed's placement.



Figure 2 - Picture of the Khet board game with a classic starting configuration.

Having briefly covered the rules and goals of the game it is deemed important to note that a newer version of the game has been released since 2006 when the original Khet was released. This new version is called Khet 2.0 and is basically the same game, with some refined and more detailed pieces but very few rule-changes. The Khet Android app is based on this newest version of the game.

### **2.2 KHET – THE EXISTING MOBILE APPLICATION**

As mentioned earlier there is already an existing Khet app (developed by Schogini Systems [2]) on Google Play, but it has not been receiving the best of feedback from the users. Hence it is found relevant to look into what the people behind this app might have done wrong in order for the game not to receive better scores. A screenshot of the game has been included (see Figure 3).



Figure 3 - Screenshot of the Khet app for Android (taken on an HTC One X).

According to Google Play [3] the Khet app has been installed between 100 and 500 times since it got released (assumed to be around the beginning of 2012 or late 2011). At the time of writing the app has received an average score of 3.3 stars (of 5 possible) in user rating with a total of 27 votes. This sample is not huge compared to e.g. Angry Birds that

currently has over 1,200,000 votes. None the less one can argue that these 27 people does in fact indicate a tendency of the app not being flawless. If not from the average score then perhaps some of the users' comments can shine a light upon which elements that would benefit from a rework and/or additions.

Reading through the user reviews on Google Play has resulted in the following list of positive and negative comments about the game. Some might be contradicting as each user can write exactly what he/she likes. Therefore it is also important to state that the reviews are of course completely subjective, and there is the possibility of some users potentially just not understanding parts of the game or interface.

Positive user feedback	Negative user feedback		
<ul> <li>Positive user feedback</li> <li>Nice/good looking graphics.</li> <li>Fast developer feedback.</li> <li>The game is a lot of fun and it is challenging.</li> <li>Good difficulty of the AI.</li> <li>Similar to the board game.</li> </ul>	<ul> <li>Negative user feedback</li> <li>Occasionally the app will not let a user perform a legal move.</li> <li>Crashes frequently during multiplayer games.</li> <li>Game did not end after a Pharaoh was hit.</li> <li>The <i>invite friend</i> functionality is inconvenient and not user friendly.</li> <li>There should be screen names for multiplayer.</li> </ul>		
	<ul> <li>Graphics glitches sometimes when firing laser.</li> </ul>		
	<ul> <li>It should be possible to move the app to SD card.</li> </ul>		
	<ul> <li>Multiplayer will not progress past the initial move.</li> </ul>		
	<ul> <li>AI difficulty is too difficult, even on the easiest setting.</li> </ul>		
	<ul> <li>It is difficult to follow the AI's moves due to lack of animations or indications.</li> </ul>		
	<ul> <li>SMS to invite friends is not an optimal solution.</li> </ul>		
	• The interface is clunky.		
	Slow developer feedback.		

Table 1 - Collection of unique user review statements found on Google Play. The statements have been<br/>divided in columns of positive feedback and negative feedback respectively [3]. Finally it should be<br/>mentioned that the statements are taken out of context and some have been slightly altered to remove<br/>slang, profanity and/or spelling errors.

Looking at the table (see Table 1) it becomes apparent that there is room for improvement. Initially it is important to state that even though the positive side of the table is much smaller than the negative side it does not necessarily mean that all hope is lost for the app. Most positive comments in the reviews have been kept very short and are generally much less descriptive than the negative feedback. Also the table does not show how many times a given positive or negative comment was present, meaning that two users agreeing that e.g. *the game is fun* will only be shown as a single point in the table. Furthermore the division between positive and negative has been carried out subjectively in this report, and is as such merely a set of guidelines to be used for indicating which

parts of the app that might function well and which parts that functions less well according to the end users.

Considering the negative feedback from the table (see Table 1) it seems like several of the statements from the users is things that could have been eliminated if involving users more during development. Of course it cannot be known whether users have been involved in the process or how much, but elements like a *clunky interface* or the bugs described that are related to multiplayer is something that would most likely have been discovered through user tests. The interesting question is however if it would have made any difference in terms of rating on Google Play, number of installations and overall success. One could easily imagine all the problems getting resolved, but still without the game becoming much more of a success due to factors external to the game itself (e.g. marketing strategy). Never the less, if disregarding elements external to the game this is why it is deemed interesting to involve users. Not only to resolve potential problems, but also to aid in making the right choices in terms of which things that should be used the most time on perfecting. Involving users during the phase of development introduces a perspective to the development phase that helps a developer to better understand the needs and preferences of the users. Ideally this should introduce an iterative process where the game is developed to more successfully meet the expectations of the majority of a target demography - the end users.

Having introduced Khet, both as board game and as mobile application, it seems relevant to have a look at what other more successful games have done in order to achieve their reputation. Hopefully this will shine a light upon which possibilities there might be for creating a better Khet application than the existing one.

### **2.3 STATE OF THE ART ANALYSIS**

Knowing that the initiating problem concerns how a game becomes popular on Google Play (see section 1.1 Motivation) it seems most relevant to take a look at a couple games that have achieved some kind of success there. For starters it is deemed relevant to have a look at *Angry Birds* and *Wordfeud* as these two games are placed in the top five of free games on Google Play at the time of writing. These games are interesting specifically because they are very different from one another and yet have both become quite popular.



Figure 4 - Screenshot of the top six games on the *Top Free* list of Google Play at the time of writing.

At the time of writing Wordfeud has received over 10,000,000 downloads, while Angry Birds has received more than 100,000,000 downloads. The other three games currently in the top five do have quite a lot of downloads as well (each of them over 1,000,000), but what is especially interesting about Angry Birds and Wordfeud is that it seems obvious that they have gotten successful for two very different things. Angry Birds is a single player game that do allow for marginal competition (through the stars that is given from defeating levels). Wordfeud on the other hand is completely non-single player, and is thus based solely on competitive multiplayer. Either is an option for Khet, and with these two being the best at what they do (if using amount of downloads as measurement) it seems obvious to include them in a state of the art analysis. Hence it is interesting to attempt to understand what these games have done well in order to become as successful as they are.

#### 2.3.1 ANGRY BIRDS

*Angry Birds* is a mobile game that has had a massive amount of downloads on Google Play (as well as on Apple's App Store). The goal of the game is to fire small birds from a slingshot towards small constructions in order to destroy all pigs in a given level. The game is so simple that most small children will not only be able to grasp the concept, but also be able to perform fairly decent in the game. Never the less this specific game has had some form of appeal to adults as well which is interesting in the context of this report.

According to Mauro [4] it is more usual to ask questions about why some given design does not work rather than asking questions about what exactly makes it work well. Never the less Mauro attempts to analyze which elements of Angry Birds contributed to the game's success.

One thing that Mauro describes as a positive element of Angry Birds is increasing complexity to an otherwise simplistic problem/solution game design. For example will new birds (with new behaviors) be introduced at a time before the game becomes trivial and boring; but after the latest bird has been firmly understood by the user. This means that the user will relatively quickly learn that new challenges will be introduced continuously aiding in keeping the user engaged in the product.

Another element that Mauro describes as being positive for Angry Birds is that the response time of the application is managed in a way that fits the game very well. One could easily have made the birds travel faster through the air after being shot from the sling shot. This however would make it a bit more difficult for the user to follow the trajectory of a given bird, resulting in a lesser chance of improvement on the following shot. The relatively slow response time allows the user to constantly attempt to improve a shot for a better score. The few seconds of birds being airborne and constructions being shattered with pigs rolling around allows the user to prepare for the next move while still viewing the result of the current shot, again aiding in the user's engagement in the product.

The above examples are just some of the things that Mauro express as contributing to the success of Angry Birds. To briefly cover some of the other elements that have aided in the success of the game Mauro mentions a clever incitement of human short term memory usage e.g. showing the goal of the game for each level and slowly sliding it off-screen creating a scenario where the user cannot both make his shot and see the goal simultaneously. And finally a well produced sound and graphical environment for the game that furthermore has a great correlation with one another is also contributing to the user enjoying the game.

Having covered Angry Birds in some detail it seems reasonable to have a look at which elements that might have contributed to the success of Wordfeud.

#### 2.3.2 WORDFEUD

*Wordfeud* is a game that is based on the board game *Scrabble*. Two players will each be given seven tiles, each with a letter on it. These tiles must be used to create words on the playing field. Depending on the tiles used, the length of the word created and the fields that becomes occupied each word will grant the player a given score. As tiles are used and the playing field is getting occupied with words each player continues to get new tiles from the remaining stack. When all tiles are used, the game is over and the player with the higher score wins.

One aspect that might have contributed to the success of Wordfeud as a mobile app might be revealed by looking at the game from a game design perspective. A key aspect of Wordfeud (or Scrabble) is that the game is highly based on asynchronous information (from Björk and Holopainen's Patterns in Game Design [5]) between the players. It's important in the game that one player does not know which tiles the opponent holds. This pattern in the game makes the mobile platform ideal as playing with random strangers does not involve any interaction the players between except through the game itself.

The networking in the application seems very well thought out for the specific purpose of the game. It is very fast and easy to find a random stranger to play with, and should some users prefer playing with friends this has been made easily possible as well. This combined with the fact that several games can be started simultaneously and that players has up to three whole days to respond to an opponent's move might also have contributed to the success of Wordfeud.

### **2.4 PRELIMINARY SURVEY**

As the state of the art analysis has been conducted in a partially subjective fashion, due to sparse information on the topic, it is decided that a small survey will be conducted in order to aid in validating the analysis to some degree. Hence this preliminary test is conducted with the intention to compare answers from users that have actually played the game with the analysis.

Ideally this survey will also aid in pointing out what exactly users like about the two games in question, because this information hopefully will allow for directing the development of a Khet application into a path that increases the chances of finding at least a single element that the users will enjoy. At least if the users to some degree are able to pinpoint elements that have been discussed in the analysis one can argue that those elements is what the users like and notice about the game, ultimately rendering the game successful from a user's perspective. What the survey will not answer is how much of the success that has base in marketing strategies, viral distribution, founding or similar.

### **2.4.1 PREPARATION OF THE SURVEY**

As the intention of this survey will be to mainly investigate whether end users agree with the analysis in this report it has been decided to create a questionnaire to be distributed online through the authors personal Facebook profile. This method is a fast solution for getting a general opinion compared to a more qualitative approach (e.g. interviews). On the other hand the quantitative method has the downside that some participants might not answer in much depth, but this is acceptable at this stage of the report as the intention is to merely disclose if a tendency can be found amongst the answers [6].

Due to the fact that the questionnaire will be distributed online (using social media) it is uncertain who exactly will be responding. Not knowing the demography makes it a bit more difficult to design the questionnaire as questions will have to be of a more general nature to ensure that participants of different age groups and social backgrounds will be able to understand and reply. Never the less it serves the purpose of quickly getting a relatively high number of replies, hopefully resulting in a dataset that will make it possible to conclude whether or not there is some sort of general tendency.

Test participants will be asked to rate Angry Birds and Wordfeud on a scale from 1 to 5 and subsequently asked to describe which elements from the game that they think are good. Participants that have not played one of the games will be redirected so that they do not get the chance to rate a game that they have never played. This also means that participants that have not played any of the games will not be prompted to answer any questions at all and their answers can thus be ignored when analyzing the data. The scale is included because it is expected that people who does not like a given game very much (i.e rating it low on the scale) will most likely have played it less that people who like it a lot. And even though the games of choice in the test are rather popular it is expected to get some answers from persons that disliked the games. Thus it can be argued that the qualitative answers from persons rating the game low on the scale will potentially contain less information about elements from the game which have contributed to its success than that of people who have rated it higher. Ultimately the scale will be used as a tool for sorting the qualitative answers, since it is estimated that higher rating means a higher chance of the game being played for a longer amount of time rendering the qualitative feedback more meaningful.

Finally it is important to note that the Khet application has not been included in the questionnaire. Due to its relatively few installations (see section 2.2 Khet – The existing mobile application) the chance that any of the test participants have ever played the game is very low. Thus it is deemed obsolete to ask test participants about the game at all. The survey can be found in the appendix (see 13.1 Appendix 1 – Preliminary survey).

#### 2.4.2 RESULTS OF PRELIMINARY SURVEY

The questionnaire was distributed using Facebook as planned. In total 69 persons answered the questionnaire over a time period of approximately 48 hours. The dataset that has been gathered can be found in the appendix (see 13.2 Appendix 2 – Dataset from preliminary survey). This section will present the results of the collected data and whenever a TPN (Test Participant Number) is mentioned it refers to the number of an answer found in prior mentioned appendix.

Firstly it is relevant to mention is that a total of 9 persons have answered that they have neither played Angry Birds nor Wordfeud. These people were not allowed to rate the games and explain which elements from the games that they like. This means that these nine answers can be ignored completely, diminishing the amount of usable answers to a total of **60 answers related to either Angry Birds, Wordfeud or both**.

Secondly it should be mentioned before presenting the results is that a single answer (TPN 13) for some reason did not fill in the required fields despite stating "yes" to having played Angry Birds. This should technically not be possible, but for some reason it has happened and that answer will have to be treated as if the participant had answered "no" to having played the game. TPN 13's answer regarding Wordfeud has been filled in correctly and the answer can as such be used with regards to Wordfeud, but not with regards to Angry Birds.

Finally, before presenting the results, it is relevant to state that statements from the test participants will be quoted loosely in order to merge similar statements into single statements in order to present a better overview. This means that one person stating that "the game is fun" and another person stating that "I usually have fun while playing the game" could be merged into two persons stating that *they find the game to be fun*. All lose quotes in the following sections will be presented in *italics* for an easy overview. If it is desired to see the original answers from test participants they can be found in the appendix (see 13.2 Appendix 2 – Dataset from preliminary survey).

#### 2.4.2.1 RESULTS RELATED TO ANGRY BIRDS

Initially it is relevant to know that of the 60 usable answers, 5 persons state that they have not played Angry Birds but have played Wordfeud, resulting in 55 answers minus the one that never received data for required fields totaling **54 answers related to Angry Birds**.

When looking at answers from people that have rated the game as either 1 or 2 on the scale, the amount of answers amounts to a total of 6. Two of these six persons have described elements in the game that they believe is positive. One mentioned that *replayability* is a good element while the other has emphasized that that he/she likes the element of *improving ones aim*, the *continuous addition of new content during progression* and that the app *is a good waste of time*. It should however be mentioned that this second person (whom rated the game 1 on the scale) has initiated the qualitative answer by writing "4" which suggests that he/she has overlooked that there is a separate field with a drop down menu in the questionnaire (which unfortunately is set to 1 by default) for rating the game (see answer from test participant number 43 in 13.2 Appendix 2 – Dataset from preliminary survey). As such there is a chance that this participant wanted to rate the game as a 4 but by mistake rated it as a 1. Despite this potential flaw his/her answer has been categorized here as rated 1, due to the fact that it cannot be ensured that the rating has been mistaken even though it seems like it.

A total of 25 persons rated Angry Birds as a 3 on the scale. Several answers describe the game as being *fun* though some indicates that it becomes trivial or repetitive over time. Furthermore the game is being described as being *simple* which can be either good or bad depending on what the individual person had in mind when writing the answer. A few persons indicate that the game is *great for killing time, it is easy to learn* and that *the graphics are good*. Finally individual persons states that *the game is addicting, it suits the platform* and that *it has interesting physics*.

