PLAYABILITY HEURISTICS FOR MOBILE GAMES USING TOUCHSCREEN DISPLAYS

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I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

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ABSTRACT

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Mobile applications market is rapidly growing. The "mobile game" is one of the most popular applications available to users and has a huge market share. Game developers are trying to release games that are more enjoyable and addictive to play. However, only a small minority of these games are successful. Development of a successful mobile game requires that preferred ways of interacting with the game is known. This knowledge is available through user experience (UX) studies. However, most of the UX research for games is on video games played on PCs or dedicated game consoles and not mobile devices. It is known that interaction mechanisms with mobile devices are fundamentally different from those with PCs or game consoles. UX in mobile games has two distinct aspects different from UX in video games in general. One of these aspects is the usability of mobile devices within the context of interacting with a mobile game and the other is the playability of a mobile game using these different means of interaction. While there exist generic sets of heuristics that address good game design, the only set of mobile game playability heuristics was developed in mid-2000s and did not address touch-based capabilities of modern mobile devices. This requires a set of guidelines for developing a good mobile game on modern mobile devices with touchscreen displays.

This thesis aims to extend existing heuristics on mobile game playability for touchscreen devices. Previous research on mobile game playability and developments in touchscreen display are reviewed. Existing mobile game playability heuristics are discussed. Four new heuristic rules addressing 1) distribution of game items, 2) user's handedness, 3) use of tilt sensors and 4) haptic feedback are proposed. These heuristic rules are then tested using subjective UX studies with the widely used game experience questionnaire (GEQ). In addition, expert views from game developers are collected and reported. It was shown through analysis of the obtained results that the distribution of the game items, the user handedness and the tilt property are significant while playing a game. However the existence of haptic feedback in a game does not affect the playability.

Keywords: Playability, Mobile Game, Playability Heuristics, Gameplay, Game Usability

ÖZ

DOKUNMATİK EKRANLI CİHAZLARDA OYNANAN MOBİL OYUNLAR İÇİN OYNANABİLİRLİK HEURİSTİKLERİ

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Mobil uygulama pazarı hızla büyümektedir. Mobil oyunlar, kullanıcılara sunulan uygulamalardın en önemlilerinden biridir ve oldukça büyük bir Pazar payına sahiptir. Oyun geliştiricileri her geçen gün daha eğlenceli oyunlar ortaya çıkarmak için uğraşmaktadırlar. Fakat bu oyunlardan küçük bir azınlık başarılı olabilmiştir. Başarılı bir oyun geliştirmek için, oyunla doğru iletişime geçmenin yollarını bilmek gerekmektedir. Bu bilgi de "kullanıcı deneyimi" çalışmalarından elde edilir. Fakat kullanıcı deneyimi çalışmalarının çoğu, mobil oyunlar için değil; PC'lerde veya oyun konsollarında oynanan video oyunlar üzerine yapılmıştır. Mobil cihazlarla etkileşime geçme mekanizması diğer cihazlardan (bilgisayar, oyun konsolu vb.) farklıdır.2000'li yılların ortalarına doğru, mobil cihazlar düşünülerek oynanabilirlik heuristikleri geliştirilmiştir. Fakat bu heuristikler yeni nesil dokunmatik ekranlı cihazları kapsamamaktadır.

Bu çalışma, var olan mobil oyunlarda oynanabilirlik heuristiklerini yeni nesil dokunmatik ekran cihazlarda oynanan oyunlar için geliştirmeyi hedefler. Bu amaçla, oynanabilirlik ve dokunmatik ekran çalışmaları incelenmiştir. Var olan heuristikler tartışılmıştır. Bu çalışmaların sonucunda dört yeni heuristik elde edilmiştir ve şu konular hakkındadırlar: 1) oyun elamanlarının ekran üzerine dağılımı, 2) kullanıcı tutuş biçimi, 3) tilt sensörlerinin kullanımı, 4) titreşimli geri bildirim alınması. Bu heuristikler kullanıcı deneyimi çalışmaları

ve oyun deneyimi anketi kullanılarak test edilmiştir. Ayrıca geliştirme aşamasında oyun geliştiriciler tarafından gözden geçirilmiş ve yorumları alınmıştır. Bu çalışmalar ve analizler sonucunda görüşmüştür ki oyun elmalarının dağılımı, kullanıcının cihazı tutuma şekli, tilt özelliği oynanabilirlik açısında önemlidir ve geliştirilen heuristiklerin doğru olduğu gözlemlenmiştir. Fakat titreşimli geri bildirim özelliğinin oynanabilirliğe bir katkısı olmayabileceği görülmüştür.

Anahtar Kelimeler: Oynanabilirlik, Mobil Oyun, Oynanabilirlik Heuristikleri, Oyunun Oynanışı, Oyunlarda Kullanılabilirlik

Dedicated to my family…

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CHAPTER 1

INTRODUCTION

Computer games and productivity software (such as word processors, spreadsheet applications etc.) are fundamentally different in terms of user experience (UX). In the former, user interaction has to be streamlined to increase enjoyment and flow, while in the latter, the aim is to increase the productivity. Although there are a number of studies about user experience, they typically involve productivity software and not computer games.

Mobile game is any type of game which is played on mobile devices. There are a large number of mobile games available in the market. However, there are only a few highly-popular mobile games. A good mobile game is typically highly playable. In other words, playability is one of the most important factors in designing a successful game, and the existing playability problems have to be identified and solved before a game is ready to be released.

Before the new generation of smart phones and tablet computers became available to users, mobile games were less attractive. Small screens, tiny memory, complexity of control keys, low computational power inhibited the widespread adoption of mobile games. Compared to today, fewer people used to buy and play mobile games. However, the advent of smart phones and tablet computers made a huge number of games and even game types available for the mobile device users. Big hardware manufacturers provide mobile games and other applications to their customers via their application stores. The people who are not game players in their daily routine started playing mobile games. Namely, mobile games targeted players with different skills and habits. This type of user is known as the “casual player”.

The use of low-cost touchscreen displays in mobile devices made them available to the wider population. This made it possible for game developers to develop games which heavily use touch-based interactions. These developments also extended the target user group to include casual gamers for which the developers develop games for.

There are a large number of mobile games available in the market. However, there are only a few highly-popular mobile games. A good mobile game is typically highly playable. In other words, playability is one of the most important factors in designing a successful game, and the existing playability problems have to be identified and solved before a game is ready to be released.

Some of the playability issues for mobile games are:

1. Handling interruptions (Ex. Phone calls)

2. Ability of control sound and environment
3. Using common styles
4. Helping the player
5. More simple GUI than PC games
6. Using terms that are familiar to the player
7. Obvious character status
8. Clear goals
9. Largeness of target group

These items about playability are applicable to any game, mobile or not. However, touchscreen displays may present some specific playability issues that need to be addressed. This study aims to develop new heuristics that will augment the existing playability heuristics for mobile games. Specifically, mobile games which require touch-based interaction are targeted. Some of these issues are outlined below:

- Distribution of game items on the screen: Distribution of game items should be arranged to cater for both right-handed and left-handed people.
- Usage of sides of the screen of the device while playing the game, for tablet size devices.
- Tilt property effect: Tilt property seems to provide a novel interaction modality for mobile games. However, it can affect the playability of mobile games negatively while playing on touchscreen mobile devices.
- Haptic feedback: Haptic feedback, also known as tactile feedback, stimulates the player and provides more qualified playability.

This thesis is organized as follows.

A brief information about the aim of this thesis, growing process of mobile game industry and touch screen technologies; thesis' outline is given in Chapter 1. Chapter 2 includes relevant work in usability, playability measurement of mobile games and other types, too. The problem statement and new heuristics which are not argued before in the literature are discussed in Chapter 3.The evaluation and test implementation part appears in Chapter 4. After testing process, revising and developing heuristics is explained. Lastly, the results are discussed. Chapter 5 includes the conclusion of the study and also discussion part appears in this chapter.

CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

This chapter and its subsections present the previous works that are related to the mobile games, playability and heuristic development. The background information is given to the reader in order to understand the connection between this thesis and previous studies. Furthermore, sample gameplay analyses are presented in order to show the different aspects to the playability and gameplay.

2.1 Gameplay

Gameplay is the one of terms that is difficult to define strictly. In the literature some authors defined it from their own perspectives.

According to Nacke et al. [1], gameplay is the gaming process of the player with the game. Gameplay is defined in the book by Tavinor [2] as "*…a player's interactive involvement typically associated with video games, that is, the activities that occur when one plays a video game…*" Sid Meier thought about gameplay from a different point of view, defining it as "*…a series of interesting decisions…"* [3]. Gameplay is the model developed through the game rules, interaction with the player, challenges, and skills to overcome these challenges, theme and the connection of the player with it.

Gameplay is created by the game developer and the player together. The developer's and the player's imaginations' common work creates the gameplay of a game. It is however, the duty of the developer as informed by the player to design the gameplay. The development process used to create the gameplay is based on four main modules: the story of the game, the rules of the game, the graphical user interface (GUI) elements, and the audio elements. This study is mostly concerned with the graphical user interface elements, and specifically with how the user interacts with these elements using a touchscreen display.

Rollings et al. (2003) [3] discusses how the GUI, gameplay, and physical conditions of a game should be. It is stated in that study that a mobile game should have simple user interfaces. Crowded screens are not acceptable for a mobile game user. The icons and images should be as simple as possible, and there should be a minimal amount of textual information on screen . It is also stated that simplicity of the game must be at its highest level since the screen sizes are small in mobile devices and this causes difficulties with the interaction. However, simplicity should not affect the perception of challenge, competition, and the overall gameplay..

2.2 Playability

Playability determines the quality of a game, including the quality of user experience and how much fun and entertainment the game provides. There exist lists of human computer interaction (HCI) issues to help researchers and game developers [4]. Playability is defined in [4] as *"…the degree to which a game is fun to play and usable, with an emphasis on the interaction style and plot-quality of the game; the quality of gameplay…"* It is also stated that *"…Playability is affected by the quality of the storyline, responsiveness, pace, usability, customizability, control, intensity of interaction, intricacy, and strategy, as well as the degree of realism and the quality of graphics and sound."*

Sanchez et al. [5] focused on usability and playability of video games, It is stated that usability is not sufficient to achieve optimum playing experience. Initially the authors tried to categorize player experience and, referring previous studies they divided the playability into seven categories to measure. These are 1) satisfaction, 2) learnability, 3) effectiveness, 4) immersion, 5) motivation, 6) emotion, and 7) socialization. The study also proposed the facets of playability. Because of the difficulty of analyzing playability, various different perspectives are needed to be used. In this study six facets are proposed such as 1)intrinsic playability, 2) mechanical playability, 3) interactive playability, 4) artistic Playability, 5) intrapersonal playability, and 6) interpersonal playability [5].

The authors proposed using a player-centered video game development approach using the principles of playability. The steps of the development are: 1) specification of Playability Requirements (deducing from the facets of Playability), designing the game adapting of Game patterns in terms of introducing the playability to these patterns, software design, development phase test it playability tests and at last Final Video Game's element. The final product is a high-quality playable video game according to the authors.

2.3 Attractive Usability

Usability with attractiveness can be accepted as the beginning of the playability research.

In 1982, Malone [6] studied why computer games are enjoyable and how other software products can be made enjoyable and attractive as well as usable. According to Malone [6], in order to create an effective interface, the enjoyment of games should be used as a starting point. Malone divided the heuristics into three categories. These are *challenge*, *fantasy* and *curiosity*.

In order to create challenge, uncertain outcomes and goals should be added to a game. One of the main differences between a tool and a toy is that a toy creates uncertain outcomes while using it. However, the user knows the result of his/her activities while using a tool.

Furthermore, it is stated that being novel and surprising provides attractiveness. However, novelty should not cause incomprehensibility and software products should be easy to understand. In other words, the user should be able to learn the rules and get sufficient information to have usage expectations in a complex environment. When these expectations are unfulfilled, this will create novelty and an element of surprise on the user.

Fantasy is one of most significant properties of a game. The aspects of a game that generate fantasy are emotions and metaphors. Fantasy pushes different personalities and different choices of these personalities. The developer must be careful while developing the system catering the expectations of the target audience, such that the game or the system can provide the enjoyment level that it aims to generate. This is the emotion part of fantasy. On the other hand, metaphors can help to create fantasy and enjoyment in a game. It is also stated that because fantasy reminds the things that the user are familiar.

Malone says "…Fantasies that are analogous to things, with which the users are already familiar, can help make the systems easier to learn and use…" [6]

2.4 Playability of Mobile Games

There was a lack of research interest on mobile game heuristics before 2006. In 2006, Korhonen et al. [7] published a study that gives successful heuristics for mobile games. According to this study, there are mainly two reasons why usability of a mobile game must be evaluated in a different way than the other digital game products:

1) It is a game: That means there are a lot of parameters, a lot of happy paths and a lot of stories (created by each player). Thus, it is not feasible to measure the usability of games with the heuristics that are developed for other software products.[7]

2) It is mobile: This means that the game will not have similar usability and playability issues as with the other computer games.[7]

Korhornen and Koivisto [7] devised a new set of heuristics to evaluate the playability and usability of a mobile game. This set of heuristics considers a game in its entirety with its usability, gameplay, mobility and multiplayer aspects.

One of the properties that can affect playability is the number of players. Pinelle et al. [8] purposes a study to evaluate the multiplayer games. This study is generally for all type of computer games.

Usability of a game cannot be evaluated automatically, yet. However, some successful attempts have been made for this purpose. Billi et al. [9] developed a tool which is able to measure accessibility and usability of mobile games. There are some problems with the tool, but it is helpful to understand the level of usability and playability.

2.5 Sample Game Analyses

Sample game analyses, which are made by game developers, are given in this section in order to understand the playability from the developer's point of view. Both games of non-mobile platforms and games of mobile platforms are discussed[1].

2.5.1 Games of mobile platforms

In this section, some popular games are analyzed for their playability. These games are not mobile games and they are gathered from a popular social platform, which has a large user community. In each analysis different methods are used and the metrics are gathered in different categories. These results were produced by game developers working at the game developer company's designer team.

2.5.1.1 Game1: Zombie Lane

Zombie Lane (Figure 1) is developed by Digital Chocolate. The game is released on Facebook and Google Plus in 2011. The genre of the game is RGP – simulation. Zombie Lane has over 1.000.000 monthly active users (MAU) and over 100.000 daily active users (DAU) on Facebook[2]. Its high ratio of DAU/MAU shows how much successful it is.

Figure 1: Zombie Lane

[1] These analyses were carried out when the author was working at Pixofun A.Ş. as a game developer.

[2] The data is obtained from http://www.appdata.com, which provides reliable data for application social and mobile platforms.

Gameplay

The game starts at the end of the world. The player's character lost everything which belongs to it. It has only a ruined hut. The character should combat with the unexpected brain-hungry zombies, rebuild the environment, clean the area, find the lost things, and help its neighbors. The character's only weapon is a shovel. It can be replaced with a new and improved one during the play.

Figure 2:Zombie Lane Gameplay Screenshot 1

Figure 3: Zombie Lane Gameplay Screenshot 2

Analysis

Goal

Main goal of the game is to destroy the zombies (Figure 2). Cleaning the area rebuilding the environment helping neighbors are the sub goals of the game. The game has also daily missions to gain prizes (Figure 3).

Rules

When the game starts, a tutorial is presented to the player. The tutorial shows how to do simple actions in the game and teach the main rules to the player.

"Combo" points are gained when the player does the same action repeatedly in a short time.

There is no need to click every gained item in order to collect them. It is sufficient to make mouse over the items.

Zombies may useful items. In order to have these items, player should kill the Zombies.

The player does every action spending energy. Energy is gained at the beginning of every new level and also, it is gained from eating food and buying them from the store with real money. If there is no case like them, the player can just wait for 5 minutes and gain energy.

The character can visit the neighbors' area and help them to kill the zombies and rebuild their environment. As the player helps the neighbors, it gains money, energy or other prizes.

Challenge

Zombies damage the character's house when they are not killed for long time. For this reason, they are destroyed as soon as they are seen on the game screen.

The missions, which are reminded with alert on the screen, should be completed even if they are bored tasks.

Energy is consumed quickly. This means that game encourages the player to buy energy with real cash, i.e. spend money for the game.

Conflicts

Energy runs out in a short time. Trying to gain energy (buying it from the sore, waiting for just one "energy" for five minutes) frustrates the player and damages the gameplay and the flow is broken.

2.5.1.2 Game 2: Idle Worship

Idle Worship (Figure 4) is developed by Idle Games. Beta version of the game was released on Facebook in 2010. The concept of the game is considerably interesting and its very first success comes from this property. Idle Worship is not released on mobile devices. The game was so successful and reviewers saw it as "Pixar of social games". Targeting only desktop browser brings the failure of the game in two and half year after it was released.

Figure 4: Idle Worship

Analysis

Goal

The goal of the game is to build the civilization and create the community, who worship their "God". In addition to the main goal, there are a lot of tasks given during the gameplay.

Rules

Figure 5: Idle Worship Gameplay Screenshot 1

Figure 6: Idle Worship Gameplay Screenshot 2

The player is the God in the game. The player creates "muddling". The God should make its community happy in order to collect "faith". Faith is the main score unit in the game. Making houses, public buildings, providing eating are the actions bringing faith point (Figure 5).

Another important faith source is "worship". The player, in other words the God has its temple and it can make some muddling worship in the temple. The more muddling worships, the more the player gains faith.

The community lives on an island. There is a volcano mountain on each island. The player can build harbor transport thing to other islands (Figure 6).

The game has a property that makes it interesting. There is no friends bar on the screen. The friend bar exists in the most of the social platform games. In addition to this, the player can share enjoyable Idle Worship videos, instead of photos.

The player can send curse or reward its muddling. Also, curses and reward can be sent to the other God's (player) community.

Challenge

There are other gods around, they can send curse to your island. This may cause decrease the player's faith point.

If the player create muddling over, some muddling can become homeless and they cannot work or worship.

Conflicts

The anatomy in the quests is weak. The player cannot cancel or get new quest before one is completed.

There is a background music that plays during the game. It becomes boring after a while.

2.5.1.3 Game 3: Sims Social

The Sims Social (Figure 7) was developed by EA. It is released in 2011 and achieved large number of users in a short time. It is almost the same with The Sims. It has little differences, such as playing online with friends. Although it was a successful social game, it was shut down by the developer, EA.

Figure 7: The Sims Social

Analysis

Goal

The main goal of the game is to keep the character's mood high. Improving the house, gaining money and doing the daily missions are the subgoals of the game. **Rules**

Figure 8: The Sims Social Screenshot 1

Figure 9: The Sims Social Screenshot 2

There is an empty house when the game starts. The player improves this house. While improving the house, the player must improve his character. The player tries to keep the character's mood high. In order to improve the house, there are furniture and stuff (Figure 8). They can be bought from the store.

Every item brings different advantages. For instance, technological items help to improve your character in this technological area. Music and art items have profits to improve in art area.

There are some secondary missions in the game like cleaning the garden, taking a photo of the bird etc. These help character to gain money.

There are two money types: Simeleons and SimCash. Simeleons can be earned any action in the game. However, SimCash can be gained from only level ups and can be bought with real money (Figure 9).

The character has also energy to do actions. Since it is consumed, player cannot spend much time playing this game. The energy can be re-gained if the player waits enough. The player completes the mission to success in the game.

Conflict

Almost all missions are related to the friends in the player's social network who play the game. These missions make the player bored as the time goes on. To wait something from your friends in order to complete an action or mission is annoying. There should be another

way to do such these actions. This property also frustrates the player. It may shorten the duration of the player's daily play.

Secondly, the game enforces the player to spend money. This is also deterrent.

Challenge

If the character's mood values are low, its action speed is low. The player cannot buy everything he wants because many things in the store are bought with real cash. In order to gain skills, the character must have some items to gain related skills. Energy is a derivable property of the character.

2.5.2 Mobile Platform Games

These are the most played or downloaded games in mobile platforms (IOS and Android). As it can be seen, they are puzzle games. The most common type in the mobile games is puzzle or puzzle adventure games.

2.5.2.1 Angry Birds

Figure 10: Angry Birds

Angry Birds (Figure 10) may be the first game which comes in minds when mobile game is called. Its adventure starts with iOS and then went on other platforms. The game is developed by Rovio Entertainment and released on iOS platforms in 2009. It reached twelve million paid downloads and near thirty million free downloads within a year [10].

Analysis

Goal

The goal of the game is to ruin the building of evil Piggies and kill them who stole the eggs of "Angry Birds" and save the eggs. Secondary goal is to make highest point and achieve all three stars in a section.

Rules

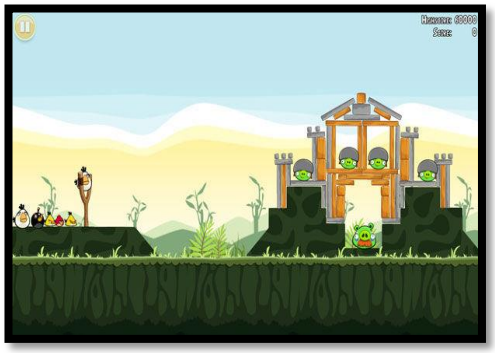

Figure 11: Angry Birds Screenshot 1

Figure 12: Angry Birds Screenshot 2

The player throws the birds towards the buildings (Figure 11). In each chapter, player has right to throw birds in different numbers. Every bird has a different property that the player can use in different situations or the player can merge them to make a combo point. Each section is repeatable. Thus, the player can return the previous sections and can make higher points (Figure 12).

The game has a 2D physical engine. So, almost every physical rules are parts of the game's rule set.

Conflict

In the game, according to your final point the player gains stars which are important for the gameplay. However, the player does not know how it is calculated. It differs in every chapter. Even if the player gets the same point, he/she cannot gain same number of stars. This fuzziness can cause player to get bored.

Challenge

As the levels are getting higher, game is getting harder.

The player should know how and when he/she will throw the bird. If not, the player cannot get the right combination and can fail in the section.

If the screen of the device is smaller, the controlling of throwing item is harder.

2.5.2.2 Bebbled

Figure 13: Bebbled

Bebbled (Figure 13) is a typical bubble breaker game. The game was developed by Nikolay Ananiev and released in 2009 on Android platforms. The screen is full of colored balls in rows and columns which can be tapped, in order to make lines of same colored gems. The second time they are clicked on that lines the gems "break" and give the player points depending on how many gems were broken at once.[11]

Analysis

Goal

The goal of the game is to finish all gems in the scene and get the highest point.

Rules

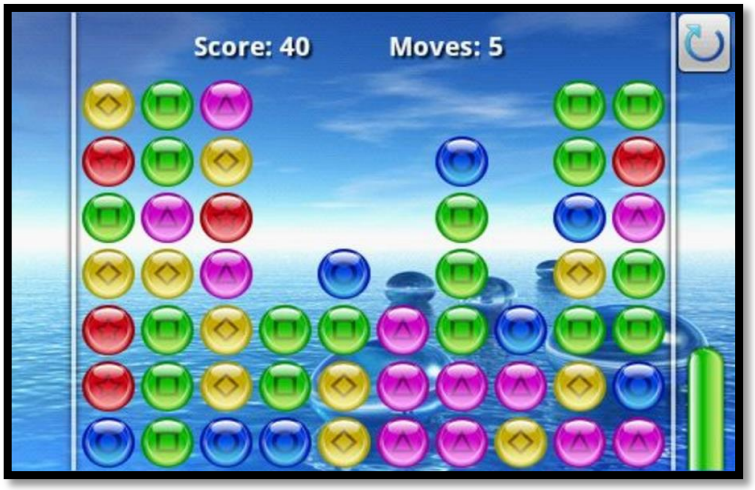

Figure 14: Bebbled Screenshot

The player drops gems on other gems to nuke larger groups of the same groups of the same color. There must be at least two same colors in a group. The player flips the device to add extra gems to help gaining more points (Figure 14).

Challenge

The player must complete the game with the minimum number of gems. The game should be completed in the shortest duration to get high points.

Conflict

There is same screen size even with different screen sizes. There is no extra property to gain more point. For instance, there can be a gem which is like a bomb and appears sometime in the game and when the player takes it, it destroys more gems than normal. Same things repeat too much, the player can get bored after a while.

2.6 Touchscreen Displays

This section of the Chapter 2 includes summaries researches about touch screen displays, and games played on touch screen devices, and also pervasive games and their game play metrics.

2.6.1 Mobile Pervasive Games

Pervasive games take place in the real physical world and with the normal activities of the player's routine. Pervasive games are mostly played using mobile devices. For this reason, pervasive games are researched in the thesis.

In 2007, Sedano et al.[12], conducted a study of mobile pervasive games. The starting point of the study is to identify the significant features of a pervasive mobile game. The research contains aspects of educational potential, social interaction, and technical interest in addition to entertainment value for game development. A pervasive game SciMyst was used for test part of the study and results are based on feedbacks of 45 participants. The game brings 5 main features together: Environment, People, Technology, Learning, and Playing. Participants were subjected to answer questionnaire, whose questions are based on Melon's research outcomes: challenge, fantasy, curiosity. Data that is gathered from the questionnaire was analyzed with chi-square test and observed that the most important feature was curiosity followed by challenge. For the future studies the authors intends to research how can be related curiosity and challenge.

An interesting study about pervasive games is conducted by Ballagas et al.[13] in 2007. In this study the game, whose name is REXplorer, is presented and whole gameplay is explained in addition to its development process. REXplorer is a pervasive mobile game targeted to the tourists visiting Regensburg Experience (REX) museum in Regensburg to learn history as looking from entertainment aspect. Target group' age interval is 15-30, these people are familiar with playing video games. The game is a spell-casting game which means that players make some gestures by waving the mobile device in the air. This is a part of the game's storyline, intending to make the player feel like that (s)he solves the meaning of the signs on the gravestone in the cathedral in Regensburg.

Ekman et al. [14] conducted a study of sound for pervasive mobile games. The study aims to find the importance of sound in a pervasive mobile game. Within the scope of this research a game named as "The Songs of North" is used. This game is at its prototype phase. Also 19 players are conducted for two weeks. The Songs of North is a multiplayer enhanced reality game. The game draws on inspiration from the Finnish mythology, especially the epic Kalevala. One of the main goals is to provide information about the game situation so that the players can make some decisions in the game without looking at their device. As a result, sound design is important as much as physical movement in a pervasive game, despite many players is not familiar to think of sound as a game mechanic.

2.6.2 Hand Gestures and Tactile (Haptic) Feedback

Hands and their gestures are utilized while using touch screen mobile devices and their applications, "hand gestures" is another significant subject, which is prominent enough to investigate as a subject of touch screen displays.

In 2009, Chan et al. [15] conducted a study about hand gestures. In the study, the relationship between use of hand gestures and user-computer interaction are stated. For this purpose, a tool prototype was developed, named Germane, which employs the hull-point analysis algorithm for gesture recognition. Four gestures were "point, scissor, paper and stone". The researchers implemented the evaluation phase in a fluorescent-lighted room and Germane was built with a 42 inch LCD TV. Three games are played, integrated with Germane. The performance of Germane was valuated and according to the results, for all gestures except for scissor, recognition rates under normal hand speed are over 90%.

Scissor recognizing is lower, which means that it should be relied too much for carrying out critical game actions.

Anttila et al. [16] from Nokia investigates the effect of tactile feedback latency in touchscreen displays. In this article, the effect of tactile feedback latency on user experience with Touchscreen devices was investigated. The hypothesis of the study, latency of tactile feedbacks makes the user experiments and their performance worse and press and release tactile feedbacks together have an impact on user experience and performance. The study is conducted to 3 experiments and the results are gathered using ANOVA methodology. In experiment 1 , participants were required to enter three-digit sequences and tactile feedback was added to press action only. In experiment 2, participants are required same actions as Experiment 1, but in addition to tactile feedback for pressing, tactile feedback for releasing was added. In experiment 3 the QWERTY keyboard was utilized and tactile feedback for pressing only was added. In all experiment there were 5 different latency duration from 18ms to 118ms. As a result, it is seen that there are no statistically significant difference in latency duration of feedbacks from the point of user experience. Namely, users do not realize the latency difference and they can tolerate it. However, the playing performance was lower with high latencies. [16]

In 2002, Poupyrev et al. [18] investigated the importance tactile feedback in a touch screen application. The study researches tactile activities and their impact on communication with handheld devices. For this purpose, TouchEngine, which is a tactile actuator providing variety of tactile feelings, is used for user studies. Space of tactile feedbacks was investigated. There are two hypotheses:

H1: Tactile feedback will result in faster task completion in one-dimensional text scrolling tasks.