The amount of people rating Angry Birds as a 4 on the scale accumulates to 22. Again it is pointed out by several persons that *the graphics are good*, it is *good for short term usage when waiting* (e.g. for a bus) and that *the game is challenging*. Also it is pointed out by a few that *the game is good/fun*, that *it is easy to learn* and that *the game is addicting*. Individual answers state that *the sound is good* and that the game *has a nice feel and good sense of progression*. And finally, the one person rating Angry Birds as a 5 on the scale states that *it is fun and original*.

#### 2.4.2.2 RESULTS RELATED TO WORDFEUD

The dataset shows that 12 people stated that they have not played Wordfeud, but have played Angry Birds. This means that of the 60 people that have played at least one of the two games there are **48 answers related to Wordfeud**.

A total of 8 persons rated Wordfeud either 1 or 2 on the scale. Of these eight people only a single answer is stating that *the game is fun*, without also criticizing it for getting boring relatively fast. The remaining answers are merely critique of the game.

15 persons have rated Wordfeud as a 3 on the scale. Several of these answers state that *the game is fun initially*, but again some points out that it gets boring over time. Three persons mention that *it is good that the game is multiplayer*. Individual answers include persons describing that they like about the game that, *it aids in learning new words, it is challenging, it brings Scrabble into the* 21<sup>st</sup> *century, it does not require constant attention* and *it requires skill*.

All in all 13 people rated the game as a 4 on the scale. Many of these 13 answers indicate that they enjoy that *the game allows for playing with friends and family* while some refer to the game as being *a social game*. Describing that *the game is fun* is also something that reoccurs throughout the answers. A few answers indicate that *the game is challenging* though others state that *it is easy to learn*.

Finally, 12 persons rated the game as a 5 on the scale. Eight of these people mention that they like that *the game allows for multiplayer* (most of them specifically stating that *it allows for playing with friends*). A few mentions that *it is good that the game is challenging* and that *it is a nice brain activity*. Finally it is described as being *fun*.

#### 2.4.2.3 RESULTS IN RELATION TO STATE OF THE ART

The idea with this section is to compare the results of the preliminary survey to the analysis of Angry Birds and Wordfeud respectively. By ensuring that the elements found in the analysis is something that the users actually notice and enjoy about the game it can be considered if similar elements could be introduced to a Khet application in order to heighten its production value and ideally chances of success.

Before delving into this comparison it does however seem reasonable to briefly discuss the results found. Initially it should be mentioned that all feedback from the survey regarding negative aspects of the games has been ignored. This is not because negative feedback cannot be used in development, but merely because those elements would most likely not have contributed much to the overall success of either game. The negative feedback given seem to primarily come from test persons rating the games relatively low on the scale and could as such be explained by those persons not being in the target demography of the games, rather than a general tendency. It was expected that some test participants would describe elements that they dislike even though they were not asked for it. Thus it has not been included in the results section, but it can be found in the appendix with the complete dataset (see 13.2 Appendix 2 – Dataset from preliminary survey).

Furthermore it should be mentioned that there is a bias to consider due to the method used for distribution of the questionnaire. As the questionnaire was distributed through the personal Facebook profile of the author this has the immediate influence that some of the participants will most likely have some sort of relation to the author of this report rendering some of them biased. Never the less it can be argued that they did not directly know what the purpose of the questionnaire is and hence they would not have much knowledge about how to color their opinion to suit the results of this report. There is a chance however that test participants have answered more in depth, or more positively than if they had not known who would receive the answers, which of course is a bias and thus should be mentioned explicitly. On the other hand the participants have been explained that answers are anonymous which ideally should encourage them to answer more freely and honestly.

Having discussed how the answers have been handled and what kind of bias that can be expected it seems reasonable to progress with comparing the results to the analysis of the two games. To best do this it has been decided to briefly sum up what was found through analysis (see section 2.3 State of the art analysis) and questionnaire respectively. In order to easily refer to points of interest in the following tables be advised that the following abbreviation (T2-4) will refer to 'Table 2 point 4' being the phrase *Well produced sound*.

Angry Birds analysis			Angry Birds questionnaire results		
1.	New challenges introduced over	Α.	Replayability		
	time	B.	Element of improving aim		
2.	Response time designed for	С.	Continuous addition of new content		
	users to evaluate and improve	D.	Good waste of time		
their shots		E.	Fun		
3.	Clever level design (forcing users to use their short term	F.	Simple		
		G.	Easy to learn		
	memory)	H.	Graphics are good		
4.	Well produced sound	I.	Suits the platform		
5.	Well produced graphics		(smartphone/tablet)		
		J.	Addicting		
		К.	Has interesting physics		
		L.	Good for short play sessions		
		М.	Nice feel of progression		
		N.	Good sounds		
		0.	Original		

 Table 2 – This table shows points of interest from the state of the art section on Angry Birds (see section 2.3.1 Angry Birds) versus statements from the preliminary survey.

First thing that the table shows is that the users seem to cover more aspects than the analysis of the application (see Table 2). On the other hand the users mention things that cannot directly be referred to as a game element (e.g. the game being "fun" or "original"). Never the less the important thing is that some coherence between the two sides can be found. Looking at the table T2-1 (New challenges introduced over time) and T2-C (*Continuous addition of new content*) seems to be somewhat identical making it possible to state that an element of *continuous addition of new content during progression* is part of the reason for its success. Other elements that seem to pair up nicely are: T2-2 with T2-B, T2-4 with T2-N and T2-5 with T2-H. Hence it can be concluded that the only point from the analysis that the users did not mention in the questionnaire is T2-3 (*Clever level design*). It cannot be concluded that the level design has not contributed to the success of Angry Birds, but it can be concluded that it has not been important enough for the users to explicitly mention it. One could argue that most users would not have the knowledge of game design to specifically point out 'level design' as an enjoyable element, but no answers seemed to even hint it, and thus it must be concluded that it from a user perspective not is important enough to bring up when asked. Chances are however that an alternative level design might have caused a negative impact on the game, but this is of course unknown and it is likely that the users do dislike it more than they like it since it has not been mentioned at all.

Wordfeud analysis		Wordfeud questionnaire results	
1.	Asynchronous information	А.	Fun
2.	Well designed network for	В.	Good that it is multiplayer
	multiplayer	С.	Aids in learning new words
3.	Clever system design allowing for	D.	Challenging
	multiple games	E.	Renewed version of Scrabble
4.	The opportunity to make response	F.	Does not require constant
	over a duration of three days		attention
		G.	Requires skill
		Н.	Allows for competing with friends
			and family
		I.	Social game
		J.	Easy to learn
		К.	Nice brain activity

Table 3 - This table shows points of interest from the state of the art section on Wordfeud (see section2.3.2 Wordfeud) versus statements from the preliminary survey.

Looking at the table (see Table 3) it can be seen that again some points from the analysis is backed up by the answers from the test. The following pairs can be made immediately: T3-2 with T3-B/T3-F, T3-4 with T3-F. Furthermore one could argue that with a bit of interpretation the statements the it is a *social game* (T3-I) and that it *allows for competing with friends and family* (T3-H) is coherent to some degree with the point in the analysis about *clever system design allowing for multiple games* (T3-3). Thus it can be concluded that the only thing that the test participants did not mention is *asynchronous information* (T3-1). A final thing that seems worth mentioning is that both for Angry Birds and for Wordfeud the test participants have mentioned that the games are *easy to learn* (T2-G and T3-J). With only two games in the sample it is of course not enough to conclude that it is a must, but it most likely cannot hurt for the game to ease the users into it as far as possible.

This illustrates that the users does in fact notice elements from the games that seem to be elements that the developers have nursed and perfected to a point where it becomes defining for the game. Knowing this it seems safe to assume that the same could in theory be done with a Khet application. At this point it is however important to state again that this report has not covered elements like marketing and viral distribution. These of course are also very important aspects of becoming a success in the game industry but despite their importance, they are deemed out of scope for this report as the intention is to focus on developing the application.

### **2.5 FINAL PROBLEM STATEMENT**

Having introduced Khet both as a board game, and the current application along with investigating what users like about some of the most popular games on Google Play it seems reasonable to narrow down the scope. It has been found that key elements of games (when well designed and implemented) are noticed by the users as being *good about the games* according to the preliminary survey.

An interesting discovery through the report this far is that some of the elements that users seem to enjoy from Angry Birds and Wordfeud are similar to features that users seem to

dislike in the Khet application. An example of such could be that users dislike how they are allowed to invite friends to play Khet, but users seem to like the way this is handled in Wordfeud. The same goes for screen names in multiplayer. Furthermore users are complaining that the AI is too difficult in Khet, whereas users enjoy the challenging levels and progression of these in Angry Birds. One could argue that both Angry Birds and Wordfeud are more well established and as such might allow for more frequent improvements than the Khet app. Also it seems like the most of the negative feedback regarding the Khet app could be said to be not focused on the users disliking the mentioned features, but rather that the users are annoyed that many features are buggy or implemented in a less than optimal fashion. This posts an interesting dilemma being if it is better to develop more features that are less polished or if it is better to focus on single features that are more polished. With respect to this dilemma the following question has been formed as the final problem statement for this report:

# Would a Khet application with few, but well developed, features result in a more positive evaluation by potential users?

This is an interesting question because answering it would give an indication of how time is most efficiently put into developing mobile games for Android. It suggests that it might be more optimal to create only parts of a game, but closer to a final implementation rather than a broad but less finished and partially buggy implementation of a game. Hence the next logical step would be to consider how to best answer this question.

# 3.0 METHODS

The intention with this section is to cover and discuss the methods that will be used in order to answer the final problem statement. But before this can be done it should be considered what information that needs to be gathered in order to achieve as good a solution to the final problem statement as possible.

### **3.1 THE HYPOTHESIS**

To ease the process of choosing a suitable approach it might be beneficial to create a hypothesis based on the final problem statement. Considering the final problem statement of this report (see 2.5 Final Problem Statement) the following hypothesis can be formulated:

**Hypothesis**: Creating a well made game but with focus on a few elements will improve the chances of potential users to grant positive feedback.

This should not be interpreted as focusing on a single element completely means disregarding everything else. Rather it should be understood as having a functional game (that can be played with only minor bugs and looks and sounds decent) is not necessarily enough. Improving an element of the game or game shell that contributes to the game as a whole, and nursing this to a point where it works really well might be a better solution for creating a successful game compared to using the same amount of time on implementing several game elements that might as a result function less well. Thus the approach in terms of developing a Khet application for this project must be planned at this point with respect to this hypothesis.

### **3.2 THE APPROACH**

Initially it is known that Khet originally is a board game and is thus designed to function well as a board game. Wordfeud has shown that it is in fact possible to come from a board game (in this case Scrabble) to a well functioning and well received, from a user perspective, mobile application. This suggests that it could be a good idea to investigate the differences between the two platforms, and consider what can be done in order to maintain the well liked aspects along with utilizing the possibilities that it gives to move a game from one platform to another. When this is done between digital platforms (e.g. taking a game from a PC to a video game console like *Xbox* or *Playstation*) it is commonly referred to as *porting* a game. This term will be adopted for the purpose of this report when talking about moving the game from a board game to the smartphone platform.

Having considered how to port Khet to Android, it might be beneficial to prioritize the features that should and/or could be implemented. As the idea is to present the game as finished as possible for potential users, it seems reasonable to investigate which elements that maybe could be left out, or at least saved for later implementation. This could be done by initially taking into consideration the rules and goals of the game at first, and then look into game shell features (i.e. everything related to the application that does not directly

relate to Khet - menus, multiplayer, artificial intelligence etc.). In relation to this it also seems relevant to consider the feedback that the existing Khet application has received in order to avoid recreating potential flaws from that application.

When the game has been developed to a playable state it is desired to involve the users as much as time allows. As hinted in the motivation (see section 1.1 Motivation) the intention is to let the users have influence through their feedback. Hopefully there will be a correlation between what users mention in a test and which elements are important to them. If focusing the implementation between iterations on elements chosen based on the users' feedback, one could argue that the end product indeed should have a higher probability of meeting end users' expectations.

In terms of testing the final product, prior experience, from earlier Medialogy [7] and game development projects [8], suggests that when dealing with a problem concerning elements in a game a qualitative approach involving the users is a decent approach. It allows for discussion and in depth answers that a quantitative method simply cannot compete with. It is rarely interesting to find answers that can be generalized to either all games or even a certain genre. It is however interesting to find answers in the context of a specific game, since these answers will aid in understanding what about the elements the users like and dislike. And understanding the users' demands is key when it comes to engaging them in a game, which is why it is deemed relevant to utilize a qualitative approach. Hence the main task at this point is to consider which kind of qualitative approach that would be suited for the problem at hand.

Knowing that a qualitative approach would most likely aid in solving the problem, and knowing that the original board game is a two player experience it seems reasonable to interview two persons simultaneously. One could do this in a fashion inspired by focus group interviews, though focus groups usually consist of more than two participants [9]. In theory one could run two play sessions concurrently, but this create a series of issues that makes it difficult to pair the total of four persons together in a single focus group. Most obviously that the games will most likely end at different times, meaning that some persons will have to wait for others, which is unwanted. Furthermore the two groups will have had different experiences which mean that group one might not be able to relate to parts of group two's arguments. Thus it seems more reasonable to accept that the groups will consist of only two persons at a time.

# 4.0 ANALYSIS

As the final problem statement has been found and the methods have been covered it is now possible to commence the needed analysis. According to the methods section (see 3.0 Methods) it is found relevant to at least investigate how to port the game, how to prioritize the features of the game and to cover the theory behind the test method to be used for final testing of the application. As such the goal of the analysis will be to prepare the necessary foundation for designing the application.

### **4.1 PORTING A BOARD GAME TO A DIGITAL PLATFORM**

Since Khet is a board game originally and a mobile phone is a digital platform it is deemed reasonable to investigate which problems and or benefits one might encounter when moving from one platform to another.

### 4.1.1 AUTOMATION OF ROUTINE ACTIVITIES

Recently a report has been written by Joseph Pape on the topic of automation and digitization on board games for digital table tops [10]. Despite the fact that the target platform in Pape's research is digital table tops, the effects of automation when digitizing a board game is arguably still applicable in the context of this report. Hence it is found relevant to delve into which positive and negative consequences it might have when a physical board game is made digital, keeping in mind that for this report the target platform is of course mobile phones and the board game is Khet.

Initially it is important to clarify what exactly is meant by the term *automation*. Automation is, as the word suggests, a way of speeding up trivial tasks and routine activities that occurs before, under and after a game. These tasks could be e.g. rolling dices, shuffling cards, setting up pieces, keeping scores, enforcing rules, etc. [10]. In the context of Khet (as a board game) one could immediately mention that setting up the game (i.e. a starting configuration of the pieces) is a trivial task. Another example is enforcing rules (as in most board games). This illustrates that Khet does in fact contain elements that are possible to automate completely in a digital port of the game.