H2: Tactile feedback will reduce overshot of target in one dimensional text scrolling tasks

10 participants were recruited, using Sony Clie Palm OS 4.1 PDA

The authors saw that task completion is 22% faster with tactile feedbacks. This supports H1. Tactile effect was also statically significant for overshoot which supports H2, but it is not numerically significant. Thus, overshoot does not affect user performance.

In 2008, Keith B. Perry et al.[19] tapping activities of one handed devices and evaluating the usability level of them. This study has three research questions.

The research questions of that study are:

1) “Is the difference in performance between the preferred and non-preferred hand large enough to justify the need for guidelines and evaluations that take into account both hands?”

2) “Is the difference in performance when walking versus standing large enough to justify the need for guidelines and evaluations that take both into account?”

3) “Do targets on the edge of the screen enable people to be more accurate than targets not on the edge?”

The study recruited 40 paid participants and they were all right-handed, own a cell phone, and have some computer experience. Half of them used their preferred hand and the other half used their non-preferred hand. Half of the users participated to the experiment while walking and the other half participated while standing. Also, for target size & positions, 25 different target positions and 5 different target sizes were used. Result shows hand use had a statically significant effect on user experience. Walking vs. standing i.e. position of the user does not affect significantly on user experience. Lastly, target position has a significant effect on user experience.

2.6.3 Multitouch Displays

Peltonen et al. [19] conducted a study of interaction with multi-touch public displays. The study presents data from detailed observation of CityWall installation is to us. CityWall is a large multi-touch display in the central location in Helsinki. The authors investigated how CityWall affects interaction between system and person and between individuals. CityWall follows two interaction paradigms. These paradigms are moving-scaling and rotation of content. The other is grabbing the item and putting a hand on it. Observations are implemented in different approach dynamics. These are Noticing Display, Stepwise approach, Parallel Use, Teamwork and Playful activities, Conflict management, Floor and Turn Taking, Expressive and pondering Gestures, Concluding Actions. In conclusion, a large multi-touch screen can create a stage and therefore a place for strangers to come into contact. Also, use of tangible interfaces provides a chance to engage in performative interactions to users.

While exploring the touchscreen devices and games played on them, public displays also come into prominence. Broll et al. [20] studied about touch based mobile interaction with public displays. The study investigates the direct mobile interaction with a large touch screen display for multiple users. For this purpose, touch-based interaction with Near Field Communication (NFC) was used and a prototype game Whack-a-Mole was conducted to this study. The researchers of the study showed that a grid of NFC tags could be used to implement direct mobile interaction with public displays. According to this paper, despite the technical advances are need to be improved, users appreciate this physical NFC-based mobile interaction. In the experimental phase of the study, 18 participants are recruited and they played the game for 3 round. After finishing playing game session, a questionnaire was conducted. As a result, the interaction with a grid of NFC-tags works well enough for gaming applications. In addition to this, the use of the overlapping tags allowed to create a completely interactive surface but also, prohibited a better recognition rate. Also, it is seen that the users are willing to interact with large displays in public, but prefer private or semi-public places.

2.6.4 Touchscreen Usability

Inostroza et al. [21] conducted a study about the heuristics for usability of mobile touchscreen displays.

The study mentioned above aims to evaluate usability of touch-screen mobile devices applications. For this purpose, eleven usability heuristics are developed and they were compared with Nielson's Heuristics. To prove that new developed heuristics are more efficient than Nielson's heuristics for touch-screen mobile devices, user tests were implemented. 10 of 11 heuristics were inspired from Nielson's usability heuristics and one of them was obtained from the analysis of mobile touch-screen context.

The heuristics for Touchscreen-based mobile devices are:

1) Visibility of System status

2) Match between system and the real world

3) User control and freedom

4) Consistency and standards

5) Error prevention

6) Minimize the user's memory load

7) Customization and shortcuts

8) Aesthetics and minimalist design

9) Help users recognize, diagnose, and recover from errors

10) Help and documentation

11) Physical interaction and ergonomics

From 1 to 10 are the inspired from Nielson's Heuristics. 11 is gathered from the mobile context analysis.

There were two groups of four participants. One group tested the application with Nielson's Heuristics; the other group tested the same application with touchscreen based mobile heuristics. A total of 53 usability problems were identified. 18 of them were identified both groups of evaluators, 12 of them were identified only by the group that used new heuristics, 14 of them were identified only by the group that used Nielson's heuristics. The correlation coefficient between two groups is 0.647. The average number of usability problems is 2.8 for the new heuristics, 2.3 for Nielson's heuristics. The T value was 1.73 and its associated probability was 0.3. Since it is the level of significance 0.05, the difference 0.5 is not significant. Therefore both heuristics group identifies usability problems in a similar way.

However, the results showed that new heuristics for touchscreen mobile applications were able to identify more usability problems.

Fernandez et al. [22] studied about user interface design evaluation for touch screen devices in 2009. The aim of this study is to evaluate different interface designs on touch screen devices to see the usability level of these interface designs and input methods. To implement the evaluation of two social network application prototypes are developed, whose name is BDroid and works on Android platforms. Two different versions of BDroid are used in the study with different UI designs. A user story is conducted to implement this evaluation. Ten people participated and were required to do some special tasks on both BDroid versions. Two versions are so:

- Layout – Scrolling/Tabbed,
- Input – Modal/Non-Modal – Menu – Device/Context.

In the results, 80% of participants chose tabbed layout version, despite scroll version is easier to use.

Rudchenko et al. [23] developed a game for practicing touch screen texting usage and a paper about the game is conducted. A new game is introduced, whose name is Text Text Revolution (TTR) helping user to do keyboard practice. TTR provides three ways to practice. The first is targeting practice, second is highlighting areas for improvement and third is generating ideal training data for key target resizing. A user study is conducted and in this user study and 6 participants are recruited and they played TTR 20 round on 3.5 inch WVGA, touch screen device. In each round, players are told to write approximately 50 words (250 characters). After the play sessions, it was seen that the game reached its goals successfully. The feedbacks from the players show that the game achieves its first goal which is providing target practice. From the questionnaire, 4/6 users are thought that touch point map is useful. For the third goal, personalized key-target resizing, is evaluated and the result shows the game reduces 21.4% over key-target resizing.

2.7 Nokia's Heuristics for Mobile Games

In the literature, Nokia is one of the corporations that research most in the usability of mobile devices and usability of the applications for these devices. Here is the study subjected about heuristic evaluation and processes while evaluating the usability of user experience.

In the mentioned paper [24] , how to develop new heuristics in different cases, applications and domains in case of Nokia is presented. Participants are recruited among the experts, senior UX designers from both Nokia and outside of Nokia. While heuristics are developed, one of the most important things is being domain specific. Since the products are different, the tasks vary according to their specifications. The problems are defined from two perspectives 1) how good the UX of the product is overall, and 2) specific competitive situation of the product. The authors advocate that applying Nielson's Heuristics, which are developed in 1994, to the new generation devices and applications would be a failure.

2.7.1 The aim of Nokia's Heuristics

According to the study, using these heuristics or tools in our evaluations, but they were not feasible. Firstly, the existing heuristics did not deal with mobility issues, which is one of our main targets. Second, all heuristics were not described in detail so that they could have been directly adapted to our process. Third, some of the heuristics were overlapping, which made them ambiguous. Therefore, we decided to start developing our own set of heuristics, which would overcome these shortcomings.

2.7.2 Method of Nokia's Heuristics Development

These heuristics have been developed by using an iterative design process of a mobile game. In addition, the heuristics have been validated and five mobile games have been evaluated by using them with the expert evaluation method.

2.7.3 Results Nokia's Heuristics Development Study

The results indicate that playability problems, which violate game usability or mobility heuristics, are quite easy to identify.

Gameplay problems are harder to find, but gameplay heuristics help in evaluation and focus on different aspects of the gameplay.

2.7.4 Nokia's Playability Evaluation Model for Mobile Games

The evaluation model is modular and consists of three core modules: gameplay, mobility and game usability. The gameplay module incorporates with Game Mechanics (Federoff's modules) [35], because they belong together inextricably. Gameplay occurs when the player interacts with game mechanics. Gameplay also contains Game Story (Desurvire's list) [36]. The gameplay is **"…the heart of the game…**" and in order to evaluate it properly there should not be any major playability problems in **game usability** nor **mobility**.

2.7.4.1 Mobile Context

How the context, in which the mobile phones are used, affects the tasks that the user does and in what kind of context the mobile phones are normally used are analyzed. Since mobile games are also mobile applications, it is presumable that similar requirements would also apply for them. In addition, physical characteristics of the mobile phones probably have some influence to mobile gaming as well. Mobile devices are an excellent companion for killing time or just doing something during short breaks. Users will use their mobile phones outdoors where lighting conditions and noise can change frequently. Taking a photo, sending a message, checking the calendar, and browsing a web site are typical tasks that should be initiated without delay. Therefore, the application and the phone should be in operating mode instantly.

In the mobile context, interruptions can be triggered by external events.

The characteristics of a mobile device:

- 12-key keypad and few navigation keys
- In some cases, they can use a miniature-size joystick
- Small screen size
- Insufficient audio capabilities
- Limited processing power
- Battery limitations

2.7.4.2 Initial Nokia Heuristics

The initial heuristics are derived from

- Results of mobile context analysis
- A review of Neilson's heuristics
- Game design guidelines

According to the study, the heuristics which are between H1 and H4 are the heuristics which are gathered from the mobile context analysis.

- H1. Don't waste player's time
- H2. Prepare for interruptions
- H3. Take other persons into account
- H4. Follow standard conventions

The second part of the heuristics set is from H5 to H8 and the heuristics in this part are acquired from the game usability analysis.

- H5. Provide gameplay help
- H6. Differentiation between device UI and the game UI should be evident.
- H7. User terms that are familiar to the player.
- H8. Status of the character and the game should be clearly visible.

The last part of the heuristics set is from H9 to H11 and the heuristics in this part are the gameplay oriented heuristics.

- H9. The player should have clear goals.
- H10. Support a wide range of players and playing styles.
- H11. Don't encourage repetitive and boring tasks.

2.7.5 Experts Evaluation of Games of Nokia Heuristics

The method of the evaluation of games is expert evaluation method. Six evaluators are participated to the evaluations. These evaluators are usability experts and some of them are also domain experts. They write a report about their findings violated with the heuristics. The report contains also design solutions to prevent the designers to change the features, which are working well.

2.7.6 Validation of the Nokia Heuristics

4 Evaluators evaluated the games. One of them experienced with game design the others had done normal utility software evaluations. Two of them are eager to play games in their spare-time. They found 61 playability problems.16 of these problems had no proper heuristic. This list of heuristics did not cover all user interface and usability and gameplay problems. In addition, 4 playability problems related to the multiplayer features are found. The game had problems with screen layout and basic navigation. These problems occurred, because Game UI design contains device UI style, this caused player to confuse how the control keys worked.

2.7.7 Re-evaluating the Nokia Heuristics

According to the study, balancing pace, challenge and strategies are the key point for all games. The game experience will create new playing styles which game designers may not have thought about.

Players try new approaches and sometimes combine different strategies in the game and this may result unexpected situations even for game developers. This is called “emergent gameplay”.

Designing an efficient screen layout which contains all necessary data, is not easy in especially mobile context that have small-size screens.

Having good graphics is an advantage but graphics of a game should support the game play and the story of the game.

The audio is another significant feature of a mobile game which sometimes creates the sound environment, but it may disturb the other people in the vicinity.

The game should use convenient controls and provide feedbacks to user about the player’s actions.

The game should not require the player to remember unnecessary things or allow the player to do irreversible errors. The player does not want to struggle with the user interface of the game, but instead concentrate on the gameplay.

As a result, 18 new heuristics are added to the original list. And some of the playability heuristics are reviewed and arranged with experienced game designers. There are totally 29 playability heuristics at the end.

2.7.8 Revised Nokia Playability Heuristics

- *Game Usability Heuristics:*

  From GU1 to GU5, the revised game usability heuristics are about visual design and presentation of information.

  - "GU1 Audio-Visual presentation supports the game"
  - "GU2 Screen layout is efficient and visually pleasing"
  - "GU3 Device UI and game UI are used for their own purposes."
  - "GU4 Indicators are visible"
  - "GU5 The player understands the terminology"

  Second part of the game usability heuristics are about navigation and controlling the character.

  - "GU6 Navigation is consistent, logical, and minimalist"
  - "GU7 Control keys are consistent and follow the standard conventions"
  - "GU8 Game controls are convenient and flexible"

  Last part of the game usability heuristics are about feedback, help and concentration.

  - "GU9 The game gives feedback on the player actions"
  - "GU10 The player cannot make irreversible errors"
  - "GU11 The player does not have to memorize unnecessary things"
  - "GU12 The game contains help"

- *Mobility Heuristics:* Mobile devices do not dictate where and when games are played, the game design should assimilate this freedom into the game experience.
  - "MO1 The game and play session can be started quickly"
  - "MO2 The game accommodates with the surroundings"
  - "MO3 Interruptions are handled reasonably"
- *Gameplay Heuristics*
  - "GP1 The game provides clear goals or supports player created goals"
  - "GP2 The player sees the progress in the game and can compare the results"
  - "GP3 The players are rewarded and rewards are meaningful"
  - "GP4 The player is in control"
  - "GP5 Challenge, strategy, and pace are in balance"
  - "GP6 The first-time experience is encouraging"
  - "GP7 The game story supports the gameplay and is meaningful"
  - "GP8 There are no repetitive and boring tasks"

- "GP9 The players can express themselves"
- "GP10 The game supports different playing styles"
- "GP11 The game does not stagnate"
- "GP12 The game is consistent"
- "GP13 The game uses orthogonal unit differentiation (Units in the game should be designed so that they are functionally different)"
- "GP14 The player does not lose any hard-won possessions"

2.7.9 Validating Nokia Heuristics

5 games were evaluated and 2 -4 evaluators valuated each game. One of the evaluators for each game was always a usability expert and the others are game designers with basic usability knowledge.

	Game Style	Player Mode	Target Player	Device	Evaluators
A1	Combat	Multi-Player	20+, male	Smart Phone	4
A2	Combat	Multi-Player	20+, male	Mobile Gaming Device	2
B	Adventure	Multi-Player	18+,male	Smart Phone	3
C	Simulation	Single Player	12+, female	Mobile Gaming Device	2
D	Puzzle	Single Player	10+, Neutral	Mobile Gaming Device	3

The game usability issues were easiest playability problems to be identified in the games. Unfortunately, they seem to be the easiest heuristics to violate too. It is noticeable quite often playability problems in a game were concentrated in a certain heuristics. Designing an efficient and visually pleasing user interfaces is not easy in mobile devices. Gameplay is the most difficult aspect to evaluate because it requires all evaluators should explore the all features in the game. The most common violations of gameplay comes from GP1, GP3, GP4, and GP5

CHAPTER 3

PROPOSED APPROACH

This chapter contains the proposed approach that is developed, implemented in the thesis. First of all the problem statement is presented. Then, Dependent and Independent Variables are defined. Afterwards, sample that is applied tests on, and instruments that will be used for playability tests are introduced. Lastly, the heuristics are revised.

3.1 Problem statement

Problem to be solved in this thesis: Present new heuristics to game developers to enlighten their way through developing a good mobile touch screen game. In other words, this thesis adds new heuristics to existing heuristic set; update them for new generation touch screen devices and naturally, mobile games compatible with these devices.

Existing mobile game heuristics are developed for old generation devices, which has mostly keypad instead of touchscreen technology. New generation mobile games are developed for devices like I-Pad, Android tablets and smarts phones, which have touchscreens. Thus new requirements emerge for mobile games playability.

As mentioned before, this study aims to expand the existing mobile playability heuristic set, focusing on touch screen technologies and mobile games relationship. New heuristics are acquired by literature review and game analysis taken from the social and mobile game market.

3.2 New Heuristics

This part includes heuristics and tests for their validation. The heuristics are targeted to the games that are played on touch screen devices. Combining these heuristics will give an idea to understand the playability level of a mobile game. To validate these heuristics tests will be implemented by eight to ten participants.

The heuristics are gained and developed by inspiring from the Nokia's playability heuristics for mobile games. Since, Nokia's heuristics are not up to date and does not cover new generation mobile devices like tablets, touchscreen smart phones etc., this research aims to

expand the Nokia's Heuristics set especially for new generation mobile devices and naturally new generation mobile games.

During the development process of new heuristics, besides reading, investigating papers and studies about the playability and touch screen devices; some popular and successful games taken from the social media and mobile platforms were analyzed by the researcher with the help of game developer team of a game developer firm. The analyzing process is done on different platforms.

First of all, social media games and their playability are tried to be specified, independently from platform. The most significant thought while this process occurred, was emphasizing and identifying the metrics of a gameplay structure. In evaluating playability, key words are *flow, challenge and their balance*. If a game is very easy to play, it will be probably boring in a short time. In other words, player will be bored and adherence ratio of this game will be very low. Symmetrically, if a game is very hard to play and player struggles excessively; this will make the player frustrated and reduce the playability level and adherence ratio of the game. Both of two situations cause failure of a game, even if it has good graphics, a good story, good sounds etc.

For the second part of the game analysis, mobile games are utilized to combine the playability metrics with the usability issues of mobile devices. The same metrics were investigated here again; additively mobile device properties and effects of these properties to the flow challenge balance were inspected. One of most conspicuous things, which impress on playability, is placement of the game items.

For the last step; the studies were investigated and tried to combine playability, mobility, touchscreen properties and usability.

Places of the *significant* game items impressed on player's playing skills and can dramatically change the flow of the game session. According to the screen sizes placement can cause striving with a simple goal for a long time and ruin the balance of flow-challenge. Placement is also dealing with left-handed and right- handed property.

The result heuristics are:

1) **Impartial Distribution of Game Items for Left-Handed and Right-Handed Players:** For both left-handed and right-handed people, game items should be distributed symmetrically/homogenized on the device screen if the gameplay mechanics allows. Alternatively it should have a setting property for left-handed and right-handed people.

2) **Usage of the Mostly Edge Part of the Screen for Two Handed Larger Screens:** The game items and control mechanism items should place mostly near the edges of the screen if the gameplay enforce the player to hold the device with two hands; prevent to put the device somewhere else. This heuristic is more applicable for tablet devices like I-Pad, Android tablets etc.

3) **Usage of Tilt Property:** Tilt property is used commonly among the mobile games. However this property can damage the playability of the game. Being enforced by the game to move the device and screen which player should look at disturbs the player and cause frustration and ruin the balance of the game.
4) **Tactile Feedback Effect:** Tactile feedback; in other words haptic feedback is not preferable when using an application. It is not the same when playing a mobile game. Tactile feedback stimulates the player during the game session and affects playability positively.

CHAPTER 4

EVALUATION

This section of the thesis aims to show the implementation of tests, how to prove methods for new added heuristics. Independent tests are implemented for each heuristics.

This chapter also contains the statistical results of each performed test and the comments of them. One way ANOVA, univariate are applied to the data gathered from the answers of the participants. These results are obtained using SPSS program.

SPSS data analysis result is declared at first part of each heuristic section and then each result is reviewed by the author.

4.1 Heuristic 1: "Distribution of the game items for both left handed and right handed people should be balanced."

In order to show that this heuristic point the right way to the developer, one game and its two different versions are tested by the participants.

4.1.1 Game Information: Burp

Figure 15: Burp

Burp (Figure 15) is developed by Umut Demirel, who is a student at the department of Game Technologies, METU.

4.1.2 Technique & participants

The game items i.e. “bugs” are coming

i) from the Right
ii) Randomly
iii) from the Left

These are three different versions. The left version and random version of the game were given to the right-handed participants. The right version and random version of the game were given to the left -handed participants. They were also told to compare these two versions by answering the survey question and Game Experience Questionnaire. There are ten participants. Five of them are right-handed and the other five are left-handed. The ages differ from 22 to 36. The participants are used to utilize mobile touch screen devices. Also, they have never played the game before.

The results of survey question and Game Experience Questionnaire will be compared and analyzed.

4.2 Heuristic 2: "The interactive game items should be placed mostly edges/sides of the device if the device has a large screen, like tablet PC. (250mmx180mm)"

In order to show that this heuristic point the right way to the developer, one game and its two different versions are tested by the participants.

4.2.1 Game Information: Futile Banana

Figure 16: Futile Banana

Futile Banana (Figure 16) is an open source game found from the internet. It is designed as two versions in order to show the usage of the sides and the middle of the screen.

4.2.2 Technique & participants

The game items i.e. "bananas" are dropping

i) Mostly from the edges.
ii) Mostly from the middle of the screen.

These are two different versions. Both of the versions are given to the participants. They were also told to compare these two versions by answering the survey question and Game Evaluation Questionnaire. There are ten participants. The participants are used to utilize mobile touch screen devices. Also, they have never played the game before.

The results of survey question and Game Experience Questionnaire will be compared and analyzed.

4.3 Heuristic 3: "The accelerometer property, in other words tilt property usage should be minimized in mobile touchscreen game."

In order to show that this heuristic point the right way to the developer, one game and its two different versions are tested by the participants.

4.3.1 Game Information: Beach Buggy Blitz

Figure 17: Beach Buggy Blitz

Beach Buggy Blitz (Figure 17) is a mobile game sold and downloaded from the application stores. The control mechanism can be modified by the player. The player can choose playing with tilt (accelerometer) or touching the sides of the screen.

4.3.2 Technique & participants

The game is controlled with

i) Tilt (Accelerometer) property.
ii) Touch property.

These are two different control mechanism provided by the game. The participants are told to play with both of the versions. They were also told to compare these two versions by answering the survey question and Game Evaluation Questionnaire. There are ten participants. The participants are used to utilize mobile touch screen devices. Also, they have never played the game before.

The results of survey question and Game Experience Questionnaire will be compared and analyzed.

4.4 Heuristic 4: "Tactile (Haptic) Feedbacks stimulate the player."

In order to show that this heuristic point the right way to the developer, one game and its two different versions are tested by the participants.

4.4.1 Game Information: Beach Buggy Blitz

Figure 18: Pinball Classic

Pinball Classic (Figure 18) is a mobile game which is sold and downloaded from the Android application stores. The feedback type can be modified by the player. The player can choose to get tactile (haptic) feedback by making the vibration property on, or the player can make it off.

4.4.2 Technique & participants

i) No tactile (haptic) feedback is given.
ii) Tactile feedback is given after the ball is hit something.

These are two different feedback options provided by the game. The participants are told to play with both of the versions. They were also told to compare these two versions by answering the survey question and Game Evaluation Questionnaire. There are ten participants. The participants are used to utilize mobile touch screen devices. Also, they have never played the game before.

The results of survey question and Game Experience Questionnaire will be compared and analyzed.

4.5 Results

4.5.1 Analysis for Heuristic 1

The section includes analyzing results and report for heuristic 1. Heuristic 1 is "Distribution of the game items for both left handed and right handed people should be balanced." One-way ANOVA method and t-test result are applied to each GEQ question and analyzed the difference between first version and second version.

Question 1: "I was interested in the game's story."

Descriptives[a]

RESPONSE								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,6000	,69921	,22111	2,0998	3,1002	1,00	3,00
Random Side	10	2,8000	,42164	,13333	2,4984	3,1016	2,00	3,00
Total	20	2,7000	,57124	,12773	2,4327	2,9673	1,00	3,00

a. Question = 1,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,200	1	,200	,600	,449
Within Groups	6,000	18	,333		
Total	6,200	19			

a. Question = 1,00

A one-way between versions ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 1. There was no significant effect of the distribution of the items on story of the game at the $p<.05$ level for the two conditions [$F(1, 18) = 0.6$, $p = 0.449$]. These results suggest that distribution of the game items does not have an effect on the interestingness of the game's story.

Question 2: "I felt successful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,0000	,81650	,25820	1,4159	2,5841	,00	3,00
Random Side	10	3,1000	,87560	,27689	2,4736	3,7264	1,00	4,00
Total	20	2,5500	,99868	,22331	2,0826	3,0174	,00	4,00

a. Question = 2,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6,050	1	6,050	8,442	,009
Within Groups	12,900	18	,717		
Total	18,950	19			

a. Question = 3,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	2,0000	,81650	,25820
	Random Side	10	3,1000	,87560	,27689

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,210	,652	-2,905	18	,009	-1,10000	,37859	-1,89540	-,30460
	Equal variances not assumed			-2,905	17,913	,009	-1,10000	,37859	-1,89567	-,30433

a. Question = 2,00

a. Question = 2,00

In this case, one-way ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 2. There was a significant effect of the distribution of the items on question 2 at the $p<.05$ level for the two conditions [$F(1, 18) = 8.442$, $p = 0.009$]. These results suggest that distribution of the game items have an effect on success of the player. According to the t-test results, there was a significant result between first ($M=2.0$, $SD=0.82$) and second version ($M = 3.1$, $SD = 0.88$); $t(18) = -2.90$, $p = 0.009$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels more successful.

Question 3: "I felt bored."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	1,9000	,99443	,31447	1,1886	2,6114	,00	3,00
Random Side	10	,6000	,69921	,22111	,0998	1,1002	,00	2,00
Total	20	1,2500	1,06992	,23924	,7493	1,7507	,00	3,00

a. Question = 3,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8,450	1	8,450	11,436	,003
Within Groups	13,300	18	,739		
Total	21,750	19			

a. Question = 3,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	1,9000	,99443	,31447
	Random Side	10	,6000	,69921	,22111

a. Question = 3,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,418	,526	3,382	18	,003	1,30000	,38442	,49237	2,10763
	Equal variances not assumed			3,382	16,151	,004	1,30000	,38442	,48569	2,11431

a. Question = 3,00

In this case, ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 3. There was a significant effect of the distribution of the items on question 3 at the p<.05 level for the two conditions [F (1, 18) = 11.43, p = 0. 03]. These results suggest that distribution of the game items have an effect on boredom of the player. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first (M=1.9, SD=0.99) and second version (M=0.6, SD=0.7); t (18) = 3.38, p = 0.03. Specifically, the results suggest that when

distribution of focus items of the game is equal for both left-handed and right handed people, the player feels less bored.

Question 4: "I found it impressive.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	1,5000	,70711	,22361	,9942	2,0058	,00	2,00
Random Side	10	2,5000	,70711	,22361	1,9942	3,0058	2,00	4,00
Total	20	2,0000	,85840	,19194	1,5983	2,4017	,00	4,00

a. Question = 4,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5,000	1	5,000	10,000	,005
Within Groups	9,000	18	,500		
Total	14,000	19			

a. Question = 4,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	1,5000	,70711	,22361
	Random Side	10	2,5000	,70711	,22361

a. Question = 4,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,000	1,000	-3,162	18	,005	-1,00000	,31623	-1,66437	-,33563
	Equal variances not assumed			-3,162	18,000	,005	-1,00000	,31623	-1,66437	-,33563

a. Question = 4,00

For question 4, ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of the sides) on GEQ question 4. There was a significant effect of the distribution of the items on question 4 at the $p<.05$ level for the two conditions [$F(1, 18) = 10$, $p = 0.005$]. These results suggest that distribution of the game items have an effect on impressiveness of the game Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first (M=1.5, SD=0.70711) and second version (M=2.5, SD = 0.70711); $t(18) = 3.38$, $p = 0.005$.

Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the game is more impressive.

Question 5: "I forgot everything around me.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,5000	,70711	,22361	1,9942	3,0058	1,00	3,00
Random Side	10	3,1000	,56765	,17951	2,6939	3,5061	2,00	4,00
Total	20	2,8000	,69585	,15560	2,4743	3,1257	1,00	4,00

a. Question = 5,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,800	1	1,800	4,378	,051
Within Groups	7,400	18	,411		
Total	9,200	19			

a. Question = 5,00

A one-way between versions ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second

version (game items come from both of sides) on GEQ question 5. There was no significant effect of the distribution of the items on story of the game at the p<.05 level for the two conditions [F (1, 18) = 1.8, p = 0.051]. These results suggest that distribution of the game items does not have an effect on the concentration.

Question 6: "I felt frustrated.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	1,7000	,67495	,21344	1,2172	2,1828	1,00	3,00
Random Side	10	1,1000	,56765	,17951	,6939	1,5061	,00	2,00
Total	20	1,4000	,68056	,15218	1,0815	1,7185	,00	3,00

a. Question = 6,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,800	1	1,800	4,629	,045
Within Groups	7,000	18	,389		
Total	8,800	19			

a. Question = 6,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	1,7000	,67495	,21344
	Random Side	10	1,1000	,56765	,17951

a. Question = 6,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,402	,252	2,151	18	,045	,60000	,27889	,01408	1,18592
	Equal variances not assumed			2,151	17,486	,046	,60000	,27889	,01284	1,18716

a. Question = 6,00

ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 6. There was a significant effect of the distribution of the items on question 6 at the $p<.05$ level for the two conditions [$F(1, 18) = 4.629$, $p = 0.045$]. These results suggest that distribution of the game items have an effect on impressiveness of the game Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first ($M = 1.7$, $SD = 0.67495$) and second version ($M = 1.1$, $SD = 0.56765$); $t(18) = 2.151$, $p = 0.045$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels less frustrated.