In Pape's thesis it is concluded that the automation of certain elements was very well received by test participants, while other elements were less appreciated. According to Pape the automation can have a negative impact on the players' awareness and enjoyment of the game. On the other hand players seemed to like the more streamlined gameplay of a highly automated interface. The automation did however make the game more restrictive which means that players might sometimes be hindered in doing something that they personally find helpful during the game due to automation [10]. Automated rule enforcement is something that should in theory aid players in learning the game faster, as one can simply attempt an illegal move, and the automation will ensure that the move is not carried through. If too much control is taken away from the players it might lead to frustration and loss of overhead in the game. The same goes for rigid game progression so Pape does suggest the implementation of undo functionalities [10].

Considering this in relation to the problem at hand it is deemed relevant to implement automated rule enforcement and an undo functionality, at least, in the Khet application to be developed. The automated rule enforcement should ideally make the learning curve of the game less steep as it will prevent the user from making illegal moves. And since the game is turn based, an undo functionality could prove itself useful in situations where users potentially makes an unwanted move (e.g. by clicking the screen by mistake). If this happened and there was no way for the user to correct the error one could easily imagine a scenario with an unhappy user - especially because Khet is a game with perfect information and as such a mistake can be difficult to "hide" from the opponent.

### 4.1.2 SOCIAL ASPECTS

Board games and digital video games have some immediate differences in the way they make people interact with one another. This might not be directly relevant for answering the final problem statement, but porting a board game to a digital platform will most likely have some form of influence in terms of social interaction between players which is why it is found relevant to at least briefly covering the subject. It is furthermore deemed relevant to touch upon this topic as some elements from the test to be performed might be influenced by the platform - in this case an Android based smartphone.

Most board games will have people gather in a close proximity in order to play giving the participants the opportunity for face-to-face interaction. Video games, on the other hand, does not always require people to meet physically. Hence the interaction between participants will be through the actual game in form to text or voice [10].

Another interesting aspect of board games is that they are mostly turn based, whereas video games can be based on a simultaneous real-time interaction. This means that board game will allow for some downtime while other players take their turn. The downtime is a situation where players that are not currently active in the game have a possibility of casual social interaction [10].

#### 4.1.3 TOUCH AND GESTURE INTERACTION FOR MOBILE SCREENS

It is known that the game application will be implemented for the smartphone platform. This means that it is relevant to investigate how the interaction should be implemented. And to ensure that this is done in a fashion that hopefully will allow for decent usability it seems reasonable to initiate this section of the analysis by looking into how it has been designed in the existing Khet application since the usability of this application has not explicitly received any negative feedback from the user reviews.

In the existing Khet application the first thing that meets the eye when opening the application is a splash screen displaying the name of the game and the name of the company behind the game. This last for a few seconds before the user is taken to the main menu of the game. The main menu provides the user with five immediate choices, in the form of buttons covering everything from feedback to developers over starting new games to loading saved games. What the buttons does is not so interesting in terms of this analysis, but it is interesting how the user interacts with them. A button in the menu is

clicked by pressing a single fingertip against the screen where the button is positioned (much like a regular click with a mouse on a PC interface). Everything in the menu is single click based interactions so the next interesting topic to look into is the ingame interaction.

Having navigated into a saved game or chosen a new game with a given starting configuration, the application presents the user with the actual game. The game is started immediately after it is loaded, and the silver player acts first. By clicking and holding a silver piece the piece is lifted from the playing field, and the user can freely move the piece to another field. Alternatively a single click (not holding the piece) will bring up a small menu with two buttons, one for turning the piece 90° clockwise and the other for turning the piece 90° counterclockwise. Having either moved or turned a piece the player is presented with a single button that fires the lazer when clicked. Firing the lazer concludes a players turn, and the red player will now have his/her turn.

This illustrates how all interactions in the existing Khet application is handled through pressing the screen with a single finger. One could argue that this allows for easy learnability and is decently user friendly. On the other hand the approach does not very well utilize the possibilities of the platform which potentially could be a downside, as this approach might not meet user expectations when they purchase the application. Of course one should not implement e.g. multi touch interactions or sensor inputs unless there is a good reason to do so, but when comparing the existing Khet application to Wordfeud something does stand out as a difference. Both are based on board games and both are implemented as 2D applications. However, in Wordfeud the user can zoom by double clicking on the screen and then move around on the playing field using swipe gestures. In Khet there is no such possibilities, but since some of the negative feedback on Khet, from the user reviews, mentions that the interface is 'clunky' it might be worth considering to grant the user a bit more freedom to move around.

### **4.2 A**NALYSIS RELATED TO THE EXISTING KHET APPLICATION

As the existing Khet application has received some negative feedback related to certain features it is deemed relevant to briefly discuss these features in order to obtain a better understanding of the reasons that might lay to ground for this along with potential solutions. Some of the features might need to be redesigned, some might need to be excluded completely and new features might need to be included in order to accommodate for mentioned flaws. This section is intended to give an overview of features that should be considered during design.

When looking at the list of negative feedback regarding the existing Khet application (see section 2.2 Khet – The existing mobile application) it becomes apparent that some of the feedback is regarding bugs in the game.

The following is a list of bugs that the users have mentioned:

- Occasionally the app will not let a user perform a legal move.
- Crashes frequently during multiplayer games.
- Game did not end after a Pharaoh was hit.
- Graphics glitches sometimes when firing laser.
- Multiplayer will not progress past the initial move.

This list of bugs is of little interest to this report as they most likely are receiving negative feedback due to poor implementation, rather than due to the ideas that lie behind the implementation. One could say that the design behind these four bullet points has not been proven faulty, but the implementation has. Hence the only thing one can conclude from these is that users will react negatively to poorly implemented features, which hardly can be considered a revolutionary discovery. It is however interesting to this report to look into the remaining points from the list of negative feedback. And again some of the points can be gathered under a single term, in this case the following points is regarding networked multiplayer:

- The *invite friend* functionality is inconvenient and not user friendly.
- There should be screen names for multiplayer.
- SMS to invite friends is not an optimal solution.

Two of the above mentioned points from the list seem to be two users complaining about the same feature. The point suggesting an implementation of screen names is unique, but the other two seems to cover the same issue - being that the current implementation of inviting friends to a game is less than optimal from a user perspective. It is unlikely that time will allow for networked multiplayer implementation during this project, but still it might be relevant to look into what could be done in order to meet user demands when it comes to networked multiplayer with respect to future implementation.

The remaining points from the list does not seem to have much in common. Never the less they deserve to be discussed and hence they are presented here:

- AI difficulty is too difficult, even on the easiest setting.
- It is difficult to follow the AI's moves due to lack of animations or indications.
- The interface is clunky.
- Slow developer feedback.
- It should be possible to move the app to SD card.

When looking at these points some of them seem like relatively superficial technicalities. A thing like "slow developer feedback" is relative, and one person mentioning this is most likely a personal experience rather than a general tendency. Especially considering that some of the positive feedback about the existing Khet application states the direct opposite. Also the point about a clunky interface is difficult to discuss as it does not provide much information about what exactly caused this comment. The only thing that immediately can be said about it is that something in the current interface might need polishing for the users to have a more enjoyable experience and that this most likely could

be resolved through user tests specifically designed for evaluating the interface. One could guess that the statement about it being difficult to follow the AI's (red. Artificial Intelligence's) movements is related to the comment about the clunky interface, but it is far from certain. Never the less this should be solvable if more explicit feedback is given to the user possibly through animations while moving a piece and/or indicators portraying the latest move. Another thing related to AI is that it is pointed out that it is too difficult. Once again this statement has a counterpart on the positive feedback stating the exact opposite i.e. good difficulty of the AI. In this case it could be an indication that some people find the AI difficulty suiting because they have a better understanding of the game. On the other hand the positive feedback could potentially stem from a superuser i.e. an expert Khet player. So what can be concluded in relation to this is that the AI might not be versatile enough in the fashion that it does not suit all parts of the target audience. Finally the last point on the list of negative feedback is that the application should grant the possibility of being moved to the SD card, which is understandable considering that it is a somewhat storage costly application compared to the game that it provides. In other words there are many games that seem to have more content but takes up much less storage. For reference it should be mentioned that the version of Khet that is used as reference in this report takes up a bit over 21MB of storage space, which is quite a lot for a mobile application, especially if it takes up space on the main storage rather than the SD card.

Having covered all points in the list of negative user feedback of the existing Khet application a set of suggestions for improvements have been established. These improvements do however not necessarily ensure that the application would be better received by the users. The only thing that can be said with certainty is that the existing application without these improvements is not receiving very good feedback in terms of rating. According to the hypothesis presented in this report (see section 3.0 Methods) it might be more beneficial to just a subset of these, and then present the application to potential users before covering all aspects (e.g. before networked multiplayer and artificial intelligence is implemented). Hence it is deemed relevant to consider which of these that might be most interesting to work with in this project. This is however not easy without knowing which parts that might be relevant to the part of the game that will be implemented in this report. Thus a strategy of which parts to focus on is needed.

### **4.3 DELIMITATION REGARDING IMPLEMENTATION**

The intention with this section is to delimit the amount of implementation to be carried out in this project. The existing Khet application provides the user with a couple of choices in terms of playing against artificial intelligence or other users. The hypothesis of this report suggests that this might not be an optimal solution in terms of getting positive feedback which is why it is needed to part the existing applications main features into a subset of features. Since Khet does not provide for a single player experience the immediate possible subsets of potential directions to implement would be the following three:

#### Local multiplayer

Local multiplayer is in this report defined as two persons playing against one another on a single device. It does not require network in any fashion, it only demands that the game is developed for two players to participate in a game on one device.

#### Networked multiplayer

Networked multiplayer again involves two persons playing against one another, but this time on two separate devices. In terms of implementation this approach is a bit more challenging as it demands data transfer between two devices, or in other words it demands network between the devices.

#### Playing versus artificial intelligence

Playing versus artificial intelligence involves only one person playing against a virtual opponent. This approach would demand the implementation of an artificial intelligence proficient of challenging the user but able to lose as well based on degrees of difficulty levels the user can chose between.

From these three possible directions it is needed to choose one that will make sense to focus on throughout the rest of this report. This will be done by considering which pros and cons that may be by choosing either of the three directions.

### 4.3.1 CONSIDERING LOCAL MULTIPLAYER

The immediate benefit of choosing this as the direction of implementation is that it seems to be the one that is the least dangerous in terms of failure. It allows for testing with a program that will not fail due to other aspects than what is presented to the user (provided that the hardware used when testing is not faulty). This means that the source of error if the test participants gives negative feedback most likely can be concluded to stem from parts of the implementation that the users dislike, which is a good thing as this is the kind of feedback that allows for changes in the design/implementation, that ideally in the end will provide end users with a better experience.

On the other hand there is downsides of choosing this direction as well. One could argue that this direction provides only a minimum of the full experience of a finished Khet application, which means that the feedback given will only be valid in a setting similar to the testing experience (involving two persons playing on a single device). It can be argued that the majority of people would prefer playing from their own device over network rather than on a single device as this would not demand that they must be situated at the same place while playing. Another downside is that this direction does not save a lot of work in terms of design, as one should ideally still consider making the program ready for implementation of network and artificial intelligence if this is to be implemented at a later point in time. It should however save a lot of work in terms of implementation.

#### 4.3.2 CONSIDERING NETWORKED MULTIPLAYER

Networked multiplayer is rather interesting as it seems like this is an element that potentially would aid in making an application popular, which also can be seen from the feedback gotten on Wordfeud from the survey (see 2.4.2.2 Results related to Wordfeud). It

allows users far apart to connect to the same game and compete against one another. When considering a finished application this seems to be more or less a must to include as it provides the user with an opportunity that is to be expected from a two player game. The downside of choosing networked multiplayer as a direction of implementation for this project is that it demands more work in terms of implementation compared to local multiplayer. Furthermore it is something that should be tested if implemented, which means that at least two devices should be available for test sessions, which again is a more complicated setup to provide. Especially because the devices ideally should be identical since different devices might influence the user experience, thus causing unnecessary bias. Networked multiplayer also introduces the chance of bugs related to networking, which could occur during tests. This is a problem as the intention is to test the game, rather than the network, and if something does fail during a test it will potentially color the feedback given by test participants. Networked multiplayer would demand the same implementation as local multiplayer, but with numeral additions and can thus be regarded a heavier workload with little payoff in terms of answering the problem statement of this report.

#### 4.3.3 CONSIDERING USER VERSUS ARTIFICIAL INTELLIGENCE

Artificial intelligence (AI) as an opponent in Khet seems like something that a finished application could benefit greatly from. Khet can be considered a competitive strategy game (similar to chess) it means that people can get good at it if they play it a lot. These people might find it difficult to become challenged by most players. Similarly newcomers to the game might find that they get beaten a lot in the beginning, losing their patience and giving up on the game due to too difficult competition. Both groups could benefit of the possibility of playing against an AI that allows for different difficulty levels rather than playing with friends, family or random strangers.

There is however a problem when it comes to developing AI for Khet. As opposed to more well known board games (like chess or backgammon) not much public knowledge exists when it comes to developing AI for Khet, which makes this approach if not the most difficult, then at least the most dangerous in terms of finishing an implementation within the timeframe of the project. When looking at the feedback the existing Khet application has gotten related to AI, it seems that it still demands some work for the broad public to become satisfied especially in terms of making the AI beatable for newer users (see section 2.2 Khet – The existing mobile application). It should be mentioned that developing AI for Khet is indeed a potential direction to go in terms of implementation, but the difference between a functioning AI and a well functioning AI from a user perspective advocates that this direction might become the most dangerous in terms of finishing within the timeframe of the project. Also the implementation of AI has influence on how the user will experience the game while testing the application, and similar to networked multiplayer it poses a new field of risk for bugs that might influence test participant's feedback.

Deciding on one of these possible branches will be done as the first thing in the design section (see section 5.0 Design).

### **4.4 THEORY ON FOCUS GROUP INTERVIEWS**

As mentioned in the methods (see 3.0 Methods) it has been found suited to utilize a qualitative approach for testing. More specifically it has been deemed suitable to design the test with inspiration from focus group interviews. Hence this section is included in order to present some theory related to focus group interviews as this should aid in performing the test as professional as possible and with respect to gathering as much useful data as possible.

The book Handbook for Excellence in Focus Group Research by Debus [9] covers a 12-step guide on how to approach a focus group interview. Everything from gathering suited respondents to probing for needed answers is part of the guidelines. The outcome of utilizing these 12 steps is a so called *topic guide*. A well constructed topic guide is a tool for the test administrator to smoothly conduct the focus group interview in a way that hopefully will seem professional from a test participant's perspective. The topic guide will, if it is well constructed, ensure that the test participants discuss matters that are relevant to the current interview while surpassing less relevant topics in a fashion that will not seem rude to the participants. Using a topic guide like Debus suggests is also what some might refer to as a *semi-structured in-depth interview*. This means that the test participants will be allowed to discuss freely whenever they feel like it, and they will only be interrupted by the test administrator if topics become irrelevant to the test, or to ensure that all aspects that is sought answered is covered. Hence the administrator will guide the participants, but will not take control over the debate unless it is needed. From the 12-step guide the following five steps are the most relevant in terms of constructing a topic guide [9]:

- 1. "Determine what background information is needed from respondents in order to evaluate their comments during the focus group interview"
- 2. "Prepare a list of topic areas that move from general, nonthreatening issues to specific topics of interest"
- 3. "Prepare a list of probing questions for each major topic area. These are to be used if the information does not emerge spontaneously"
- 4. "Prepare probing questions to be used depending on the response given"
- 5. "Prepare transition approaches to be used when moving to a new topic or introductory stimulus materials"

By utilizing these five points when preparing for the test it should be possible to sustain a decent structure of the interview and it should enable the test administrator to collect useful data. The main limitation of this approach is that test participants might not have a shared terminology when it comes to discussing game elements, which is why it might be good to consider paring up persons that seem to be somewhat in the same demography. An example of this could be that people that state that they have little gaming experience is paired with other people that states the same rather than with a person that has played a lot of games.