Question 7: "I found it tiresome.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,2000	1,13529	,35901	1,3879	3,0121	1,00	4,00
Random Side	10	1,2000	1,13529	,35901	,3879	2,0121	,00	3,00
Total	20	1,7000	1,21828	,27242	1,1298	2,2702	,00	4,00

a. Question = 7,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5,000	1	5,000	3,879	,064
Within Groups	23,200	18	1,289		
Total	28,200	19			

a. Question = 7,00

A one-way between versions ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 7. There was no significant effect of the distribution of the items on tiresomeness of the game at the p<.05 level for the two conditions [F (1, 18) = 3. 879, p = 0.064]. These results suggest that distribution of the game items does not have an effect on the tiresomeness of the game.

Question 8: "I felt irritable.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	1,4000	1,07497	,33993	,6310	2,1690	,00	3,00
Random Side	10	,2000	,42164	,13333	-,1016	,5016	,00	1,00
Total	20	,8000	1,00525	,22478	,3295	1,2705	,00	3,00

a. Question = 8,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7,200	1	7,200	10,800	,004
Within Groups	12,000	18	,667		
Total	19,200	19			

a. Question = 8,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	1,4000	1,07497	,33993
	Random Side	10	,2000	,42164	,13333

a. Question = 8,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	8,733	,008	3,286	18	,004	1,20000	,36515	,43285	1,96715
	Equal variances not assumed			3,286	11,705	,007	1,20000	,36515	,40218	1,99782

a. Question = 8,00

ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 8. There was a significant effect of the distribution of the items on question 8 at the $p<.05$ level for the two conditions [$F(1, 18) = 4.629$, $p = 0.045$]. These results suggest that distribution of the game items have an effect on irritation of the player. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first ($M=1.4$, $SD=1.075$) and second version ($M=0.2$, $SD=0.422$); $t(18)= 3.286$, $p = 0.04$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels less irritated.

Question 9: "I felt skillful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,0000	,47140	,14907	1,6628	2,3372	1,00	3,00
Random Side	10	3,2000	,42164	,13333	2,8984	3,5016	3,00	4,00
Total	20	2,6000	,75394	,16859	2,2471	2,9529	1,00	4,00

a. Question = 9,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7,200	1	7,200	36,000	,000
Within Groups	3,600	18	,200		
Total	10,800	19			

a. Question = 9,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	2,0000	,47140	,14907
	Random Side	10	3,2000	,42164	,13333

a. Question = 9,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,596	,450	-6,000	18	,000	-1,20000	,20000	-1,62018	-,77982
	Equal variances not assumed			-6,000	17,780	,000	-1,20000	,20000	-1,62056	-,77944

a. Question = 9,00

ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 9. There was a significant effect of the distribution of the items on question 9 at the $p<.05$ level for the two conditions [$F(1, 18) = 36$, $p = 0.0$]. These results suggest that distribution of the game items have an effect on skillfulness of the player. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first ($M=2$, $SD=0.47$) and second version ($M=3.2$, $SD=0.42$); $t(18)= -6$, $p = 0$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels more skillful.

Question 10: "I felt completely absorbed.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,4000	,96609	,30551	1,7089	3,0911	1,00	4,00
Random Side	10	3,1000	,87560	,27689	2,4736	3,7264	1,00	4,00
Total	20	2,7500	,96655	,21613	2,2976	3,2024	1,00	4,00

a. Question = 10,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2,450	1	2,450	2,882	,107
Within Groups	15,300	18	,850		
Total	17,750	19			

a. Question = 10,00

A one-way ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 10. There was no significant effect of the distribution of the items on being absorption at the p<.05 level for the two conditions [F (1, 18) = 2.882, p = 0.107]. These results suggest that distribution of the game items does not have an effect on the absorption and focusing of the game.

Question 11: "I felt content.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,2000	,78881	,24944	1,6357	2,7643	1,00	3,00
Random Side	10	3,5000	,52705	,16667	3,1230	3,8770	3,00	4,00
Total	20	2,8500	,93330	,20869	2,4132	3,2868	1,00	4,00

a. Question = 11,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8,450	1	8,450	18,778	,000
Within Groups	8,100	18	,450		
Total	16,550	19			

a. Question = 11,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	2,2000	,78881	,24944
	Random Side	10	3,5000	,52705	,16667

a. Question = 11,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,173	,293	-4,333	18	,000	-1,30000	,30000	-1,93028	-,66972
	Equal variances not assumed			-4,333	15,700	,001	-1,30000	,30000	-1,93696	-,66304

a. Question = 11,00

ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of the sides) on GEQ question 11. There was a significant effect of the distribution of the items on question 11 at the $p<.05$ level for the two conditions [$F(1, 18) = 18.778$, $p = 0.0$]. These results suggest that distribution of the game items have an effect on feeling content. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first ($M=2.2$, $SD=0.78881$) and second version ($M=3.5$, $SD=0.52705$); $t(18)= -4.33$, $p = 0$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels more content.

Question 12: "I felt challenged.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,7000	,67495	,21344	2,2172	3,1828	2,00	4,00
Random Side	10	1,5000	,70711	,22361	,9942	2,0058	,00	2,00
Total	20	2,1000	,91191	,20391	1,6732	2,5268	,00	4,00

a. Question = 12,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7,200	1	7,200	15,070	,001
Within Groups	8,600	18	,478		
Total	15,800	19			

a. Question = 12,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	2,7000	,67495	,21344
	Random Side	10	1,5000	,70711	,22361

a. Question = 12,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,077	,784	3,882	18	,001	1,20000	,30912	,55056	1,84944
	Equal variances not assumed			3,882	17,961	,001	1,20000	,30912	,55046	1,84954

a. Question = 12,00

One way ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 12. There was a significant effect of the distribution of the items on question 12 at the $p<.05$ level for the two conditions [$F(1, 18) = 15.07$, $p = 0.001$]. These results suggest that distribution of the game items have an effect on feeling challenged. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first ($M=2.7$, $SD=0.675$) and second version ($M=1.5$, $SD=0.707$); $t(18)= 3.882$, $p = 0.001$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels less challenged.

Question 13: "I felt stimulated.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,5000	,84984	,26874	1,8921	3,1079	1,00	4,00
Random Side	10	3,2000	,42164	,13333	2,8984	3,5016	3,00	4,00
Total	20	2,8500	,74516	,16662	2,5013	3,1987	1,00	4,00

a. Question = 13,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2,450	1	2,450	5,444	,031
Within Groups	8,100	18	,450		
Total	10,550	19			

a. Question = 13,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	2,5000	,84984	,26874
	Random Side	10	3,2000	,42164	,13333

a. Question = 13,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	5,972	,025	-2,333	18	,031	-,70000	,30000	-1,33028	-,06972
	Equal variances not assumed			-2,333	13,178	,036	-,70000	,30000	-1,34722	-,05278

a. Question = 13,00

One way ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 13. There was a significant effect of the distribution of the items on question 13 at the $p<.05$ level for the two conditions [$F(1, 18) = 15.07$, $p = 0.001$]. These results suggest that distribution of the game items have an effect on feeling stimulated. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first version ($M=2.5$, $SD=0.850$) and second version ($M=3.2$, $SD=0.422$); $t(18)= -2.33$, $p = 0.031$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels more stimulated.

Question 14: "I felt good.**"**

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
From One Side	10	2,1000	,87560	,27689	1,4736	2,7264	1,00	3,00
Random Side	10	3,5000	,70711	,22361	2,9942	4,0058	2,00	4,00
Total	20	2,8000	1,05631	,23620	2,3056	3,2944	1,00	4,00

a. Question = 14,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9,800	1	9,800	15,474	,001
Within Groups	11,400	18	,633		
Total	21,200	19			

a. Question = 14,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	From One Side	10	2,1000	,87560	,27689
	Random Side	10	3,5000	,70711	,22361

a. Question = 14,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,495	,491	-3,934	18	,001	-1,40000	,35590	-2,14772	-,65228
	Equal variances not assumed			-3,934	17,236	,001	-1,40000	,35590	-2,15011	-,64989

a. Question = 14,00

One way ANOVA was conducted to compare the effect of the first version (game items come from the opposite site of the user handling side), and the second version (game items come from both of sides) on GEQ question 14. There was a significant effect of the distribution of the items on question 14 at the $p<.05$ level for the two conditions [$F(1, 18) = 15.07$, $p = 0.001$]. These results suggest that distribution of the game items have an effect on feeling good. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first version ($M = 2.1$, $SD = 0.875$) and second version ($M = 3.5$, $SD = 0.707$); $t(18) = -3.93$, $p = 0.001$. Specifically, the results suggest that when distribution of focus items of the game is equal for both left-handed and right handed people, the player feels better.

4.5.2 Analysis for Heuristic 2

The section includes analyzing results and report for heuristic 2. Heuristic 2 is "The interactive game items should be placed mostly edges/sides of the device if the device has a large screen, like tablet PC (250mmx180mm)." One-way ANOVA method and t-test result are applied to each GEQ question and analyzed the difference between first version and second version.

Question 1: "I was interested in the game's story."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	2,1000	,73786	,23333	1,5722	2,6278	1,00	3,00
Edge	10	2,1000	,73786	,23333	1,5722	2,6278	1,00	3,00
Total	20	2,1000	,71818	,16059	1,7639	2,4361	1,00	3,00

a. Question = 1,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,000	1	,000	,000	1,000
Within Groups	9,800	18	,544		
Total	9,800	19			

a. Question = 1,00

One way ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 1. There was no significant effect of the usage of middle or edge of the screen on the story of the game at the $p<.05$ level for the two conditions [$F(1, 18) = 0.0$, $p = 0.544$]. These results suggest that the usage of middle or edge of the screen does not have an effect on the story of the game.

Question 2: "I felt successful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	1,7000	,48305	,15275	1,3544	2,0456	1,00	2,00
Edge	10	3,3000	,67495	,21344	2,8172	3,7828	2,00	4,00
Total	20	2,5000	1,00000	,22361	2,0320	2,9680	1,00	4,00

a. Question = 2,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12,800	1	12,800	37,161	,000
Within Groups	6,200	18	,344		
Total	19,000	19			

a. Question = 2,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Middle	10	1,7000	,48305	,15275
	Edge	10	3,3000	,67495	,21344

a. Question = 2,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,357	,259	-6,096	18	,000	-1,60000	,26247	-2,15142	-1,04858
	Equal variances not assumed			-6,096	16,303	,000	-1,60000	,26247	-2,15556	-1,04444

a. Question = 2,00

One way ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 2. There was a significant effect of usage of middle or edge of the screen on question 2 at the p<.05 level for the two conditions [F (1, 18) = 37.161, p = 0.0]. These results suggest that usage of middle or edge of the screen has an effect on feeling successful. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first version (M = 1.7, SD = 0. 483) and second version (M = 3.3, SD = 0.674); t (18) = -6.096, p = 0.0. Specifically, the results suggest that when the edges are used mostly in a mobile game played on tablets, the player feels more successful.

Question 3: "I felt bored."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	3,2000	1,22927	,38873	2,3206	4,0794	,00	4,00
Edge	10	1,1000	,56765	,17951	,6939	1,5061	,00	2,00
Total	20	2,1500	1,42441	,31851	1,4834	2,8166	,00	4,00

a. Question = 3,00

ANOVA

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	22,050	1	22,050	24,055	,000
Within Groups	16,500	18	,917		
Total	38,550	19			

a. Question = 3,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Middle	10	3,2000	1,22927	,38873
	Edge	10	1,1000	,56765	,17951

a. Question = 3,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,979	,177	4,905	18	,000	2,10000	,42817	1,20044	2,99956
	Equal variances not assumed			4,905	12,671	,000	2,10000	,42817	1,17254	3,02746

a. Question = 3,00

One way ANOVA was conducted to compare the effect of the first version (bananas drop mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 3. There was a significant effect of usage of middle or edge of the screen on question 3 at the p<.05 level for the two conditions [F (1, 18) = 24.055, p = 0.0]. These results suggest that usage of middle or edge of the screen has an effect on feeling bored. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first version (M = 3.2, SD = 1.230) and second version (M = 1.1, SD = 0.567); t (18) = 4.905, p = 0.0. Specifically, the results suggest that when the edges are used mostly in a mobile game played on tablets, the player feels less bored.

Question 4: "I found it impressive."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	1,7000	,48305	,15275	1,3544	2,0456	1,00	2,00
Edge	10	3,1000	,73786	,23333	2,5722	3,6278	2,00	4,00
Total	20	2,4000	,94032	,21026	1,9599	2,8401	1,00	4,00

a. Question = 4,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9,800	1	9,800	25,200	,000
Within Groups	7,000	18	,389		
Total	16,800	19			

a. Question = 4,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Middle	10	1,7000	,48305	,15275
	Edge	10	3,1000	,73786	,23333

a. Question = 4,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,559	,464	-5,020	18	,000	-1,40000	,27889	-1,98592	-,81408
	Equal variances not assumed			-5,020	15,517	,000	-1,40000	,27889	-1,99271	-,80729

a. Question = 4,00

One way ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 4. There was a significant effect of usage of middle or edge of the screen on question 4 at the p<.05 level for the two conditions [F (1, 18) = 25.2, p = 0.0]. These results suggest that usage of middle or edge of the screen has an effect on feeling impressive. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first version (M = 1.7, SD = 0.483) and second version (M = 3.1, SD = 0.737); t (18) = -5.020, p = 0.0. Specifically, the results suggest that when the edges are used mostly in a mobile game played on tablets, the player feels more impressed.

Question 5: "I forgot everything around me."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	1,9000	,73786	,23333	1,3722	2,4278	1,00	3,00
Edge	10	2,9000	,87560	,27689	2,2736	3,5264	2,00	4,00
Total	20	2,4000	,94032	,21026	1,9599	2,8401	1,00	4,00

a. Question = 5,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5,000	1	5,000	7,627	,013
Within Groups	11,800	18	,656		
Total	16,800	19			

a. Question = 5,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Middle	10	1,9000	,73786	,23333
	Edge	10	2,9000	,87560	,27689

a. Question = 5,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,788	,386	-2,762	18	,013	-1,00000	,36209	-1,76073	-,23927
	Equal variances not assumed			-2,762	17,497	,013	-1,00000	,36209	-1,76230	-,23770

a. Question = 5,00

ANOVA was applied to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 5. There was a significant effect of usage of middle or edge of the screen on question 5 at the $p<.05$ level for the two conditions [$F(1, 18) = 7.627$, $p = 0.013$]. These results suggest that the usage of middle or edge of the screen has an effect on focusing. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first version ($M = 1.9$, $SD = 0.737$) and second version ($M = 2.9$, $SD = 0.875$); $t(18) = -2.762$, $p = 0.013$. Specifically, the results suggest that when the edges are used mostly in a mobile game played on tablets, the player can focus more.