Using the above mentioned approach after letting test participants play the game, should make it possible to get some inputs in terms of which game elements that would be

beneficial to focus on implementing for the Khet application. In terms this means that it should be possible to get user feedback that allows for answering the final problem statement.

# 5.0 DESIGN

Having gathered the needed information and considered diverse aspects throughout the report up until this point the design of the application can now commence. This section is intended to give an overview of the design behind the implementation to be done. As hinted throughout the report it is deemed reasonable to design the application a bit broader than what will be implemented in order to more easily add more content at a later point in time. It is relevant to present information about how the user interaction is designed, how the game and game-shell is designed as well as which features from the analysis (see section 4.2 ) that relate specifically to the branch of the game that will be implemented.

Before the actual design can commence it is however needed to establish a direction for the design, since the intention of this project is to focus on few elements. As such the following delimitation will be made based on the section on delimitation of the implementation from the analysis (see section 4.3 Delimitation Regarding Implementation). Having considered upsides and downsides of implementing local multiplayer, networked multiplayer and user versus AI it is now possible to delimit the amount of implementation to be performed in this project by choosing one over the others.

Either of the three directions (see sections 4.3.1 Considering Local Multiplayer, 4.3.2 Considering networked multiplayer and 4.3.3 Considering user versus artificial intelligence) are valid choices in terms of answering the final problem statement, as long as not all of them are implemented. However *local multiplayer* is deemed the most suitable since it provides for a test setup with as few elements that can cause failure and/or bias as possible in this case. Local multiplayer is the direction that will save the most work in terms of implementation while it provides everything needed in order to test the game. This is the reasoning behind choosing local multiplayer as the direction of implementation. And with this choice of local multiplayer as the direction of implementation the design of the application can begin.

### **5.1 DESIGNING THE APPLICATION**

This section is dedicated to present an overview of how the entire application is designed. The application is divided into two main categories being "in-game" and "game-shell". Everything that relates specifically to Khet (the board game) is considered in-game content while anything designed for the application that is not included in the actual gaming experience (e.g. menus, invite friend functionality, etc.) is considered game-shell material.

Before delving into specifics it does however seem reasonable to mention that it has been decided to implement the application with 3D graphics rather than 2D as the existing application is. The reason for this is that the easiest solution for creating 2D games in Unity3d is to use 3D objects in the virtual world but rendering them using a virtual camera with an orthogonal view (thus simulating 2D). Since everything is to be implemented in 3D

anyhow one could argue that a 2D version should be made selectable in the game settings if at all wanted, but as it has been decided to implement the game in Unity3d it might as well be presented to the user as a 3D application.

#### 5.1.1 GAME-SHELL DESIGN

The game shell is designed to allow for adding content to the application. As for now it covers aspects that will not be implemented in this project, but never the less do have some influence on how the application is to be built. The following chart is meant to illustrate the options a user will be presented with before the actual game is launched (see Figure 5).



Figure 5 - Illustration of the design of the game shell.

As shown in the figure the first thing that happens after a user launches the application is that the Unity splash screen appears. The splash screen will stay for a brief moment taking the user to the main menu of the application. As for now this menu is designed with three choices in the form of buttons with the text "Rules / Help", "Play Khet" and "Quit". The quit

button will close the application, while the rules / help button will bring the user to a page that covers the rules of Khet and contact information (e.g. to report bugs).

More interesting in terms of this project is the play game button which brings up the opponent selection menu. This is where the user will decide whether to play versus AI, a friend locally or over network. Playing locally is the simplest branch in the design. It will only demand that the user chooses a starting configuration before launching the game. Playing against AI will do the same, but before letting the user choose a starting configuration it will demand that the user chooses a difficulty level for the AI. Finally the user can choose to play over network. This action will bring up the starting configuration menu and after the user has chosen a starting configuration an opponent must be found. The user can choose to either invite an opponent or play against a random stranger. Having found an opponent the game can be launched.

Since the focus in this project will be to create the local multiplayer it is important to mention that both the AI and networked multiplayer branches have not been finished design wise. For example it has not been decided which methods that might be most suited in order to create a decent AI for Khet. Likewise it has not been investigated how to most optimal gather user data that can be used as player names and invite friend functionality.

#### 5.1.2 IN-GAME DESIGN

The in-game design is to be considered having more of a hard demand than the game-shell design. Most of what is contained in the in-game design has been required in order to make the game similar to the board game. Thus the most interesting aspect of this design section is not so much what the design does, but rather the mechanics used to achieve the needed functionality. Similarly to the game-shell design a chart has been made that illustrates the mechanics behind how the game will be implemented (see Figure 6).



Figure 6 - Illusration of how the in-game mechanics is designed.

As can be seen from the chart (see Figure 6) it takes over where the game-shell chart (Figure 5) ends, with the game being started. The first thing that happens is that the current and next players is registered before the actual game loop begins. Silver player will always take the first turn (similar to the white player in chess). When the player performs a move the move has to be validated as an automatic routine activity (see section

4.1.1 Automation of routine activities). If the move is rendered illegal according to the rules of Khet, the movement of the game piece will not be carried out, and the player will once again have to make a move. If the move, on the other hand, is rendered legal the movement of the selected piece will be performed.

With a move successfully performed the player must decide whether the move is satisfactory or not. If the player is not satisfied with the move (e.g. either realizing that the performed move is unwanted, having miss clicked a piece or similar) there is an option to undo the move. Undoing a move will reset the board to the state before the current move was performed, and yet again query the current player to perform a legal move. If the player decides to be satisfied with the move performed he can choose to fire the laser.

Firing the laser in Khet is similar to letting go of a piece when playing chess. It is a point of no return, where the game state is now updated and the player is committed to the move that he has made. Also it brings the program one step further in his turn. The next step is however more or less unnoticed for the players as the program will check if the winning conditions have been met at this point. This basically means that if a Pharaoh has been hit by the laser, the current player has won the game and the game session will come to an end. If the winning conditions have not yet been met, the program will switch who is the current player and the game loop can restart with a new player taking his turn under the same conditions as the previous player. This goes on until one of the two players has performed a winning move. The winning screen should at least give the players the options of taking a rematch (with no settings from the game-shell changed) or returning to the main menu from game shell chart (see Figure 5) while of course displaying information about who won the current game.

### **5.2 USER INTERACTION**

Having provided an outline of the mechanics behind the application it is found relevant to include this section covering how the user interaction of the application has been designed. The existing Khet application has received negative feedback regarding aspects related to interaction design which also is a reason to consider carefully how the user is to interact with the application to be implemented.

Everything in the game-shell consists of menus in the form of buttons with text on them (with few exceptions such as the invite friend functionality which might include some text input field). This interface is somewhat straight forward and something that most users can be expected to be familiar with from other mobile applications. Hence it should be relatively safe to assume that as long as the graphical expression is kept simplistic the majority of the users will be able to figure it out as long as the interaction is made similar to other applications. This means that button interaction should be a touch (click) on the button and potential use of scroll if needed - though this could be considered better to avoid if possible. Touching a text input field should bring up the keyboard on the phone allowing the users to input the needed information with their respective installed on-screen keyboard. It can however be argued that it would be a good idea in time to investigate the possibility of implementing functionality for diverse Android based phone
models that might have special buttons (e.g. the "back" or "settings" buttons that some phone models has).

In terms of the in-game design a bit more interaction design has to be considered. The existing Khet application got negative feedback regarding its interface being "clunky". As mentioned in the analysis (see section 4.2 ) no information is given as to exactly what might have caused a given user to find that the interface is less than optimal. A qualified guess is however that utilizing the capabilities of the platform a bit more might introduce the user with a feeling of more freedom to move around in the virtual environment (see section 4.1.3 Touch and Gesture Interaction for Mobile Screens). This could aid in reducing the so called clunky feel while it does not directly influence the game play. Hence the design of the application to be built will grant the user the ability to move the camera around in the virtual environment using pinch to zoom and swipe to translate.

Having explained how the user interaction is designed in terms of camera movement the final thing to cover is how the user will interact with the game itself. When the game is launched the playing field will be made visible for the user (with the camera pointed at the centre of the board). The silver player will need to make an input in order for the first move to be made. This will be done by the silver player touching a silver piece (touching red pieces should be ignored as the silver player cannot move those). Having touched a silver piece a feedback should be given to the player so that it is easy to see which piece that has been selected. The feedback could be in the form of a light indicator, a graphical ring/square or a sort of outline of the piece. Either solution should work as it provides the user with the needed information - and which that are the best suited solution could always be tested upon and changed if needed. With a piece successfully selected the next thing the player must do is selecting a valid playing field to move the selected piece to, or rotate the selected piece as described in the section about Khet rules (see section 2.1 Khet - The board game). Having done this the player will be prompted to either undo the move (and try again) or fire the laser completing the turn for this player. With the silver player ending his turn the red player can take his turn in a similar fashion. This goes on until a winner has been found and the game is ended.

## **5.3 GRAPHICS DESIGN**

In the ideal world on would design and implement well made 3D models with good texturing and use those as early in the testing phase as possible. The models could either be representative of the pieces that are used in the board game, or one could re-imagine the theme of the game if desired. An example of a design that would suit the game could be replacing the laser with a metal ball and the mirrors with bouncers (as known from pinball arcade machines). If the application to be made becomes polished enough to submit it to Google Play it will draw benefit from not being too identical to the existing application due to copyrights.

Fortunately, in Unity3d each virtual object to be used in a game can be saved as a so called "prefab" (i.e. prefabricated object). This means that it is possible to apply scripts to empty parent objects that has 3D models as children, thus separated from the scripts. By building

the prefabs of the game in such a fashion it should be possible to develop the entire game using placeholder models that relatively easy can be substituted for better and polished models at a later point in time. In terms of getting the product finished in time for testing this is deemed a valid solution because it will save the time otherwise required to create said polished models.

# **6.0 IMPLEMENTATION**

In this section the process of implementation will be explained with emphasis on the elements from the design chapter that either has not been achieved as intended, or in other ways been compromised. Before delving into details it does however seem reasonable to present an overview of how the final product looks.

## 6.1 THE PRODUCT

This section is intended to portray the product as it looks at its final stage for this project. The following screenshot will show the playing field with all pieces (with the placeholder models). As it might be recognized the setup is the classic starting configuration (see Figure 7).



Figure 7 - Screenshot of the implemented Khet application - cropped (taken on an HTC One X).

The screenshot (see Figure 7) shows what the users will be presented with in the final test. The placeholder models have been made in unity, using combinations of simple geometric shapes (cubes, spheres and cylinders). The only thing that has been considered when creating the placeholders is that they should be easily distinguishable while they should afford their purpose. Thus the laser has been altered so that it is displayed as a tail of light following a ball around through the tubes of the pieces.



Figure 8 - Close up of the models used showing from left to right: Pharaoh, Djed, Obelisk and Pyramid.

Figure 8 displays a closer look at the pieces that has been used as placeholders. Briefly explained the idea behind these placeholders is that they ideally should afford that a ball rolls into the piece through one tube, and exits through another tube. The pyramid placeholder has a backside similar to the original pyramid from Khet (see Figure 1). In order for the user to be able to understand which tubes are connected in the Djed piece its tubes has been color coded. Furthermore a stretched cube has been attached through the middle of the piece to emphasize which tubes that are connected, and to avoid confusion when several Djed pieces (with their color coding) are placed in a close proximity. The Obelisk is a simplistic cube and the Pharaoh consists of a sphere that is held above a platform by four pillars. It might be argued that the placeholders does not fit well with the original Khet names for the pieces but as the names is not presented for the users in the test that should be acceptable.



Figure 9 - Screenshot showing implementation of the laser (and ball).

Figure 9 shows an example of how the laser travels from one piece to another. It was found that the simplest way to implement a laser in Unity3d would be through a so called trail renderer. It basically displays a trail behind a given object. For this specific implementation, with the placeholder models in mind, it was deemed reasonable to render the ball as well, but in theory it is possible to simply not render the ball while still rendering it's trail which could be beneficial at a later stage in implementation if wanted.

## **6.2 DEVIATIONS FROM THE DESIGN**

The intention with this section is to shine a light upon the expectations of the design of the product that either have not been met or in some ways compromised. This is relevant as it gives a better insight as to what exactly has been implemented and in some cases differently than intended.

### **6.2.1 DEVIATION IN THE RULES OF KHET**

Most rules of the game has been implemented and is functional. However the one rule about it being allowed to place two Obelisks on top of one another has been left out, and is thus not implemented. This was a tough decision but an error in the implementation of referencing pieces on the playing field caused this specific rule to be difficult to implement without changing several parts of the underlying code. As this rule has been removed in Khet 2.0 (and furthermore is rarely applied in a game of Khet) it was deemed too time consuming to go through a relatively big change to get it implemented. Instead it has been decided to adopt the rule from Khet 2.0 and likewise reduce the amount of Obelisks per player from four to two, just as in Khet 2.0. One could argue that this solution is simpler anyhow and as such might be better suited for testing purposes since test participants cannot be expected to know the game beforehand.

#### **6.2.2 P**RIORITIZATIONS IN THE ORDER OF IMPLEMENTATION

Despite the fact that it would be wonderful to be able to implement everything at once that is simply not a possibility. Hence it was deemed important to implement as much of the ingame design as possible before implementing the game-shell related design. The reasoning behind this choice was simply that it seemed like a better situation to end up with a functioning game without a game-shell compared to a functioning game-shell without a game for the final test. This prioritization did however have the consequence that time did not allow for much implementation of the game-shell.

Having designed the game-shell before implementation of the game did allow for some preparations in terms of making the game ready for the shell to be implemented. This for example means that loading a game with a different starting configuration should be a relatively simple task as the setup of all pieces are coded rather than hand-placed in the virtual environment - hence another code would grant a different starting configuration without the need of changing other scripts than the one that places pieces on the board. Another example is that the game currently is implemented so that it automatically will wait for players to give an input. The only thing that would have to be changed in order for the game to work with an AI opponent or over network would be to restrict the current input method to only be valid for one of the player colors on the device. Inputs for the opposing player would then be handled either via remote procedure calls (network) or by an AI that performs a move based on its algorithms. Details behind both network and AI is yet to be considered though.

## **6.3 CODE EXAMPLES**

All code behind the application has been developed in C# and all code has been developed for this project specifically (with the exception of parts of the code related to touch gestures - which have been adopted and adapted from a project by Alexander Orozco). This section is included to just briefly give an insight to some interesting code examples from the game.