Question 6: "I felt frustrated."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	,7000	,94868	,30000	,0214	1,3786	,00	2,00
Edge	10	1,3000	1,05935	,33500	,5422	2,0578	,00	3,00
Total	20	1,0000	1,02598	,22942	,5198	1,4802	,00	3,00

a. Question = 6,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,800	1	1,800	1,780	,199
Within Groups	18,200	18	1,011		
Total	20,000	19			

a. Question = 6,00

One way ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 6. There was no significant effect of the usage of middle or edge of the screen on the frustration feeling of the game at the $p<.05$ level for the two conditions [$F(1, 18) = 1.780$, $p = 0.199$]. These results suggest that the usage of middle or edge of the screen does not have an effect on the frustration feeling.

Question 7: "I found it tiresome."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	1,2000	,91894	,29059	,5426	1,8574	,00	3,00
Edge	10	,6000	,51640	,16330	,2306	,9694	,00	1,00
Total	20	,9000	,78807	,17622	,5312	1,2688	,00	3,00

a. Question = 7,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,800	1	1,800	3,240	,089
Within Groups	10,000	18	,556		
Total	11,800	19			

a. Question = 7,00

ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 7. There was no significant effect of the usage of middle or edge of the screen on the tiresomeness of the player at the $p<.05$ level for the two conditions [$F(1, 18) = 1.780$, $p = 0.199$]. These results suggest that the usage of middle or edge of the screen does not have an effect on the tiresomeness of the player.

Question 8: "I felt irritable."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	3,3000	,48305	,15275	2,9544	3,6456	3,00	4,00
Edge	10	,4000	,69921	,22111	-,1002	,9002	,00	2,00
Total	20	1,8500	1,59852	,35744	1,1019	2,5981	,00	4,00

a. Question = 8,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	42,050	1	42,050	116,446	,000
Within Groups	6,500	18	,361		
Total	48,550	19			

a. Question = 8,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Middle	10	3,3000	,48305	,15275
	Edge	10	,4000	,69921	,22111

a. Question = 8,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,103	,308	10,791	18	,000	2,90000	,26874	2,33539	3,46461
	Equal variances not assumed			10,791	15,997	,000	2,90000	,26874	2,33028	3,46972

a. Question = 8,00

ANOVA was applied to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 8. There was a significant effect of usage of middle or edge of the screen on question 8 at the $p<.05$ level for the two conditions [$F(1, 18) = 116.446$, $p = 0.0$]. These results suggest that the usage of middle or edge of the screen has an effect on feeling irritable. Since ANOVA results are statistically significant, an independent t-test is conducted. There was a significant result between first version ($M = 3.3$, $SD = 0.438$) and second version ($M = 0.4$, $SD = 0.699$); $t(18) = 10.791$, $p = 0.0$. Specifically, the results suggest that when the edges are used mostly in a mobile game played on tablets, the player feels less irritable.

Question 9: "I felt skillful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	1,5000	,84984	,26874	,8921	2,1079	1,00	3,00
Edge	10	1,6000	,84327	,26667	,9968	2,2032	1,00	3,00
Total	20	1,5500	,82558	,18460	1,1636	1,9364	1,00	3,00

a. Question = 9,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,050	1	,050	,070	,795
Within Groups	12,900	18	,717		
Total	12,950	19			

a. Question = 9,00

ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 9. There was no significant effect of the usage of middle or edge of the screen on the skillfulness of the player at the $p<.05$ level for the two conditions [$F(1, 18) = 0.070$, $p = 0.795$]. These results suggest that the usage of middle or edge of the screen does not have an effect on the skillfulness.

Question 10: "I felt completely absorbed."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	2,7000	,48305	,15275	2,3544	3,0456	2,00	3,00
Edge	10	2,5000	,70711	,22361	1,9942	3,0058	1,00	3,00
Total	20	2,6000	,59824	,13377	2,3200	2,8800	1,00	3,00

a. Question = 10,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,200	1	,200	,545	,470
Within Groups	6,600	18	,367		
Total	6,800	19			

a. Question = 10,00

ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 10. There was no significant effect of the usage of middle or edge of the screen on the absorption of the player at the $p<.05$ level for the two conditions [$F(1, 18) = 0.545$, $p = 0.470$]. These results suggest that the usage of middle or edge of the screen does not have an effect on the absorption.

Question 11: "I felt content."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	2,7000	,48305	,15275	2,3544	3,0456	2,00	3,00
Edge	10	2,5000	,70711	,22361	1,9942	3,0058	2,00	4,00
Total	20	2,6000	,59824	,13377	2,3200	2,8800	2,00	4,00

a. Question = 11,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,200	1	,200	,545	,470
Within Groups	6,600	18	,367		
Total	6,800	19			

a. Question = 11,00

ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 11. There was no significant effect of the usage of middle or edge of the screen on feeling content at the $p<.05$ level for the two conditions [$F(1, 18) = 0.545$, $p = 0.470$]. These results suggest that the usage of middle or edge of the screen does not have an effect on feeling content.

Question 12: "I felt challenged."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	1,6000	1,17379	,37118	,7603	2,4397	,00	3,00
Edge	10	2,2000	,91894	,29059	1,5426	2,8574	,00	3,00
Total	20	1,9000	1,07115	,23952	1,3987	2,4013	,00	3,00

a. Question = 12,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,800	1	1,800	1,620	,219
Within Groups	20,000	18	1,111		
Total	21,800	19			

a. Question = 12,00

ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 12. There was no significant effect of the usage of middle or edge of the screen on feeling challenged at the $p<.05$ level for the two conditions [$F(1, 18) = 1.620$, $p = 0.219$]. These results suggest that the usage of middle or edge of the screen does not have an effect on feeling challenged.

Question 13: "I felt stimulated."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	2,6000	,51640	,16330	2,2306	2,9694	2,00	3,00
Edge	10	2,1000	,99443	,31447	1,3886	2,8114	,00	4,00
Total	20	2,3500	,81273	,18173	1,9696	2,7304	,00	4,00

a. Question = 13,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,250	1	1,250	1,991	,175
Within Groups	11,300	18	,628		
Total	12,550	19			

a. Question = 13,00

ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 13. There was no significant effect of the usage of middle or edge of the screen on feeling stimulated at the $p<.05$ level for the two conditions [$F(1, 18) = 1.991$, $p = 0.175$]. These results suggest that the usage of middle or edge of the screen does not have an effect on feeling stimulated.

Question 14: "I felt good."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Middle	10	2,6000	1,17379	,37118	1,7603	3,4397	1,00	4,00
Edge	10	2,0000	1,05409	,33333	1,2459	2,7541	,00	4,00
Total	20	2,3000	1,12858	,25236	1,7718	2,8282	,00	4,00

a. Question = 14,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,800	1	1,800	1,446	,245
Within Groups	22,400	18	1,244		
Total	24,200	19			

a. Question = 14,00

ANOVA was conducted to compare the effect of the first version (bananas drops mostly from the middle of the screen), and the second version (bananas drops mostly from the edges of the screen) on GEQ question 14. There was no significant effect of the usage of middle or edge of the screen on feeling good at the $p<.05$ level for the two conditions [$F(1, 18) = 1.446$, $p = 0.245$]. These results suggest that the usage of middle or edge of the screen does not have an effect on feeling good.

4.5.3 Analysis for Heuristic 3

The section includes analyzing results and report for heuristic 3. Heuristic 3 is "The accelerometer property, in other words tilt property usage should be minimized in mobile touchscreen game." One-way ANOVA method and t-test result are applied to each GEQ question and analyzed the difference between first version and second version.

Question 1: "I was interested in the game's story."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	3,6000	,51640	,16330	3,2306	3,9694	3,00	4,00
Touch	10	3,6000	,51640	,16330	3,2306	3,9694	3,00	4,00
Total	20	3,6000	,50262	,11239	3,3648	3,8352	3,00	4,00

a. Question = 1,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,000	1	,000	,000	1,000
Within Groups	4,800	18	,267		
Total	4,800	19			

a. Question = 1,00

ANOVA was conducted to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 1. There was no significant effect of the usage of tilt or touch control on the story of the game at the $p<.05$ level for the two conditions [$F(1, 18) = 0.0$ $p = 1.0$]. These results suggest that the usage of tilt or touch control does not have an effect on story of the game.

Question 2: "I felt successful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,5000	,52705	,16667	1,1230	1,8770	1,00	2,00
Touch	10	3,0000	,47140	,14907	2,6628	3,3372	2,00	4,00
Total	20	2,2500	,91047	,20359	1,8239	2,6761	1,00	4,00

a. Question = 2,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11,250	1	11,250	45,000	,000
Within Groups	4,500	18	,250		
Total	15,750	19			

a. Question = 2,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,5000	,52705	,16667
	Touch	10	3,0000	,47140	,14907

a. Question = 2,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	5,063	,037	-6,708	18	,000	-1,50000	,22361	-1,96978	-1,03022
	Equal variances not assumed			-6,708	17,780	,000	-1,50000	,22361	-1,97020	-1,02980

a. Question = 2,00

In this case, one-way ANOVA was conducted to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 2. There was a significant effect of the controlling type of the game on question 2 at the $p<.05$ level for the two conditions [$F(1, 18) = 45.0$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on success of the player. According to the t-test results, there was a significant result between first ($M=1.5$, $SD=0.527$) and second version ($M = 3.0$, $SD = 0.471$); $t(18) = -6.708$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player feels more successful.

Question 3: "I felt bored."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	2,4000	,84327	,26667	1,7968	3,0032	1,00	3,00
Touch	10	1,1000	,73786	,23333	,5722	1,6278	,00	2,00
Total	20	1,7500	1,01955	,22798	1,2728	2,2272	,00	3,00

a. Question = 3,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8,450	1	8,450	13,460	,002
Within Groups	11,300	18	,628		
Total	19,750	19			

a. Question = 3,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	2,4000	,84327	,26667
	Touch	10	1,1000	,73786	,23333

a. Question = 3,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,911	,352	3,669	18	,002	1,30000	,35434	,55556	2,04444
	Equal variances not assumed			3,669	17,688	,002	1,30000	,35434	,55462	2,04538

a. Question = 3,00

In this case, one-way ANOVA was conducted to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 3. There was a significant effect of the controlling type of the game on question 3 at the $p<.05$ level for the two conditions [$F(1, 18) = 13.468$, $p = 0.002$]. These results suggest that the controlling type of the game has an effect on boredom of the player. According to the t-test results, there was a significant result between first ($M=2.4$, $SD=0.843$) and second version ($M = 1.1$, $SD = 0.233$); $t(18) = 3.669$, $p = 0.002$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player feels less boring.

Question 4: "I found it impressive."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,6000	1,07497	,33993	,8310	2,3690	,00	4,00
Touch	10	2,9000	,73786	,23333	2,3722	3,4278	2,00	4,00
Total	20	2,2500	1,11803	,25000	1,7267	2,7733	,00	4,00

a. Question = 4,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8,450	1	8,450	9,941	,006
Within Groups	15,300	18	,850		
Total	23,750	19			

a. Question = 4,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,6000	1,07497	,33993
	Touch	10	2,9000	,73786	,23333

a. Question = 4,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,017	,327	-3,153	18	,006	-1,30000	,41231	-2,16623	-,43377
	Equal variances not assumed			-3,153	15,940	,006	-1,30000	,41231	-2,17433	-,42567

a. Question = 4,00

One-way ANOVA was conducted to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 4. There was a significant effect of the controlling type of the game on question 4 at the $p<.05$ level for the two conditions [$F(1, 18) = 9.941$, $p = 0.006$]. These results suggest that the controlling type of the game has an effect on impressiveness of the game. According to the t-test results, there was a significant result between first ($M=1.6$, $SD=1.075$) and second version ($M = 2.9$, $SD = 0.738$); $t(18) = -3.153$, $p = 0.006$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player feels more impressive.

Question 5: “I forgot everything around me.”

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,5000	,97183	,30732	,8048	2,1952	1,00	4,00
Touch	10	3,2000	,42164	,13333	2,8984	3,5016	3,00	4,00
Total	20	2,3500	1,13671	,25418	1,8180	2,8820	1,00	4,00

a. Question = 5,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14,450	1	14,450	25,752	,000
Within Groups	10,100	18	,561		
Total	24,550	19			

a. Question = 5,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,5000	,97183	,30732
	Touch	10	3,2000	,42164	,13333

a. Question = 5,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	3,112	,095	-5,075	18	,000	-1,70000	,33500	-2,40380	-,99620
	Equal variances not assumed			-5,075	12,272	,000	-1,70000	,33500	-2,42810	-,97190

a. Question = 5,00

ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 5. There was a significant effect of the controlling type of the game on question 5 at the $p<.05$ level for the two conditions [$F(1, 18) = 25.752$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on focusing and absorption of the player. According to the t-test results, there was a significant result between first ($M=1.5$, $SD=0.972$) and second version ($M = 3.2$, $SD = 0.422$); $t(18) = -5.075$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player is more absorbed.

Question 6: “I felt frustrated.”

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	2,0000	,81650	,25820	1,4159	2,5841	,00	3,00
Touch	10	,8000	,42164	,13333	,4984	1,1016	,00	1,00
Total	20	1,4000	,88258	,19735	,9869	1,8131	,00	3,00

a. Question = 6,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7,200	1	7,200	17,053	,001
Within Groups	7,600	18	,422		
Total	14,800	19			

a. Question = 6,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	2,0000	,81650	,25820
	Touch	10	,8000	,42164	,13333

a. Question = 6,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,116	,738	4,129	18	,001	1,20000	,29059	,58949	1,81051
	Equal variances not assumed			4,129	13,481	,001	1,20000	,29059	,57448	1,82552

a. Question = 6,00

ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 6. There was a significant effect of the controlling type of the game on question 6 at the $p<.05$ level for the two conditions [$F(1, 18) = 17.053$, $p = 0.001$]. These results suggest that the controlling type of the game has an effect on frustration of the player. According to the t-test results, there was a significant result between first ($M=1.5$, $SD=0.972$) and second version ($M = 2.0$, $SD = 0.8$); $t(18) = 4.129$, $p = 0.001$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player is less frustrated.