### 6.3.1 GUI INTERACTION

When developing the GUI (Graphical User Interface) for the application a problem occurred. User interaction with the pieces on the playing field are handled by a ray cast from a 2D screen coordinate and into the scene. However when clicking on a button this ray cast were not ignored at first before the following implementation:

```
if (selectedPiece != null)
       Ł
            Rect areaRect = new Rect(0f, Screen.height * 0.8f, Screen.width, Screen.height * 0.2f);
            GUILayout.BeginArea(areaRect);
            GUILayout.BeginHorizontal();
16
16
17
            if (GUILayout.Button("Rotate \n Left"))
            ſ
                RotateLeft(selectedPiece.forward);
            3
17
            if (Event.current.type == EventType.Repaint)
            ł
                Rect btnRect = GUILayoutUtility.GetLastRect();
                AddRect("LeftBtn", new Rect(btnRect.x + areaRect.x, btnRect.y + areaRect.y, btnRect.width, btnRect.height))
```

Figure 10 - Code example 1, showing how a button is accompanied by a rect.

When looking at the figure above (see Figure 10) it can be seen how a button definition in the code is immediately followed by adding a rect to an array of rects. This array will thus hold information about which areas of the screen that are occupied by GUI buttons. Using this information a check was made before casting aforementioned ray into the scene, so that the ray cast would not happen if the user interacts with a button. Before this addition were made a user would not be able to push a button without also interacting with whatever game elements that were placed behind the given button. An example of this could be that the player wanted to rotate a piece and thus clicked the "Rotate left" button. But because the user at the same time would interact through the button the result could be almost anything like deselecting the current piece, selecting another piece or actually moving the currently selected piece.

#### 6.3.2 STARTING A GAME

This code example is included to portray how the application has been made ready for implementing the game-shell. As it is implemented now the only possibility for starting a game would be to choose the classic starting configuration when the game is loaded. The following code shows how this would result in a set of pieces getting instantiated on the playing field.

20	<pre>else if (startSetup == StartSetup.CLASSIC)</pre>	
90	{	
91	<pre>// Black pieces from left to right</pre>	
92	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.TubePiece, new Vector2(0, 4), Direction.North);
93	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.TubePiece, new Vector2(0, 3), Direction.East);
4	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.TubePiece, new Vector2(2, 6), Direction.South);
5	InstantiatePieceOnBoard(PieceColor.Black,	<pre>PieceType.DoubleTubePiece, new Vector2(4, 4), Direction.North);</pre>
6	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.Blocker, new Vector2(4, 7), Direction.North);
7	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.King, new Vector2(5, 7), Direction.North);
8	InstantiatePieceOnBoard(PieceColor.Black,	<pre>PieceType.DoubleTubePiece, new Vector2(5, 4), Direction.East);</pre>
9	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.TubePiece, new Vector2(6, 2), Direction.East);
0	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.Blocker, new Vector2(6, 7), Direction.North);
1	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.TubePiece, new Vector2(7, 7), Direction.East);
2	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.TubePiece, new Vector2(7, 4), Direction.East);
3	InstantiatePieceOnBoard(PieceColor.Black,	PieceType.TubePiece, new Vector2(7, 3), Direction.North);

Figure 11 - Code example 2, showing how pieces gets instantiated in the game.

As can be seen from the figure (see Figure 11) a finite state machine decides which setup is chosen depending on the startSetup variable. The shown code adds only the black pieces, but the white pieces will of course also be added in this part of the state machine. But in terms of understanding the example that part has been left out. The instantiatePieceOnBoard() method takes four parameters. It take a color of the piece to be added, it takes a type of piece to add, it takes a 2D coordinate being the piece's placement on the playing field and finally it takes a direction for the piece to face. The color parameter is used for applying the correct textures to the given piece. The piece type only defines which kind of piece the method should retrieve and clone from a predefined array. The coordinate is recalculated from a board coordinate to where in the virtual world a piece should be placed. And finally the direction parameter decides the rotation a piece will be given upon instantiation.

For the game to start with another starting configuration all that is needed is to change the startSetup variable before loading the game scene and then the state machine will handle the rest. This of course assumes that the placing of pieces for the given starting configuration has been defined similarly as in the figure.

# **7.0 TEST**

As mentioned earlier (see section 1.1 Motivation and 3.2 The Approach) a user centered progression is desired in order to achieve as well developed a product as possible before a final test. This means that the intention is to perform several small tests that are focused on getting information from the test participants that will allow for improvements of the products followed by more testing for as long as time allows.

## 7.1 PLAY TEST

The intention with this play test is to ensure that the application will run through an entire game without any bugs that are so crucial that it might completely ruin a test at a later point. Hence no official questions have been prepared for the test. Instead it has been decided to involve two prior Medialogy students and perform the test under a casual setting. The structure of the test will resemble that of a qualitative narrative interview where the participants are allowed to talk freely and will only be stopped and guided if the topic becomes too irrelevant. The intention is merely to locate and talk about potential problems with the game, interface and interaction. Also the progression of this test could help with inspiration for how to conduct the following tests, both in terms of structure, setting and questions for the interview. As such it can be regarded as a pilot test for the tests to come.

The two test participants were placed in a sofa in front of a laptop with the game ready to be played. Initially the rules and goal of the game were introduced followed by a play session where the participants were asked to play the game against each other.

## 7.1.1 FIRST PLAY THROUGH

The first game was very brief, due to a mistake in the programming. A small spike occurred while the laser was being rendered in the game, and the Unity engine corrected for this spike by moving the laser along its local forward direction. Unfortunately the correction moved the head of the laser past the field on which it was supposed to be destroyed. This had the effect that the laser would continue to draw itself in the given direction resulting in what became a stop in the game flow. Because this task could not be finished it meant that the game was stuck in a mode from which it could not recover and progress.

The solution to this specific problem is however relatively simple. Adding a few lines of code that checks if the distance is increased to the point where the laser is supposed to stop will easily handle the situation. It might not look completely perfect, as a small graphical glitch might occur, but the game will at least not fail to progress. This means that the game will be playable for testing purposes, however a smarter solution should be thought out for the finished product in order to ensure that the potential graphical glitch will not be portrayed for end users.

#### 7.1.2 SECOND PLAY THROUGH

The second game that was started was finished by one player defeating the other – as intended. This created the foundation for discussing the overall quality of the product with the two participants. It was found that the game in itself was from this point forth deemed testable, but that there is room for improvement.

#### 7.1.3 FINDINGS FROM THE PLAY TEST

A flaw in the interaction design and programming has resulted in a certain move being difficult for the participants to perform. The rule about a Djed piece being allowed to swap places with a neighbor piece was difficult to carry out for the participants. The reason for this flaw is that the interaction design made had not taken into consideration that the user wants to interact with two pieces in one move. Hence the participants would have trouble swapping places using the Djed piece because it would either deselect or they would select another piece. The swap could however be performed by carefully clicking the field underneath the neighboring piece (rather than clicking the piece itself).

The temporary graphics that was used during this test was not received well by the participants. They commented that the game looked a bit unfinished and argued that participants in a final test might find it difficult to disregard the state of the current graphics. Furthermore the temporary graphical representation of the Djed piece made it tedious to imagine the route that the laser would travel after performing a move.

Another problem was that pieces that were hit by the laser were removed from the game before they were in physical contact with the laser. It was argued that this problem made it a bit difficult to see what exactly happened in terms of game logic.

In conclusion the game was deemed playable and testable, but it would be a much better experience if the problems described above were to be resolved before a final test.

#### 7.1.4 ALTERATIONS IN THE IMPLEMENTATION BASED ON FINDINGS FROM THE PLAY TEST

It has been decided to change the implementation of how pieces are removed from the game when killed by the laser. The program will calculate the entire route of the laser (behind the scene) before the laser is actually fired. In the implementation for the play test it would thus be decided by the program if a piece should be removed from the game before the laser is actually fired - and if a piece should be removed it would be removed before the laser is fired. This has been changed so that the laser will now be fired (and rendered for the user) and if a piece is to be removed from the game, that will happen when the laser reaches this given piece - it's end destination for this turn. Furthermore the bug with the laser being able to move past its destination was repaired as mentioned earlier.

Nothing else has been altered at this point, as solutions to the other problems described by the participants are deemed relatively time consuming. If the problems are to be mentioned in a later test session, it might be decided to implement changes at that time but as for now they will remain unchanged.

## 7.2 USER TESTS

With the feedback from the play test, and the general idea of involving users in the process of developing the game it has been decided to conduct a series of miniature test similar to the play test. It can be argued that the amount of feedback given from the play test is relatively sparse, but considering that the play test was conducted without much preparation one must expect more feedback from tests that are designed with the purpose of getting feedback in relation to features that needs improvement. Hence this section is devoted to design a more structured test. When designing the test the five points found in the analysis will be followed (see section 4.4 Theory on Focus Group Interviews).

### 7.2.1 THE PURPOSE OF THE USER TESTS

The idea behind these tests is to improve the overall quality of the game before a final test. Several small scale tests are preferred as opposed to one test with many participants. Since the feedback given in these tests will be considered on a session to session fashion, rather than gathering data over several tests and then considered the results. Hopefully this will allow for improving the game to a state that eliminates most negative feedback that will be gathered in a final test with more participants.

### **7.2.2 PREPARATION OF THE USER TESTS**

When preparing the tests the most important element is to ensure that all five points found in the analysis are covered. Thus the first thing to do is to determine what background information that is needed from the respondents. In this case it has been deemed sufficient to make a small screener question asking the potential participants if they are familiar with the game Khet. Both persons that are familiar with the game and persons that are unfamiliar with the game can be allowed to test the application, but it has been decided that players that know the game beforehand should not play against players that are completely new to the game. The reason for this is that a player with more experience in the game might too easily win during the play session, thus potentially giving the less experienced player a worse experience than if he/she had played a more equal opponent.

The next step is to create the list of topic areas moving from general nonthreatening issues to more specific topics of interest as described earlier (see section 4.4 Theory on Focus Group Interviews). This is of course done in order for the participants to be eased into a mindset where they do not feel as bad about giving negative feedback. It has been decided to let the participants know from the beginning (introduction) of the test that the purpose of the test is to specify elements that could need improvement. Hence the list of topic areas looks as follows:

#### 1. Screener question

- 1.1. Ask potential test participants if they know the game Khet, and if they have played it before.
- 1.2. Ensure that both participants are either familiar or unfamiliar with the game.
- 1.3. When two suited participants have been found, bring them to the test setup.
- 2. Introduce the test

2.1. Brief introduction to the main points and progression of the test. Let the participants know that their answers and participation will only be used in my project. Let the participants know that the purpose of the test is to discover elements that could improve the quality of the application if altered, added or removed.

### 3. Introduce the rules of Khet

- 3.1. Show the participants the four pieces and explain that the goal is to destroy the Pharaoh.
- 3.2. Explain how pieces are killed in the game by getting hit by the laser.
- 3.3. Explain how all pieces can move only to a neighbor field or rotate 90 degrees.
- 3.4. Explain the rule about field colors.
- 3.5. Explain that the Djed piece the swap places with Pyramids and Obelisks.
- 3.6. Mention that the turn is passed to the next player when the laser is fired.
- 3.7. Finally of course clarify anything that seem to confuse, and answer potential questions.

### 4. Try-out session

- 4.1. Start the game.
- 4.2. Let the participants know that the game will be restarted in a moment.
- 4.3. Give the participants a few minutes to briefly try the interface and ask if they have questions. Let them know that they can take their time if they like.
- 4.4. Stop the game.

### 5. Play session

- 5.1. Decide which player will play silver at random.
- 5.2. Start the game.
- 5.3. Tell the participants that they may ask questions during the game if they like.
- 5.4. Let the participants know that this time they will be playing until they finish (if they like to) or until they get bored or for other reasons might want to stop.

## 6. Interview

- 6.1. What do you think about the game?
- 6.2. Did you experience any odd or unwanted behavior from the application while playing?
- 6.3. What do you think could be done in order to make the game better or improve the quality of the application?

6.3.1.What do you think about the graphics in the game?

6.3.2.Did you have any difficulties with the interface?

6.3.3.Do you have any general feedback that has not been covered yet?

This list should illustrate how both the order of with the test progresses and the questions in the interview has been built up based on the five points taken from Mary Debus' 12-step guide. Looking at the interview the points 6.1 through 6.3 are considered to be non-threatening at first and then moving towards questions that should encourage respondents to provide whatever negative feedback they might have. The idea is that any changes made between tests should be added as sub-questions (probing questions) under 6.3 in the interview in a way that respondents are asked directly about their opinion about a certain changed, added or removed element in the game (i.e. if the first test results in a

change of textures on the models, then the following tests will have an added probing question related to how the respondents feel about the textures in the game).

The user tests will be performed at Lautrupgård Kollegiet in Ballerup. The setup will be a closed environment with a rather casual setup. Two persons will be placed in a sofa, and an Android device with the game installed will be ready and available to them. I - the author - will be present as the test administrator, and it should be mentioned that some of the participants may know me as a resident of Lautrupgård kollegiet. It would of course be more ideal to test the application with complete strangers, but time constrains makes it more efficient this way, in terms of performing a test followed by implementation followed by a new test and so forth.

### 7.2.3 RESULTS OF THE USER TESTS

This section will present the results of the diverse user tests in a chronological fashion. It will cover which changes that have been made to the application between tests, based on the respondents feedback. Observations and interview answers can be found in appendix (see 13.3 Appendix 3 - Dataset from user tests).

#### 7.2.3.1 USER TEST - SESSION 1

Both test participants were male and neither of them knew about Khet beforehand. Based on their feedback in the interview the following changes has been implemented before the next test session:

- Added selection indicators instead of light
  - Test participants found it difficult to see which pieces that were selected. Based on this the light that prior indicated selection of a piece has been interchanged for a bright green indicator placed around the bottom of a selected piece.
- Resized buttons on handheld device (and put in graphic textures)
  - Test participants said that the original design of buttons were too small rendering them almost illegible. These have been interchanged for larger buttons with icons rather than text.
- Placement of fire and undo buttons have been reversed
  - One test participant argued that it would feel more natural if the fire and undo buttons changed sides. He argued that it would feel more logical to him to push a button on the right side of the screen to proceed and the other participants agreed. Thus the fire button has been moved to the right of the screen, and the undo button has been moved to the left - being opposite to their prior placement.
- Changed camera restrictions (so that a bit more of the top of the board is visible)
  - One test participant argued that he felt restricted towards the top of the playing field. He said that even though he were able to see all fields and pieces, he would still like to be able to come a bit closer and he did not mind that it would have the influence that the camera would see beyond the top of the

board. Thus the camera restrictions has been altered slightly to allow the camera to move more towards the top of the board.