Question 7: “I found it tiresome.”

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	2,9000	,87560	,27689	2,2736	3,5264	1,00	4,00
Touch	10	,8000	,42164	,13333	,4984	1,1016	,00	1,00
Total	20	1,8500	1,26803	,28354	1,2565	2,4435	,00	4,00

a. Question = 7,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	22,050	1	22,050	46,694	,000
Within Groups	8,500	18	,472		
Total	30,550	19			

a. Question = 7,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	2,9000	,87560	,27689
	Touch	10	,8000	,42164	,13333

a. Question = 7,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,194	,289	6,833	18	,000	2,10000	,30732	1,45435	2,74565
	Equal variances not assumed			6,833	12,961	,000	2,10000	,30732	1,43588	2,76412

a. Question = 7,00

ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 7. There was a significant effect of the controlling type of the game on question 7 at the $p<.05$ level for the two conditions [$F(1, 18) = 46.694$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on tiresomeness of the player. According to the t-test results, there was a significant result between first ($M=2.9$, $SD=0.876$) and second version ($M = 0.8$, $SD = 0.422$); $t(18) = 6.883$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player is less tiresome.

Question 8: “I felt irritable.”

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,6000	,69921	,22111	1,0998	2,1002	,00	2,00
Touch	10	2,7000	1,25167	,39581	1,8046	3,5954	,00	4,00
Total	20	2,1500	1,13671	,25418	1,6180	2,6820	,00	4,00

a. Question = 8,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6,050	1	6,050	5,886	,026
Within Groups	18,500	18	1,028		
Total	24,550	19			

a. Question = 8,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,6000	,69921	,22111
	Touch	10	2,7000	1,25167	,39581

a. Question = 8,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	1,209	,286	-2,426	18	,026	-1,10000	,45338	-2,05252	-,14748
	Equal variances not assumed			-2,426	14,119	,029	-1,10000	,45338	-2,07164	-,12836

a. Question = 8,00

One-way ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 8. There was a significant effect of the controlling type of the game on question 8 at the $p<.05$ level for the two conditions [$F(1, 18) = 5.886$, $p = 0.026$]. These results suggest that the controlling type of the game has an effect on irritation of the player. According to the t-test results, there was a significant result between first ($M=1.6$, $SD=0.699$) and second version ($M = 2.7$, $SD = 1.252$); $t(18) = -2.426$, $p = 0.026$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player is more irritated.

Question 9: "I felt skillful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,7000	,48305	,15275	1,3544	2,0456	1,00	2,00
Touch	10	2,9000	,31623	,10000	2,6738	3,1262	2,00	3,00
Total	20	2,3000	,73270	,16384	1,9571	2,6429	1,00	3,00

a. Question = 9,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7,200	1	7,200	43,200	,000
Within Groups	3,000	18	,167		
Total	10,200	19			

a. Question = 9,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,7000	,48305	,15275
	Touch	10	2,9000	,31623	,10000

a. Question = 9,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	5,684	,028	-6,573	18	,000	-1,20000	,18257	-1,58357	-,81643
	Equal variances not assumed			-6,573	15,517	,000	-1,20000	,18257	-1,58802	-,81198

a. Question = 9,00

One-way ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 9. There was a significant effect of the controlling type of the game on question 9 at the $p<.05$ level for the two conditions [$F(1, 18) = 43.200$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on feeling skillful. According to the t-test results, there was a significant result between first ($M=1.7$, $SD=0.483$) and second version ($M = 2.9$, $SD = 0.316$); $t(18) = -6.573$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player feels more skillful.

Question 10: "I felt completely absorbed."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,3000	1,33749	,42295	,3432	2,2568	,00	4,00
Touch	10	3,3000	,48305	,15275	2,9544	3,6456	3,00	4,00
Total	20	2,3000	1,41793	,31706	1,6364	2,9636	,00	4,00

a. Question = 10,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	20,000	1	20,000	19,780	,000
Within Groups	18,200	18	1,011		
Total	38,200	19			

a. Question = 10,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,3000	1,33749	,42295
	Touch	10	3,3000	,48305	,15275

a. Question = 10,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	9,598	,006	-4,447	18	,000	-2,00000	,44969	-2,94477	-1,05523
	Equal variances not assumed			-4,447	11,309	,001	-2,00000	,44969	-2,98648	-1,01352

a. Question = 10,00

One-way ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 10. There was a significant effect of the controlling type of the game on question 10 at the $p<.05$ level for the two conditions [$F(1, 18) = 19.780$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on absorption. According to the t-test results, there was a significant result between first ($M=1.3$, $SD=1.337$) and second version ($M = 3.3$, $SD = 0.483$); $t(18) = -4.447$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player is more absorbed.

Question 11: "I felt content."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,2000	1,22927	,38873	,3206	2,0794	,00	4,00
Touch	10	3,8000	,42164	,13333	3,4984	4,1016	3,00	4,00
Total	20	2,5000	1,60591	,35909	1,7484	3,2516	,00	4,00

a. Question = 11,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	33,800	1	33,800	40,026	,000
Within Groups	15,200	18	,844		
Total	49,000	19			

a. Question = 11,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,2000	1,22927	,38873
	Touch	10	3,8000	,42164	,13333

a. Question = 11,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	4,388	,051	-6,327	18	,000	-2,60000	,41096	-3,46340	-1,73660
	Equal variances not assumed			-6,327	11,089	,000	-2,60000	,41096	-3,50364	-1,69636

a. Question = 11,00

ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 11. There was a significant effect of the controlling type of the game on question 11 at the $p<.05$ level for the two conditions [$F(1, 18) = 40.026$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on feeling content. According to the t-test results, there was a significant result between first ($M=1.2$, $SD=1.229$) and second version ($M = 3.8$, $SD = 0.422$); $t(18) = -6.327$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player fees more content.

Question 12: "I felt challenged."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	2,2000	,42164	,13333	1,8984	2,5016	2,00	3,00
Touch	10	1,1000	1,10050	,34801	,3127	1,8873	,00	4,00
Total	20	1,6500	,98809	,22094	1,1876	2,1124	,00	4,00

a. Question = 12,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6,050	1	6,050	8,712	,009
Within Groups	12,500	18	,694		
Total	18,550	19			

a. Question = 12,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	2,2000	,42164	,13333
	Touch	10	1,1000	1,10050	,34801

a. Question = 12,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,750	,398	2,952	18	,009	1,10000	,37268	,31703	1,88297
	Equal variances not assumed			2,952	11,586	,013	1,10000	,37268	,28478	1,91522

a. Question = 12,00

ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 12. There was a significant effect of the controlling type of the game on question 12 at the $p<.05$ level for the two conditions [$F(1, 18) = 8.712$, $p = 0.009$]. These results suggest that the controlling type of the game has an effect on feeling challenged. According to the t-test results, there was a significant result between first ($M=2.2$, $SD = 0.422$) and second version ($M = 1.1$, $SD = 1.101$); $t(18) = 2.952$, $p = 0.009$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player feels less challenged.

Question 13: "I felt stimulated."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	2,0000	,47140	,14907	1,6628	2,3372	1,00	3,00
Touch	10	3,4000	,51640	,16330	3,0306	3,7694	3,00	4,00
Total	20	2,7000	,86450	,19331	2,2954	3,1046	1,00	4,00

a. Question = 13,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	9,800	1	9,800	40,091	,000
Within Groups	4,400	18	,244		
Total	14,200	19			

a. Question = 13,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	2,0000	,47140	,14907
	Touch	10	3,4000	,51640	,16330

a. Question = 13,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	4,160	,056	-6,332	18	,000	-1,40000	,22111	-1,86453	-,93547
	Equal variances not assumed			-6,332	17,852	,000	-1,40000	,22111	-1,86481	-,93519

a. Question = 13,00

ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 13. There was a significant effect of the controlling type of the game on question 13 at the $p<.05$ level for the two conditions [$F(1, 18) = 40.091$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on feeling stimulated. According to the t-test results, there was a significant result between first ($M=2.0$, $SD = 0.471$) and second version ($M = 3.4$, $SD = 0.516$); $t(18) = -6.332$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player feels more stimulated.

Question 14: "I felt good."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Tilt	10	1,8000	,63246	,20000	1,3476	2,2524	1,00	3,00
Touch	10	3,7000	,48305	,15275	3,3544	4,0456	3,00	4,00
Total	20	2,7500	1,11803	,25000	2,2267	3,2733	1,00	4,00

a. Question = 14,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	18,050	1	18,050	57,000	,000
Within Groups	5,700	18	,317		
Total	23,750	19			

a. Question = 14,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	Tilt	10	1,8000	,63246	,20000
	Touch	10	3,7000	,48305	,15275

a. Question = 14,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,199	,661	-7,550	18	,000	-1,90000	,25166	-2,42872	-1,37128
	Equal variances not assumed			-7,550	16,834	,000	-1,90000	,25166	-2,43136	-1,36864

a. Question = 14,00

ANOVA was applied to compare the effect of the first version (controlling with tilt), and the second version (controlling with touch) on GEQ question 14. There was a significant effect of the controlling type of the game on question 14 at the $p<.05$ level for the two conditions [$F(1, 18) = 57.0$, $p = 0.0$]. These results suggest that the controlling type of the game has an effect on feeling good. According to the t-test results, there was a significant result between first ($M=1.8$, $SD = 0.632$) and second version ($M = 3.7$, $SD = 0.483$); $t(18) = -7.550$, $p = 0.0$. Specifically, the results suggest that when the controlling type of the game is not tilt property of the device, the player feels better.

4.5.4 Analysis for Heuristic 4

The section includes analyzing results and report for heuristic 4. Heuristic 4 is "Tactile (Haptic) feedbacks stimulate the player." One-way ANOVA method and t-test result are applied to each GEQ question and analyzed the difference between first version and second version.

Question 1: "I was interested in the game's story."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,6000	,51640	,16330	2,2306	2,9694	2,00	3,00
Haptic	10	2,5000	,52705	,16667	2,1230	2,8770	2,00	3,00
Total	20	2,5500	,51042	,11413	2,3111	2,7889	2,00	3,00

a. Question = 1,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,050	1	,050	,184	,673
Within Groups	4,900	18	,272		
Total	4,950	19			

a. Question = 1,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 1. There was no significant effect of the usage of haptic feedback on the story of the game at the $p<.05$ level for the two conditions [$F(1, 18) = 0.184$ $p = 0.673$]. These results suggest that the usage of haptic feedback does not have an effect on story of the game.

Question 2: "I felt successful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	3,0000	,47140	,14907	2,6628	3,3372	2,00	4,00
Haptic	10	3,2000	,63246	,20000	2,7476	3,6524	2,00	4,00
Total	20	3,1000	,55251	,12354	2,8414	3,3586	2,00	4,00

a. Question = 2,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,200	1	,200	,643	,433
Within Groups	5,600	18	,311		
Total	5,800	19			

a. Question = 2,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 2. There was no significant effect of the usage of haptic feedback on feeling successful at the p<.05 level for the two conditions [F (1, 18) = 0.643 p = 0.433]. These results suggest that usage of haptic feedback does not have an effect on feeling successful.

Question 3: "I felt bored."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	1,5000	,97183	,30732	,8048	2,1952	,00	3,00
Haptic	10	1,3000	,94868	,30000	,6214	1,9786	,00	3,00
Total	20	1,4000	,94032	,21026	,9599	1,8401	,00	3,00

a. Question = 3,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,200	1	,200	,217	,647
Within Groups	16,600	18	,922		
Total	16,800	19			

a. Question = 3,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 3. There was no significant effect of the usage of haptic feedback on feeling bored at the p<.05 level for the two conditions [F (1, 18) = 0.217 p = 0.647]. These results suggest that the usage of haptic feedback does not have an effect on feeling boring.

Question 4: "I found it impressive."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,8000	,63246	,20000	2,3476	3,2524	2,00	4,00
Haptic	10	2,9000	,99443	,31447	2,1886	3,6114	1,00	4,00
Total	20	2,8500	,81273	,18173	2,4696	3,2304	1,00	4,00

a. Question = 4,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,050	1	,050	,072	,791
Within Groups	12,500	18	,694		
Total	12,550	19			

a. Question = 4,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 4. There was no significant effect of the usage of haptic feedback on the impressiveness of the game at the $p<.05$ level for the two conditions [$F(1, 18) = 0.072$, $p = 0.791$]. These results suggest that the usage of haptic feedback does not have an effect on the impressiveness of the game.

Question 5: "I forgot everything around me."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,4000	,51640	,16330	2,0306	2,7694	2,00	3,00
Haptic	10	2,7000	,48305	,15275	2,3544	3,0456	2,00	3,00
Total	20	2,5500	,51042	,11413	2,3111	2,7889	2,00	3,00

a. Question = 5,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,450	1	,450	1,800	,196
Within Groups	4,500	18	,250		
Total	4,950	19			

a. Question = 5,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 5. There was no significant effect of the usage of haptic feedback on the absorption of the player at the $p<.05$ level for the two conditions [$F(1, 18) = 1.8$, $p = 0.196$]. These results suggest that the usage of haptic feedback does not have an effect on the the absorption of the player.

Question 6: "I felt frustrated."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,1000	1,19722	,37859	1,2436	2,9564	,00	4,00
Haptic	10	1,3000	1,05935	,33500	,5422	2,0578	,00	3,00
Total	20	1,7000	1,17429	,26258	1,1504	2,2496	,00	4,00

a. Question = 6,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3,200	1	3,200	2,504	,131
Within Groups	23,000	18	1,278		
Total	26,200	19			

a. Question = 6,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 6. There was no significant effect of the usage of haptic feedback on the frustration of the player at the $p<.05$ level for the two conditions [$F(1, 18) = 2.504$, $p = 0.131$]. These results suggest that the usage of haptic feedback does not have an effect on the frustration of the player.