- Move camera to overview the entire board when laser is fired
  - Both participants agreed that it was a problem that when they were zoomed in and performed a move followed by firing their laser, they would sometimes not be able to see their shot as it was performed in the other side of the playing field (which when zoomed in would be outside of the field of view). With this in mind an addition has been made so that the camera will be translated towards the center of the board and with a large enough distance to see the entire board.
- Changed background color to black
  - One test participant stated that the color behind the playing field were distracting, and that this was annoying to him. He suggested to make it black to indicate that nothing relevant for the game is going on behind the board.
- Changed wall/laser colors to a dark low saturated green with dark edges
  - One participant mentioned that the walls were dull to look at and that their white color made them look almost 2D due to the light settings. To solve this a new material and texture has been added to the walls (including the lasers in the wall).
- Removed the directional light and put in four point lights
  - Both participants stated that they found the light in the scene to be a bit dull. Thus the directional light has been replaced by four point lights allowing for the pieces to change slightly in appearance depending on their placement on the playing field.

Having implemented these changes based on the feedback from test session 1, the following probing questions has been added as sub-questions to the interview under point 6.3:

- Was it always obvious to you which piece you had selected?
- How was the size/graphics/placement of buttons?
- How was the camera movement?
- What do you think about the colors in the game?

With both the application and the interview updated after test session 1, the next test can be conducted. It should be mentioned that the test participants did give more feedback than the elements that have been changed before the following test. It was decided to not implement changes that were very complex (unless they get mentioned again in a later test) and it was decided to not implement elements that was related to later stages in development (e.g. implementing rules for the "help/rules" in the game-shell).

#### 7.2.3.2 TEST SESSION 2

Once again both participants are male and neither of them knows about Khet beforehand. Based on their feedback in the interview the following changes has been implemented before the next test session:

- Camera will now flip corresponding to device orientation (between landscape and portrait)
  - Since this has been mentioned in both tests it was decided to implement the feature. Thus changing the orientation of the device will result in the game flipping accordingly.
- Zoom has been tweaked so that the camera stops almost immediately after pinch is released
  - It was argued in the interview that the current implementation of the zoom made it feel like the camera would slide after pinching. This has been changed so that the camera will stop almost immediately after pinching of the screen has stopped.
- Swipe speed has been made relative to zoom
  - One test participant argued that it felt unnatural to him that the speed of the camera would change depending on if he was zoom in close, or far away from the board. This was however a situation where perception plays a role because actually the camera would have the same speed regardless of the zoom which made it seem unnatural to this test participant. Hence the camera's distance to the playing field has been applied as an extra factor when calculating it's speed for swipe movement. When the camera is far away from the playing field it will now move faster than when it is zoomed in close.
- Swipe tweaked so a longer swipe is needed for camera to move
  - Both test participants found it difficult to perform actions in the game without moving the camera (either instead or simultaneously). Hence the threshold for which swipes should be ignored was tweaked so that a bit longer swipes are needed to initiate camera movement.
- Djed piece can now swap if a piece (as well as a field) is selected
  - During the play session it was observed that the players had difficulties swapping the Djed piece with another piece. This was due to a problem in the program that had the effect that the field under the piece should be touched rather than the piece (actually the same problem as found during the very first play test - see section 7.1.3 Findings from the play test). A solution to this issue has been found and implemented so that swapping should no longer cause troubles.
- Buttons for rotation, undo and fire has been moved to the bottom of the screen
  - One of the test participants argued that it was annoying to him that parts of the buttons would overlap with the playing field. This would obstruct his view of a few fields in the sides of the board rendering it more difficult for him to predict the trajectory the laser would take. Hence buttons was moved from the middle of the screen towards the bottom.

This covers all changes made to the game based on the feedback from the second user test. Since several of the alterations can be said to lay within the same elements as alterations after the previous test it is only found relevant to add the following question to the interview before a new test: • Did you utilize different screen orientations (portrait/landscape), if so, did it act different from your expectations?

Ideally one would carry out a few more user tests similar to the ones above based on the fact that new problem areas was disclosed from the latest test. Alas time does not allow for performing more user tests at this point if a final test is to be conducted. Thus it has been decided to put a stop to the user tests, and commence with the final test instead.

## 7.3 FINAL TEST

In order to answer the final problem statement of this thesis, a final test must be conducted. This section is intended to give insight as to how this final stage of testing will be performed. In the methods section (see section 3.0 Methods), it has been explained how the intention in this project was to improve a single element of Khet to a point where it works really well by involving users during development. In reality this approach has been carried out through initially a play test and two user tests. Thus a total of six users has been involved before the final test, and their feedback has been turned into improvements implemented in the application. The question remains, if this approach has improved the application to a point where it will be well received by end users. This will be sought answered through the final test.

### 7.3.1 PREPARING THE FINAL TEST

In order to get another perspective than the one from the user tests it has been decided to conduct the final tests at another location. Thus it has been decided that the final test will take place at Aalborg University Copenhagen. In terms of getting unbiased test participants, this location might not be an optimal solution, but on the positive side it should be possible to gather test participants that can agree to use between 30 and 40 minutes of their time for testing.

Since the topic guide used for the user tests (see section 7.2.2 Preparation of the user tests) has proven rather functional in terms of gathering feedback from the respondents it has been decided to also use it for the final test. It will contain the added probing questions from after each user test in order to ensure feedback specifically in relation to the improvements made through the user tests. The reason for this is of course that it is interesting to investigate whether the work that has been put into the application based on the user tests indeed has resulted in an implementation that gets well received by potential end users. If the test participants in the final tests seem to like these features it would be an indication that the approach chosen for developing the Khet application has been well chosen. If they on the other hand still have a lot of critique of these features it could be an indication that the method either has not been well suited or potentially a sign that listening to so very few person's feedback before making changes is dangerous.

Furthermore it is found relevant to add another question at the end of the interview, asking test participants to rate the game on a scale between 1 and 5. One could argue that it would make sense to let the participants rate diverse elements in the game instead (in

order to easier discover which parts of the game that might drag down the score). However the reason for adding this question is merely to see how well the implemented Khet application scores in relation to the existing one on Google Play. As for now Google Play only allows for a general rating, and for the numbers to be comparable in any way this question should be similar to this kind of overall rating. This means that the questions for the interview for the final test looks as follows:

- What do you think about the game?
- Did you experience any odd or unwanted behavior from the application while playing?
- What do you think could be done in order to make the game better or improve the quality of it?
- What do you think about the graphics in the game?
- Did you have any difficulties with the interface?
- Was it all ways obvious which piece you had selected?
- How was the size/graphics/placement of buttons?
- How was the camera movement?
- What do you think about the colors in the game?
- Did you utilize different screen orientations (portrait/landscape), if so, did it act different from your expectations?
- General feedback
- If you had to rate the game on a scale of 1 to 5 (one begin lowest score and five being highest) how would you rate the game?

With the interview and location in place there is a few more things to consider. First off is the setting of the test. It has been decided to keep the setting as casual as possible, because this provides for an atmosphere where the test participants can feel relatively relaxed and hopefully it feels less staged to them. It is possible to book a room for the test at AAU Copenhagen, but it has been decided to move the test to the participants instead of the other way around. This way it should be less of a problem to get people to test when they do not have to relocate in order to do so. This choice has the obvious downside that it provides a less controlled testing environment, but seeing that the game is turn based this might actually be a good thing because in a closed room with two participants and a test administrator one participant would at all times be unoccupied which in the worst case to make the unoccupied participant feel a bit observed. With things going on around the test at least the unoccupied participant can choose freely if he wants to follow the other participant's moves or focus on something else. Furthermore this is a decent way of seeing whether or not the application is entertaining enough to hold the attention of the unoccupied participant - if disregarding that he/she might feel obligated to stay focused due to his/her knowledge that they are part of a test. Finally in relation to the setting, it will of course be an option to book a room and move the following tests there if the decided approach seems to not work out as intended.

Secondly it has been decided not to take notes while the participants are playing. This decision can seem odd, but there is a simple reasoning behind it. During the user tests it seemed like the participants in general felt observed when taking notes while they were playing. From time to time the unoccupied participant would notice that notes were taken, and look away from the device with the game going on focusing on the test administrator instead. The amount of notes taken during these tests were relatively sparse, and it did

seem like participants would comment on the things noted while they were playing during the interview anyhow.

Finally it should be mentioned that in order to conduct the final test as effectively as possible it has been decided to acquire an extra tests administrator for these final tests. Another Medialogy master student, Anders Hansen, has agreed to aid with the testing and will as such take the responsibility of being the other test administrator. He will initially be observing the first one or two tests conducted in order for the tests to be as unified as possible, and will then proceed to conduct tests by himself.

### **7.3.2 THE FINAL IMPLEMENTATION**

Since it will not be possible to carry out any more user tests before the final test it is found relevant to include an image of the application as it will look for the final test. This is done both to make it possible to compare the visual appearance of the changed implementation with the previous (see Figure 7), but also because it is found relevant for the reader to know what the game looks like for the final test.



Figure 12 - Screenshot of the implemented Khet application with the changes made after the user tests.

The image (see Figure 12) shows how the implemented Khet application will look for the final test. In the image the changed buttons can be seen, one in either side of the bottom of the screen. Also the selection indicator can be seen around the rightmost white Obelisk - the green corners surrounding the piece.

# 8.0 RESULTS

Having conducted the final test at Aalborg University Copenhagen the results can now be presented. The dataset gathered from the final test can be found in the appendix (see 13.4 Appendix 4 - Dataset from final tests).

In total six test groups played the game and participated in the interview. This means that the gathered data is based on feedback from a total of 12 persons. Of these twelve persons eight are male and four are female. By coincidence there was no groups of mixed genders, meaning that two of the test groups consisted of only female participants, while the remaining four consisted of only male participants. None of the twelve participants in the final test knew about Khet beforehand, and was as such new to the game.

## **8.1 COMPARING ANSWERS FROM ALL TEST SESSIONS**

This section is intended to cover all questions from the interviews in the final test, in order to shine a light on the tendencies that can be found.

## **8.1.1 WHAT PARTICIPANTS THINK ABOUT THE GAME**

This question was added as a broad non-threatening question, and it was as such expected to get relatively broad answers to it. Looking at the answers from the interview this expectation seems to hold up well in reality as many different answers were provided. Of the six groups, four stated that they found the game funny, entertaining, engaging or something similar. The remaining two groups did not explicitly state that they were entertained, but on the other hand they did not state the opposite either. Furthermore the game was compared by some individuals to both Chess and Pipes. Half the groups stated that they found it to be a positive thing. One group did on the other hand refer to the game as being complex seemingly in a more negative tone of voice. It seemed that the majority of the participants did enjoy playing the game, while a few (only female) participants seemed like they did not enjoy the game so much.

#### 8.1.2 UNEXPECTED OR ODD BEHAVIOR FROM THE APPLICATION

None of the twelve participants in the final test experienced behavior from the application that they found to be odd or unexpected. This is a clear indication that the application as it is now are relatively bug free and reacts more or less intuitively when interacted with. At least it can be stated that if any bugs exist they were not discovered in the final test.

#### **8.1.3 Things that could improve the quality of the application**

This question was included as a non-threatening question with a hope that some comparable answers could provide insight as to which shortcomings that the application has at the time of testing. The one element that is mentioned more than by one test group is that the camera movement could use a bit more freedom. Other than that the individual suggestions include implementation of sounds, more/different levels, a laser trajectory indicator, a chess clock, more graphical detail to pieces and playing field and finally a larger playing field.

#### **8.1.4** THE GRAPHICS IN THE GAME

When looking at the feedback for the question about the graphics in the game it seems that there is a tendency of the test participants being pleased but not overly impressed. There is a mixture of positive and negative feedback. When the feedback is positive it is most often not very descriptive while some of the negative elements have been described in more detail. Of negative elements one group mentions that the pieces looks a bit too much like one another, and are as such not easily distinguishable. Another group however comments that the graphics are easy understandable, well made for a smartphone and with no annoying elements. One group states that they would prefer the game in 2D, while another group states that it would be nice with a better 3D representation through more free camera movements. As such the concrete suggestions seem to contradict one another in between test groups. Overall this could be an indication that the current state of graphics are neither bad nor optimal and as such could benefit from more work (e.g. by replacing the placeholder models with more detailed and well designed models).

#### **8.1.5 DIFFICULTIES WITH THE INTERFACE**

Three of the six test groups stated that they did not have any difficulties with the interface. The remaining three groups mentioned one thing each being: they did not know which pieces belonged to them just in the beginning of the game, it was difficult to see if it is currently white or black's turn and finally that switching between button clicking and piece selecting/moving was less than optimal.

#### 8.1.6 PROBING QUESTIONS ADDED AFTER USER TESTS

These questions were more concrete, less broad and integrated to get feedback specifically on the features that had been changed after the first user test. The gathered data shows that all participants found it obvious which piece that they had selected while playing. In terms of buttons, it seems that the participants in the final test agree that buttons are fairly well implemented as they are now. One person did however suggest that a popup could potentially be a better solution than the "fire" button, but he did not disagree that the buttons are fine as they are. Of the six groups only one group disliked the current implementation of camera movement. Of the five groups that liked the camera movement one person did however mention that he would like a bit more freedom to move around the same person that mentioned that he would like more of a 3D feel in the game through more free camera movements (see 8.1.4 The graphics in the game). The one group that disliked the current camera angle.

The colors of the Pharaohs in the game seemed to not be well fitting because they looked too much alike one another. At least this was mentioned by two of the groups as an issue. Other than that the colors in the game seem to fit the preferences of half the groups. The other half commented individually that some combination of colors did not fit well according to them. One person even specified that he had troubles with the green walls

and the yellow/sand-colored fields as he is colorblind and as such found it tedious to distinguish between them.

Finally it should be mentioned that none of the participants in the final test utilized the possibility of playing the game in another orientation than portrait. Hence no feedback was given in terms of this feature living up to the users' expectations.

### **8.1.7 GENERAL FEEDBACK**

This question was added to ensure that if a participant still had some feedback that he/she would like to give, then the opportunity should be given. This however also means that there are no general tendencies to be found in this part of the interviews. Mostly suggestions for further implementation were mentioned, if anything.

### 8.1.8 RATING OF THE GAME

In the last question of the interview the participants were asked to rate the game on a scale from one to five - merely to get an idea of how this application will be rated compared to the existing Khet application. The results of the ratings from the twelve participants came out as follows: 4, 4, 4, 4, 4, 4, 3, 4, 2, 3, 4 and 4. This averages out to  $\sim$ 3.667 which is slightly higher than the 3.3 that the existing Khet application has (see 2.2 Khet – The existing mobile application). It should however be mentioned that the sample in this report is less than half of the one of the existing application.

Having covered answers to all questions from the final test interview an overview of the strongest tendencies can be made.

## 8.2 OVERVIEW OF STRONG TENDENCIES

This section is included in order to provide a less descriptive overview of answers from the final test that have been agreed upon by at least five of the six groups. The following list shows these indications based on the data gathered from the final test:

- No odd or unexpected behavior occurred during the final test.
- No participants were in doubt about which piece they had selected, if any.
- All, except one participant, had no negative feedback regarding the buttons.
- All, except one group, was satisfied with the implementation of camera movement.
- No participants used different screen orientations.

These five points are the strongest tendencies that have been found based on the test results.

# 9.0 DISCUSSION

The intention with this section is to discuss the results found in the final test and the general approach taken in order to solve the final problem statement.

## **9.1 DISCUSSION OF THE OVERALL APPROACH**

As mentioned in the methods chapter of this report (see 3.0 Methods), the intention was to have a user centered progression during the development of the product. This was achieved through two user tests carried out after the game had been implemented to a playable state. The participants in the user tests did give a lot of feedback, but the time that it took to convert that feedback into implemented features in the game might have been slightly underestimated. This meant that there was not enough time for involving more users before the final test which is a bit of a disappointment. It would have been more optimal to be able to keep testing with few users until a point was reached where less feedback would be given from the users as that would be an indication that the game indeed had improved.

Furthermore one could argue that users could have been involved in the process of development at an even earlier stage (i.e. after the design had been finished). It would have been possible to let the users play a mockup version of the game, or the actual board game, and then presenting them with the design ideas to get their feedback. The reason for not taking this approach is however that much of the implementation that was made before the first user test was more or less needed for the game to be similar to Khet. Only very few elements would have been up for debate, and as such it was found more reasonable to not involve the users before a playable version was ready.

Both of the user tests and the final test were conducted with placeholder models for the pieces in the application. Through the project period some attempts were made in hopes of getting better models into the application, because this would have fitted better when considering the final problem statement and hypothesis of this report (see sections 2.5 Final Problem Statement and 3.0 Methods). The intention was to focus on few but well developed elements. Even though some thought was put into designing the placeholders, they are most likely not to be referred to as being "well developed". It was attempted to create models that were better, but unfortunately the outcome was arguably worse than the placeholders, and the time it took making one model was too extensive due to lack in skills. It was also attempted to get models delivered by an outsider for this project, but those were not really good either. Thus the end product ended up having only placeholders as pieces, but fortunately the users in the final test did not focus too much on this to give feedback on other elements. However it would have been preferred to exchange the placeholders with better models in order to better live up to the hypothesis of this report.

### **9.2 DISCUSSION OF THE RESULTS OF THE FINAL TEST**

When looking at the results a few things are worth discussion. First and foremost it is interesting to consider if the used approach were fitting and worked well. It was decided to conduct the test with focus group interviews in the end. However the groups consisted of only two persons which is rather few participants in a focus group. During the user tests the amount of feedback given were fairly well proportioned with the time it took to improve on the product in relation to the feedback. In the final tests however there was a tendency of the test participants not debating each other's arguments much. When it was decided to have only two persons in the groups it was with the reasoning explained in the last section of the methods chapter (see 3.0 Methods) - namely that if putting together four people in a group they would not have the same experience to base their feedback on, which could pose some problems. However having only two persons in the group meant that the flow of speech in the interviews would often stop because the participants would wait for the test administrator to ask a new question. This brakes part of the idea of having a focus group as the participants ideally should debate with one another. Hence it might have been better to actually interview the participants one at a time using a completely different approach.

In the last question of the interview the participants in the final test were asked to rate the game on a scale of one to five. Looking back this was not an optimal solution. Not because the feedback given is not interesting but because of the lack of anonymity from the raters perspective. The chance of a test participant being generous and rating a bit higher is increased when the participant is sitting face to face with a test administrator. Having the participants write their rating on a piece of paper (or marking it on a scale) and put in a container would have been a much better solution in terms of getting honest answers. The answers given is however not useless at all. Actually seeing that none of the twelve participants rated the game 5 on the scale is a rather clear indication that the application still has room for improvements. Especially since the issue described in this section might have caused at least some of the participants to rate the game higher than they would if they had rated it anonymously.

# **10.0** CONCLUSION

A user centered progression during development was utilized in order to meet the expectations of the hypothesis in this report:

# "Creating a well made game but with focus on a few elements will improve the chances of potential users to grant positive feedback"

The intention was as such to limit the application to be built to a minimum of features in order to be able to present the users in a final test with a relatively polished product. Based on the analysis of diverse games for Android and how a game best be ported to a digital platform the design for the application was made followed by an implementation phase. As soon as the developed Khet application was deemed playable a set of user tests were conducted. This was done in hopes of eliminating as many potential flaws and imperfections from the application as possible before a final test.

Involving the users during the development aided in terms of polishing the product in certain areas. When looking at the feedback from the user tests it becomes apparent that the features that received the most feedback, and as such got improved, are very much related to usability (see section 7.2.3 Results of the user tests). Hence, based on the feedback from the user tests, an effort was put into polishing the camera movement (and the underlying gesture input), the buttons, the colors/light settings and the feedback from the game.

When time did not allow for further user testing a final test was conducted. In this test a total of six groups of two persons each (12 persons in total) participated. These 12 persons answered questions in an interview designed specifically to investigate whether the final implementation of the changes made after each user test had indeed been polished enough to be well received by the test participants. When considering the strongest tendencies that were found in the results of the final test (see section 8.2 Overview of Strong Tendencies) it becomes apparent that many of the elements that were deemed problematic in the user tests were not receiving negative feedback by the majority of the participants in the final test.

#### So to answer the final problem statement:

# "Would a Khet application with few, but well developed, features result in a more positive evaluation by potential users?"

It was found through the final test that a majority of the participants enjoyed playing the game as four of the groups in the final test stated that the game was funny/engaging or similar (see section 8.1.1 What participants think about the game). Furthermore it was found that the elements polished during the phase of user testing received little, if any, negative feedback during the final tests. As such it can be concluded that the game did in fact receive a more positive evaluation after the user tests than it did during the user tests - at least when considering the most finished features. If the developed game will receive better feedback than the existing Khet application is however uncertain. Looking at the

feedback from the final test and considering that no users during the final test rated the game as a five on the scale ensures that there is still room for improvement.

# **11.0 FUTURE PERSPECTIVES**

As the project has now been concluded upon, this section is included in order to elaborate on the potential next steps to take.

First and foremost it would be interesting to look at the negative feedback that were given during the final tests. This could provide useful information in terms of which parts of the product that might need further work in order to live up to users' expectations. Several things were mentioned like *the colors of Pharaohs not being fitting* and *sounds would be nice*. Refining such elements could potentially make the game polished enough to be received even better by end users. Also it should be mentioned that when the application is developed to a point where it is generally well received it would make sense to consider including the elements that were purposely not included for this implementation. This means implementing an artificial intelligence for the game and a network that would allow players to play on two devices rather than one.

In terms of testing the application at later stages it might be interesting to consider a more quantitative approach. Imagining the application implemented with a functioning game-shell it could relatively easily be distributed online to many users in order to get their feedback on the application. A survey could potentially be integrated directly in the application in the form of a link that it shown to users after a game has ended.

Another possible strategy of future testing of the application could include so called superusers. Few users (that like playing Khet) could be asked to participate through several iterations of implementation. This method is good for discovering bugs, and for getting feedback in relation to elements in the game that might not be problematic during few games but becomes annoying to users after many games. An example of such could be sounds that become repetitive to the users.

Finally when the game is developed to a point where it is deemed fairly well implemented it could be interesting to release it on Google Play and see how end users will receive it.

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# **13.0 APPENDICES**

## **13.1** APPENDIX **1** – **P**RELIMINARY SURVEY

This appendix shows the content of the questionnaire that test participants were asked to fill out during the preliminary survey. Unfortunately Google Forms (that has been used for making the survey) does not support a printer friendly layout, so it is worth noticing that the questionnaire looked better to the test participants than this appendix suggests.

Sma	Il survey about mobile game usage
	il sulvey about mobile game usage.
Pleas Your	e answer the following questions. The questionnaire will take under five minutes of your time. answers will be anonymous, and the data gathered will be analyzed and used for finishing my Master Thesis
Best John	regards and thanks in advance ny Myhre Mikkelsen
'age 2	
Que	stions about the game 'Angry Birds'
Have	you ever played Angry Birds? *
0	/es
0	lo
age 3	
Que	stions about the game 'Angry Birds'
Plea	se rate on a scale from 1 to 5 how good of a game you think that Angry Birds is *
lťs yr	ur personal opinion that matters. 1 is the lowest score, 5 is the highest.
1 - L	owest score
Diee	
gave	it? *
gave age 4	it? *
gave	it? *
age 4	se descripe in short what you think that is good about the game. Why did it deserve the score you it? *
age 4	se descripe in short what you think that is good about the game. Why did it deserve the score you it? * stions about the game 'Wordfeud' you ever played Wordfeud?*
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age 4	se descripe in short what you think that is good about the game. Why did it deserve the score you it? * stions about the game 'Wordfeud' you ever played Wordfeud?* es
age 5	stions about the game 'Wordfeud' you ever played Wordfeud?*
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Piela gave Page 4 Que Have 0 N age 5	stions about the game 'Wordfeud' 'es stions about the game 'Wordfeud' stions about the game 'Wordfeud'
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age 5 Que Have 0 N age 5 Que Plea: It's yo 1 - I	stions about the game 'Wordfeud' you ever played Wordfeud?* 'es lo stions about the game 'Wordfeud' stions about the game 'Wordfeud' se rate on a scale from 1 to 5 how good of a game you think that Wordfeud is.* ur personal opinion that matters. 1 is the lowest score, 5 is the highest. .owest score
Piea gave Page 4 Que Have 0 N age 5 Que Piea It's yc 1 - 1 Piea scor	stions about the game 'Wordfeud' you ever played Wordfeud?* 'es lo stions about the game 'Wordfeud' set rate on a scale from 1 to 5 how good of a game you think that Wordfeud is.* ur personal opinion that matters. 1 is the lowest score, 5 is the highest. 

Thank you for your answers.

## **13.2 APPENDIX 2 – DATASET FROM PRELIMINARY SURVEY**

This appendix displays the complete dataset gathered over 48 hours through the preliminary survey questionnaire.

Participant number.	Have you ever played Angry Birds?	Please rate on a scale from 1 to 5 how good of a game you think that Angry Birds is.	Please descripe in short what you think that is good about the game. Why did it deserve the score you gave it?	Have you ever played Wordfeud?	Please rate on a scale from 1 to 5 how good of a game you think that Wordfeud is.	Please descripe in short what you think that is good about the game. Why did it deserve the score you gave it?
1	Yes	3	very entertaining at first, but gets boring over time	Yes	2	Funny to compete with friends, but requires spelling skills
2	Yes	4	It's awesome if you're bored, riding a train or car just to make the time go by faster. :-)	Yes	3	I gave it 3 because it's an awesome game and you get to learn a lot of new words and so, but when you've played it for some time it gets a bit boring. That's why I gave it 3 and not 4.
3	Yes	4	It's the same over and over again, but i still enjoy playing it time to time!	No		
4	Yes	3	Simple	Yes	4	Social
5	Yes	2	The game does not have lvl up features, and the graphics are not all that good. The game gets an average rating because of the fact that the concept of the game is somewhat entertaining, but the thing about getting stars, stresses me out like fuuuck!	No		
6	Yes	4	It's easy to get into and hard to stop playing. Nice feel, good sense of progression, attractive graphics.	Yes	3	Fun at first, but it became a bit tedious when there was no real sense of progression.

7	Yes	3	It's a cute game that's fairly easy to get started on	Yes	4	Lovely social game, quite challenging, with an ever-varying gameplay because of the fact that you play against real people.
8	Yes	3	it's time killing	Yes	4	you can play it for so long
9	Yes	4	pretty, challenging, fun/good sound	Yes	4	p v p, fun, challenging, learning game
10	Yes	3	It's a decent game, does what it says it does.	Yes	4	It's a handheld version of Scrabble, of course it's good
11	Yes	3	you can't resist getting addicted to the game	No		
12	No			Yes	4	Fun, most of the time
13	Yes			Yes	3	play against people you know, and strangers. easy rules. game is easy to pick up, and put down when you need to
14	No			No		
15	Yes	4	fantastic time escape	Yes	5 - Highest score	new version of the fantastic game scrable
16	Yes	2	Replayability	No		It dooon't got
17	Yes	1 - Lowest score	Because it's too easy, and gets borring almost instantly	Yes	3	more than 3, because of how poor the dictionay of the game is, but I like scrabble though.
18	Yes	3	it is slow om my fone at take lot of time to start! some of the levels is a bit to easy.	Yes	5 - Highest score	i love to play wordfeud! it is a learning game and I can play with my friends and family!
19	Yes	3	Nothing fancy, but is a game you get into fast, and can leave and pickup again without any hazzle.	Yes	2	Glorified Scrabble. Fun for 5 mins, then boring.
20	No			No		
21	Yes	4	Good time consumer. Good as a toilet game.	Yes	3	Basically scrabble for your phone. gets 3

			Did not get 5 stars because it sometimes needs luck rather than skill to get all three stars			because it is only as fun as scrabble is, which means alot in the start and then not later
22	No			No		
23	No			No		
24	Yes	5 - Highest score	Its fun and original	Yes	3	Fun sometimes, but it gets boring after a while.
25	Yes	3	good production quality, but kinda boring mechanic	No		
26	Yes	4	It made me want to continue	Yes	2	I didn"t like it
27	Yes	3	It makes the bustrip seem shorter.	Yes	4	Like scrabble, awesome.
28	Yes	3	Its funny.	Yes	2	Ok, but kinda boring.
29	Yes	4	Great and funny gameplay	Yes	3	Multiplayer!
30	Yes	3	It's not THAT great, i think people make more of it than it really is. its just a bird flying into some pigs	Yes	5 - Highest score	It's a really fun game, and a good game for brain activity
31	Yes	3	Grafikken er rigtig god. The graffic is very good :p	Yes	2	Ikke min type spil
32	Yes	2	Mainstream game	Yes	3	Mainstream
33	Yes	4	Simple but yet addicting.	Yes	4	Simple, well- known and you're able to compete against friends.
34	Yes	4	fun	Yes	5 - Highest score	you can play with others
35	Yes	3	Because there have been many flash games similar to it all over the internet, and it is nothing special compared to those.	No		
36	Yes	4	Simple and	No		
37	Yes	3	A lot of gameplay though it is simple	Yes	3	Does not require constant attention
38	No			No		

39	Yes	4	Good looking/funny graphics, funny sounds, rising level of difficulty	Yes	5 - Highest score	The opportunity to play against others + they updated the dictionary to an official danish one
40	No			Yes	5 - Highest score	I callenge the clever people i know, and i have to think!!
41	Yes	4	Smashing things is always fun, and the variation in bird "powers" adds a bit extra.	Yes	4	Playing against friends is fun. I find it fun because I like games that require a bit f thinking and to some degree some strategy as well.
42	No			Yes	4	Its good due to its low barrier to entry and wide appeal, but its hardly innovative. Thus 4
43	Yes	1 - Lowest score	4 har ikke spillet det forfærdelig meget, men synes det er sjovt nok, og finde ud af hvor man skal skyde fuglene hen, for at dræbe flest mulig grise, så det er vel hel okay tidsfordriv! og godt der kommer nyt til, ny længere man kommer ind i spillet.	No		
44	No			Yes	4	keeps the creative part of the brain going. fun getting as high points as possible.
45	Yes	3	It suits it platform really well, and allows for convenient time-waste. The physics are interesting.	Yes	3	As the former - time waste. The game also allows for keeping touch with people. There is a decent amount of skill required to play.
46	Yes	3	Good - idea, bad - short story	No		

47	No			No		
48	Yes	3	Easy and fun	No		
49	Yes	3	its fun but not fantastic : )	No		
50	Yes	4	the seeming dedication to the product by the developers. Their love for the game is infectuos	Yes	5 - Highest score	I love words. And I love being the best among my friends!
51	Yes	4	fun	Yes	5 - Highest score	very fun
52	Yes	2	DET FOR TRIVIELT	Yes	1 - Lowest score	I DONT5 THINK ITS GOOD
53	Yes	3	solid game, but quite tedious the long run.	Yes	3	too low competition level
54	Yes	4	Its simple, but fun. And the graffic is good	No		
55	Yes	4	At the time of release, it was an innovative and challenging experience, easily avaliable.	Yes	3	The game Scrabble in its original form was a very stationary game. The well- developed mobile platform was a good way to bring back a classic game to the 21st century.
56	Yes	4	Timespender	Yes	5 - Highest	Challenging. Play
57	No			No		
58	Yes	4	its good fun. its addictive. you want to beat friends score	Yes	5 - Highest score	same reasons as last question. its requires you to think
59	Yes	3	challenging	Yes	1 - Lowest score	boring
60	Yes	3	it is fun, and for all	Yes	3	you have to think
61	No			Yes	3	well, it's it's a fun and challenging game, but the translations to danish is really bad, and some well known danish words doesn't exist in the game,
62	Yes	4	The good thing is that it is really catchy and its easy to learn	Yes	3	Its okay, but really boring in the lenght and all the cheating sucks!
63	Yes	3	its great when you are waiting	Yes	4	Its a fun game you can play

			for a bus or any other kind of waiting, but I wouldn't play in my sparetime			with family and friends.
64	Yes	3	It is fun but it quickly becomes the same	Yes	2	To much the same
65	Yes	4	Easy to play	Yes	4	The interaction with friends in a "game zone"
66	No			No		
67	No			No		
68	Yes	4	a good Challenge	Yes	5 - Highest score	mindchallange
69	Yes	3	fun at first, but became boring and repetitive fast. Stopped playing after a week or two	Yes	5 - Highest score	because it's a two player game, i can play against my friends and use my mind

## **13.3 APPENDIX 3 - DATASET FROM USER TESTS**

The intention with this appendix is to display the notes taken from the user tests, both observations and interviews.

#### **Observations** - User test - session 1

What	t was observed during the play session of the test:
•	GUI buttons are too small (players did not notice them by before they were told about them).
•	A player mentioned that it would be nice if the camera movement was restricted around GUI buttons.

#### Interview - User test - session 1

#### What do you think about the game?

- One person states that he is entertained.
- The other found it difficult in the beginning but was entertained after a little while. He states that he felt like he had to make a few moves in the game before he was getting an idea of what to do in order to win.

#### Did you experience any odd or unwanted behavior from the application while playing?

- It is difficult to see when the king is selected --> This goes for all pieces except the pyramids.
- One would not always see where the laser hits (unless zooming out to see it).
- The placement of the "fire" and the "undo" buttons should be swapped (so that fire is right side of the screen).

# What do you think could be done in order to make the game better or improve the quality of it?

• The size of buttons (fire, undo and rotation) is too small. Almost illegible and difficult to hit with a finger.

#### What do you think about the graphics in the game?

- They are simple, and could use some polishing.
- The background color (a dark green) is not good. Maybe change it to black.

#### Did you have any difficulties with the interface?

- An ingame explanation of selection/de-selection would be nice.
- When a piece is selected it would be nice with highlight on the fields it can move to.
- It is difficult to see when a white piece is selected, due to the light in the scene.
- It is difficult to select a piece without moving the camera.

#### **General feedback**

- Camera movement is too restricted when zoomed in close.
- It would be nice to have a choice of seeing the game in 2D.
- Lighting in the scene makes the walls around the board look funny.
- Rules should be added in the application.
- Tilting the phone should put the game in landscape mode (instead of portrait).
- It might be nice if the camera moved to the other side of the playing field when black is playing.

#### **Observations** - User test - session 2

#### What was observed during the play session of the test:

- A player mentions that he cannot see which piece was moved just before his turn.
- Players are having difficulties with swapping the Djed piece and any other piece.

#### **Interview** - User test - session 2

#### What do you think about the game?

- Both players like the game, but they agree that playing it on two devices would be better than on only one.
- It is too difficult at the moment to follow the other player's moves.

#### Did you experience any odd or unwanted behavior from the application while playing?

- At one point during the play session the screen went black for a second. The game continued immediately after, and the glitch could not be reproduced.
- One player played through the entire game without knowing how to de-select a piece (he did however manage to select another piece when needed).
- One player suggested that double-tap could be implemented for swapping the Djed and another piece.

# What do you think could be done in order to make the game better or improve the quality of it?

- Both players felt that zooming in the game was tedious because the camera would act sliding (braking too slow). They stated that they felt that they needed more control over the zoom.
- One player suggests that a drag gesture could be implemented as an alternative to the rotation buttons, thus dragging around a selected piece to rotate it.
- It was stated that the layout of the playing field is too simple. Different textures or reflection of pieces might help.
- One player mentions that the design of the Djed piece makes it difficult to see where a laser would be redirected after entering.

#### What do you think about the graphics in the game?

• Both players agreed that the pieces currently are too simplistic in their appearance.

#### Did you have any difficulties with the interface?

• It was mentioned that when zoomed in close the swipe gesture would move the camera faster than the player thought felt natural.

Added probing questions after first user test:

#### Was it always obvious which piece you had selected?

• Yes - both players.

#### How was the size/graphics/placement of buttons?

• The placement of buttons (one in each side, middle of the screen) made the buttons overlap the playing field. Moving them to the bottom of the screen would solve this problem.
#### How was the camera movement?

- Fine, except was has been mentioned earlier.
- Also it would be nice to be able to play in landscape mode.

## What do you think about the colors in the game?

- It is more difficult to see the rotation of black pieces, compared to the white pieces, due to the
- difference in contrast.
- Overall it is pleasant to look at.

## **General feedback**

- The opportunity of seeing earlier moves would be nice. Either by replaying moves, or indications on the board.
- It could be nice with a prediction of the lasers trajectory.

## **13.4 APPENDIX 4 - DATASET FROM FINAL TESTS**

This appendix is included in order to portray all gathered notes from the interviews in the final stage of testing.

## **INTERVIEW - FINAL TEST - SESSION 1**

Both participants are male - playing on an HTC One X.

#### What do you think about the game?

- Both players stated that they found the game to be fun --> funnier than chess (because it is more visual).
- One player stated that the mechanics reminded him of the game "pipes".

## Did you experience any odd or unwanted behavior from the application while playing? No.

## What do you think could be done in order to make the game better or improve the quality of it?

- Ingame instructions would be a nice addition
- It would be nice with more "3D" (more options for camera movement)
- More and different levels
- An indication of where the laser will hit before accepting a move would be a nice "newcomer" feature.

#### What do you think about the graphics in the game?

- The white pieces seem more anonymous, possibly due to some contrast between body and tubes on the black pieces.
- One player would like buttons for moving pieces rather than clicking the board (the other players disagrees).

## Did you have any difficulties with the interface?

• Players had difficulties in the beginning knowing which pieces belonged to them.

Added probing questions after first user test:

#### Was it always obvious which piece you had selected?

• Yes.

## How was the size/graphics/placement of buttons?

The players like the buttons as they are.

#### How was the camera movement?

• It was fine except that one player would like a bit more freedom to move around.

#### What do you think about the colors in the game?

• One player stated that he is colorblind and thus the combination of green (the walls) and yellow (fields on the board) was not good for him.

Added probing questions after second user test:

Did y	you utilize different screen orientations (portrait/landscape), if so, did it act different
from	your expectations?
•	They did not use it.

General feedback (Included since first interview - but is placed here for better chronology in questions)
Nothing that has not been mentioned.

Added question for the final test:

If yo high	ou had to rate the game on a scale of 1 to 5 (one begin lowest score and five being est) - how would you rate the game?
•	Player 1: 4
•	Player 2: 4

## **INTERVIEW - FINAL TEST - SESSION 2**

Both participants are male - playing on an HTC One X.

What do you think about the game?
They found it funny, and one player said that he likes that it reminds him of chess.

## Did you experience any odd or unwanted behavior from the application while playing? No.

What do you think could be done in order to make the game better or improve the quality of it?

• They stated that they felt that each turn took some time to perform and suggested that a game mode with a chess clock or a finite amount of time per turn could be implemented to resolve this.

What do you think about the graphics in the game?

• They are ok, but does not grant any "wow" effects.

## Did you have any difficulties with the interface?

Nothing.

Added probing questions after first user test:

Was it always obvious which piece you had selected?

• Yes.

#### How was the size/graphics/placement of buttons?

• They are fine.

#### How was the camera movement?

- It was easy to use (similar to normal smartphone gestures).
- It was nice that one was able to overview the entire playing field.
  - The zooming feature was very helpful when trying to select a piece.

## What do you think about the colors in the game?

One of the players found it difficult in the beginning to know which pieces was his. •

Added probing questions after second user test:

Did you utilize different screen orientations (portrait/landscape), if so, did it act different from your expectations? •

- They did not use it.
- **General feedback** (Included since first interview but is placed here for better chronology in questions)
  - An implementation of fields that neither player could use could be interesting for the game play.
  - One player stated that he really likes the game, but he stresses that he would like to see an
  - implementation that forcibly reduces the amount of time a player can use to perform a move.

Added question for the final test:

If you had to rate the game on a scale of 1 to 5 (one begin lowest score and five being highest) - how would you rate the game?

- Player 1:4 •
- Player 2:4

## **INTERVIEW - FINAL TEST - SESSION 3**

Both participants are male - playing on an HTC One X.

## What do you think about the game?

- One player stated that he think that the game is similar to chess, but more tactical. •
- Both players stated that they were entertained.

Did you experience any odd or unwanted behavior from the application while playing? No. •

## What do you think could be done in order to make the game better or improve the quality of it?

Sounds would be nice. ٠

### What do you think about the graphics in the game?

• They are fine.

### Did you have any difficulties with the interface?

It was not easy to read who's turn it is. •

Added probing questions after first user test:

#### Was it always obvious which piece you had selected?

• Yes.

## How was the size/graphics/placement of buttons?

It was ok. ٠

How was the camera movement?

Very natural, and it works fine. •

## What do you think about the colors in the game?

- One player stated that he was confused about the colors of the Pharaohs in the beginning.
- When a piece is next to a wall, and rotated with a tube pointing towards the wall, it is difficult to see
  - the tube.
- The colors seem well chosen. •

Added probing questions after second user test:

Did you utilize different screen orientations (portrait/landscape), if so, did it act different from your expectations? ٠

They did not use it.

**General feedback** (Included since first interview - but is placed here for better chronology in questions) • No general feedback.

### Added question for the final test:

If you had to rate the game on a scale of 1 to 5 (one begin lowest score and five being highest) - how would you rate the game?
• Player 1: 4

• Player 2: 4

## **INTERVIEW - FINAL TEST - SESSION 4**

Both participants are female - played on an LG Optimus 2x

## What do you think about the game?

- Both participants agree that the design is smart.
- They find the game to be tactical.

## Did you experience any odd or unwanted behavior from the application while playing? No.

What do you think could be done in order to make the game better or improve the quality of it?

• It would be nice if more details were added to the pieces.

What do you think about the graphics in the game?

• The game might be simpler in 2D.

Did you have any difficulties with the interface?
No.

Added probing questions after first user test:

Was it always obvious which piece you had selected?
Yes.

How was the size/graphics/placement of buttons?

• They are fine.

How was the camera movement?

• Good.

What do you think about the colors in the game?

- It is nice that it is clear/bright.
- The black Pharaoh should have black body parts (not only it's base).
- Maybe it would be nice if the Pharaohs had a different color.

Added probing questions after second user test:

Did you utilize different screen orientations (portrait/landscape), if so, did it act different from your expectations?

• They did not use it.

General feedback (Included since first interview - but is placed here for better chronology in questions)
It was fun and it makes you think.

Added question for the final test:

 If you had to rate the game on a scale of 1 to 5 (one begin lowest score and five being highest) - how would you rate the game?

 • Player 1: 3

 • Player 2: 4

## **INTERVIEW - FINAL TEST - SESSION 5**

Both participants are female - played on an LG Optimus 2x

### What do you think about the game?

• One participant states that the game is complex and requires patience.

• The other participant states that it takes time to learn.

## Did you experience any odd or unwanted behavior from the application while playing? No.

## What do you think could be done in order to make the game better or improve the quality of it?

• The current camera angle could be altered.

### What do you think about the graphics in the game?

• The pieces look slightly too much alike one anohter.

• Visually pleasing.

#### Did you have any difficulties with the interface?

• Changing between buttons and clicking on pieces is not so nice.

Added probing questions after first user test:

## Was it always obvious which piece you had selected? Yes.

### How was the size/graphics/placement of buttons?

• Fine.

#### How was the camera movement?

• It was difficult to zoom - and the camera angle could be altered (as mentioned).

#### What do you think about the colors in the game?

• Black versus white is not so nice. Red versus green is suggested instead.

Added probing questions after second user test:

Did you utilize different screen orientations (portrait/landscape), if so, did it act different from your expectations?

• They did not use it.

#### **General feedback** (Included since first interview - but is placed here for better chronology in questions)

- Good game if you like tactical games.
- One participant mentions that it reminds her of stratego.
- It would be better if it could be played like Wordfeud (two devices, networked).
- Both participants mentions that they do not play games often and found it a bit difficult.

Added question for the final test:

If you had to rate the game on a scale of 1 to 5 (one begin lowest score and five b	eing				
highest) - how would you rate the game?					

- Player 1: 2
- Player 2: 3

## **INTERVIEW - FINAL TEST - SESSION 6**

Both participants are male - played on an HTC One X

#### What do you think about the game?

- One participant mentions that the game is interesting and attractive.
- The other participant mentions that it is nice that it involves a lot of strategy and that it allows for
- taking the opponent by surprise.
- Both players agreed that they found the game to be engaging.

# Did you experience any odd or unwanted behavior from the application while playing? No.

## What do you think could be done in order to make the game better or improve the quality of it?

- It would be nice if the pieces reflected in the playing field.
- It would be nice with a larger playing field.

### What do you think about the graphics in the game?

Well made for smartphone, simple, easy to understand and there is no annoying elements.

## Did you have any difficulties with the interface?

• Not really. It is simple and intuitive.

Added probing questions after first user test:

## Was it always obvious which piece you had selected?

• Yes.

#### How was the size/graphics/placement of buttons?

Good.

•

٠

One player stated that some users might prefer a popup to accept their current move (instead of the fire button)

#### How was the camera movement?

Intuitive and similar to other smartphone applications. •

#### What do you think about the colors in the game?

Easily understandable and looks decent.

Added probing questions after second user test:

Did you utilize different screen orientations (portrait/landscape), if so, did it act different from your expectations? •

They did not use it.

**General feedback** (Included since first interview - but is placed here for better chronology in questions)

- After the laser is fired it would be nice with a clear indication that it is the other player's turn. ٠
- It would be nice if the camera would zoom back in to its previous position after the laser is fired. •

Added question for the final test:

If you had to rate the game on a scale of 1 to 5 (one begin lowest score and five being highest) - how would you rate the game? Player 1:4 ٠

Player 2:4 •