Question 7: "I found it tiresome."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,1000	,99443	,31447	1,3886	2,8114	,00	3,00
Haptic	10	1,2000	,78881	,24944	,6357	1,7643	,00	2,00
Total	20	1,6500	,98809	,22094	1,1876	2,1124	,00	3,00

a. Question = 7,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4,050	1	4,050	5,028	,038
Within Groups	14,500	18	,806		
Total	18,550	19			

a. Question = 7,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	No haptic	10	2,1000	,99443	,31447
	Haptic	10	1,2000	,78881	,24944

a. Question = 7,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,110	,744	2,242	18	,038	,90000	,40139	,05672	1,74328
	Equal variances not assumed			2,242	17,114	,038	,90000	,40139	,05358	1,74642

a. Question = 7,00

ANOVA was applied to compare the effect of the first version (no haptic feedback), and the second version haptic feedback) on GEQ question 7. There was a significant effect of the usage of the haptic feedback on question 7 at the $p<.05$ level for the two conditions [$F(1, 18) = 5.028$, $p = 0.038$]. These results suggest that the the usage of the haptic feedback has an effect on feeling tiresome. According to the t-test results, there was a significant result between first ($M=2.1$, $SD=0.314$) and second version ($M = 1.2$, $SD = 0.788$); $t(18) = 2.242$, $p = 0.038$. Specifically, the results suggest that when the haptic feedback is given to the player for the actions done by the player, the player feels more tiresome.

Question 8: “I felt irritable.”

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,0000	,81650	,25820	1,4159	2,5841	,00	3,00
Haptic	10	1,3000	,67495	,21344	,8172	1,7828	,00	2,00
Total	20	1,6500	,81273	,18173	1,2696	2,0304	,00	3,00

a. Question = 8,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2,450	1	2,450	4,366	,051
Within Groups	10,100	18	,561		
Total	12,550	19			

a. Question = 8,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 8. There was no significant effect of the usage of haptic feedback on the irritation of the player at the p<.05 level for the two conditions [F (1, 18) = 4.366, p = 0.051]. These results suggest that the usage of haptic feedback does not have an effect on the irritation of the player.

Question 9: "I felt skillful."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,6000	,84327	,26667	1,9968	3,2032	1,00	3,00
Haptic	10	2,9000	,56765	,17951	2,4939	3,3061	2,00	4,00
Total	20	2,7500	,71635	,16018	2,4147	3,0853	1,00	4,00

a. Question = 9,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,450	1	,450	,871	,363
Within Groups	9,300	18	,517		
Total	9,750	19			

a. Question = 9,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 9. There was no significant effect of the usage of haptic feedback on feeling skillful at the $p<.05$ level for the two conditions [$F(1, 18) = 4.366$, $p = 0.363$]. These results suggest that the usage of haptic feedback does not have an effect on feeling skillful.

Question 10: "I felt completely absorbed."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,7000	1,15950	,36667	1,8705	3,5295	1,00	4,00
Haptic	10	3,2000	,78881	,24944	2,6357	3,7643	2,00	4,00
Total	20	2,9500	,99868	,22331	2,4826	3,4174	1,00	4,00

a. Question = 10,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1,250	1	1,250	1,271	,274
Within Groups	17,700	18	,983		
Total	18,950	19			

a. Question = 10,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 10. There was no significant effect of the usage of haptic feedback on the absorption at the $p<.05$ level for the two conditions [$F(1, 18) = 1.271$, $p = 0.274$]. These results suggest that the usage of haptic feedback does not have an effect on the absorption.

Question 11: "I felt content."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,9000	1,37032	,43333	1,9197	3,8803	1,00	4,00
Haptic	10	3,3000	,67495	,21344	2,8172	3,7828	2,00	4,00
Total	20	3,1000	1,07115	,23952	2,5987	3,6013	1,00	4,00

a. Question = 11,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,800	1	,800	,686	,418
Within Groups	21,000	18	1,167		
Total	21,800	19			

a. Question = 11,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 11. There was no significant effect of the usage of haptic feedback on feeling content at the p<.05 level for the two conditions [F (1, 18) = 0.686, p = 0.418]. These results suggest that the usage of haptic feedback does not have an effect on feeling content.

Question 12: "I felt challenged."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	1,5000	1,08012	,34157	,7273	2,2727	,00	3,00
Haptic	10	,5000	,84984	,26874	-,1079	1,1079	,00	2,00
Total	20	1,0000	1,07606	,24061	,4964	1,5036	,00	3,00

a. Question = 12,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5,000	1	5,000	5,294	,034
Within Groups	17,000	18	,944		
Total	22,000	19			

a. Question = 12,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	No haptic	10	1,5000	1,08012	,34157
	Haptic	10	,5000	,84984	,26874

a. Question = 12,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,900	,355	2,301	18	,034	1,00000	,43461	,08691	1,91309
	Equal variances not assumed			2,301	17,056	,034	1,00000	,43461	,08327	1,91673

a. Question = 12,00

ANOVA was applied to compare the effect of the first version (no haptic feedback), and the second version haptic feedback) on GEQ question 12. There was a significant effect of the usage of the haptic feedback on question 12 at the $p<.05$ level for the two conditions [$F(1, 18) = 5.294$, $p = 0.034$]. These results suggest that the usage of the haptic feedback has an effect on feeling challenged. According to the t-test results, there was a significant result between first ($M=1.5$, $SD=0.342$) and second version ($M = 0.5$, $SD = 0.850$); $t(18) = 2.301$, $p = 0.034$. Specifically, the results suggest that when the haptic feedback is given to the player for the actions done by the player, the player feels less challenged.

Question 13: “I felt stimulated.”

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	2,8000	,42164	,13333	2,4984	3,1016	2,00	3,00
Haptic	10	3,2000	,42164	,13333	2,8984	3,5016	3,00	4,00
Total	20	3,0000	,45883	,10260	2,7853	3,2147	2,00	4,00

a. Question = 13,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,800	1	,800	4,500	,048
Within Groups	3,200	18	,178		
Total	4,000	19			

a. Question = 13,00

Group Statistics[a]

	VERSION	N	Mean	Std. Deviation	Std. Error Mean
RESPONSE	No haptic	10	2,8000	,42164	,13333
	Haptic	10	3,2000	,42164	,13333

a. Question = 13,00

Independent Samples Test[a]

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
RESPONSE	Equal variances assumed	,000	1,000	-2,121	18	,048	-,40000	,18856	-,79615	-,00385
	Equal variances not assumed			-2,121	18,000	,048	-,40000	,18856	-,79615	-,00385

a. Question = 13,00

ANOVA was applied to compare the effect of the first version (no haptic feedback), and the second version haptic feedback) on GEQ question 13. There was a significant effect of the usage of the haptic feedback on question 13 at the $p<.05$ level for the two conditions [$F(1, 18) = 4.5$, $p = 0.048$]. These results suggest that the usage of the haptic feedback has an effect on feeling stimulated. According to the t-test results, there was a significant result between first ($M=2.8$, $SD=0.422$) and second version ($M = 3.2$, $SD = 0.133$); $t(18) = -2.121$, $p = 0.048$. Specifically, the results suggest that when the haptic feedback is given to the player for the actions done by the player, the player feels more stimulated.

Question 14: "I felt good."

Descriptives[a]

RESPONSE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
No haptic	10	3,2000	1,03280	,32660	2,4612	3,9388	1,00	4,00
Haptic	10	3,3000	,82327	,26034	2,7111	3,8889	2,00	4,00
Total	20	3,2500	,91047	,20359	2,8239	3,6761	1,00	4,00

a. Question = 14,00

ANOVA[a]

RESPONSE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	,050	1	,050	,057	,813
Within Groups	15,700	18	,872		
Total	15,750	19			

a. Question = 14,00

ANOVA was conducted to compare the effect of the first version (no haptic feedback), and the second version (haptic feedback) on GEQ question 14. There was no significant effect of the usage of haptic feedback on feeling good at the $p<.05$ level for the two conditions [$F(1, 18) = 0.057$, $p = 0.813$]. These results suggest that the usage of haptic feedback does not have an effect on feeling good.

4.6 Discussion

This subsection includes the summary of the statistical analysis results and discussion of them.

4.6.1 GEQ "In Game Module" Question Set

Q 1: "I was interested in the game's story".

Q 2: "I felt successful"

Q 3: "I felt bored"

Q 4: "I found it impressive**"**

Q 5: "I forgot everything around me**"**

Q 6: "I felt frustrated**"**

Q 7: "I found it tiresome.**"**

Q 8: "I felt irritable**"**

Q 9: "I felt skillful"

Q 10: "I felt completely absorbed**"**

Q 11: "I felt content**"**

Q 12: "I felt challenged**"**

Q 13: "I felt stimulated**"**

Q 14: "I felt good**"**

4.6.2 Interview Questions after the game

1. What are the differences between two versions of the game?
2. Which version of the game was more enjoyable for you?
3. In which version did you feel more challengeable? What was the challenging element in the game?
4. In both versions, which were the most pleasing and making you unhappy element?

4.6.3 Summary of the results

The statistical results of the GEQ answers are declared and reviewed in section 5.1 to 5.4. The summary of these results are discussed in this section. First question of GEQ is not statistically significant and heuristics does not change anything on the answers of this question because it is about the story of the game. The stories are the same for each version (heuristic not applied, heuristic applied versions). Thus, this question does not need to be discussed here. Interview questions were asked to the participants in order to gather qualitative data. It may be helpful to get expected results for the heuristics, if there is no statistically significant result.

Heuristic 1: Distribution of the game items for both left handed and right handed people should be balanced.

The answers of Q2, Q3, Q4, Q6, Q8, Q9, Q11, Q12, Q13, and Q14 are statistically different and they supports that the heuristic does affect the playability positively. The other questions do not differ between versions. Thus, it can be said that the heuristic is successful.

Heuristic 2: The interactive game items should be placed mostly edges/sides of the device if the device has a large screen, like tablet PC. (250mmx180mm)

The answers of Q2, Q3, Q4, Q5, and Q8 are statistically different and they supports that the heuristic affects the playability positively. However, the other questions are not statistically different. In order to understand that the heuristic is successful or not some interview questions are asked to the participants. The answers of second and third questions show that the second version of the game, namely heuristic applied version is more enjoyable and not so challengeable that frustrate the player. As a result, it can be said that the heuristic is not successful statistically. However, it can be successful according to the qualitative results.

Heuristic 3: The accelerometer property, in other words tilt property usage should be minimized in mobile touchscreen game.

Q2, Q3, Q4, Q5, Q6, Q8, Q9, Q10, Q11, Q12, Q13, and Q14 differ between two versions statistically. Also, the results supports that the heuristic affects the playability positively. From the results, usage of tilt property increases over the level of challenge in the game. That's why the player feels more frustrated, tiresome and unsuccessful. The tilt property may be used in order to balance the skill and challenge of the game, if the game provides little challenge without tilt usage.

Heuristic 4: Haptic (tactile) feedbacks stimulate the player.

Q7, Q12, Q13 differ between two versions statistically. However, the other questions do not differ. Unfortunately, the answers of the interview questions do not differ, too. Only 3 participants of 10 noticed the feedbacks and found them slightly more enjoyable.

CHAPTER 5

CONCLUSION AND FUTURE WORK

This chapter contains the conclusion and the future work, that may be helpful for the advanced studies about similar subjects..

5.1 Conclusion

In this work, a playability heuristic set is developed for the games played on touchscreen mobile games. These four heuristics aims to update existing playability heuristics for mobile games. A user study is implemented for each heuristics. Four different games are used; each one is for each heuristic. Two different versions are developed/set for each heuristics. The first versions are the ones that the heuristics are not applied and the second versions are the ones that the heuristics are applied. In order to understand the difference between two versions, Game Experience Questionnaire (GEQ) is applied. Beside the questionnaire, an interview is also done by the researcher in order to gain quantitative data. The results of the user study revealed that the heuristics 1, 2 and 3 can be added as a rule for developing a mobile game played on touchscreen devices. In a touchscreen mobile game, the items that the player usually interacts should be placed on the screen in such a manner that both of the right handed and left handed players do not struggle with the gameplay.

Secondly, It is seen that using the middle part of the screen make players to have difficulty while playing the game, which is played on tablet-sized devices (250mm x180mm) . This difficulty decreases the player's bliss. When the player holds the device with two hands, the player should use the thumb nails to control the game. Since the thumb nails are not long enough to touch the middle of the screen, the player struggles with this issue while playing the game and the flow-challenge balance is ruined. The statistical results and the answers of the interview questions show that the interactive game items should be placed on the edges and sides of the screen touchscreen mobile games which are played on the tabled-sized mobile touchscreen devices.

In the third place, it is observed that the player does not like using accelerometer while playing a game. This result is reached by getting the quantitative responses from the participants. The accelerometer complicates the gameplay which does not affect it in a positive way. There is a question here, about the effect of making the gameplay complicated. Is a simple gameplay always better? The answer is no, not always. However,

the complication here does not come from the nature of the game. The game chosen for the tests of this thesis can be played with both touch property and tilt property of the device. The control mechanism of the game is optional. While using tilt property, the player cannot use the fingers except (thumbnails). Furthermore; when the player moves the device in order to control the game with the tilt property, it moves the screen that (s)he looks and this annoys him/her. These are the reasons why the touch control is more preferable.

5.2 Future Work

As future improvements, the heuristics may be enlarged for the game types that played on mobile touch screen displays. It can be researched which game types are more common in the markets, which type gameplay is compatible with mobile devices. This work mostly focused on visual elements of a mobile game. Audio elements may also be researched and new heuristics may be developed about them.

The study has some limitations. The heuristics were tested on different games. A game may be developed which provides the conditions to test all these heuristics. Heuristic 2 is just for tablet-sized devices. It may be researched for different touchscreen devices. Also tactile (haptic) feedback cannot be tested on Apple devices because they do not support vibration property.

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APPENDICES

APPENDIX A – INFORMATION OF RESEARCHER PART OF THE QUESTINNAIRE PRESENTED TO THE PARTICIPANTS

Researcher Information

Student: Gülşah ÜLGER

Thesis Subject: Playability Heuristics for Mobile Using Touchscreen Displays

Name of the game:

This document is translated from original English version of survey, which is well accepted by the international literature and prepared for the purpose of measurement and evaluation of playability metrics for video games, including other interview questions applied to the participants.

APPENDIX B – INFORMATION OF PARTICIPANT PART OF THE QUESTINNAIRE

Participant Information

Sex: ☐ Female ☐ Male

Age:

☐ I am left-handed

☐ I am right-handed

	Version1	**Version2**
Game Score1		
Game Score2		
Game Score3		
Average		

APPENDIX C – INTERVIEW PART OF THE QUESTINNAIRE

Interview

1) What are the differences between two versions of the game?

2) Which version of the game was more enjoyable for you?

3) In which version did you feel more challengeable? What was the challenging element in the game?

4) In both versions, which element were the most pleasing and making you unhappy?

APPENDIX D – GAME EXPERIENCE QUESTIONNAIRE (GEQ) PART OF THE QUESTINNAIRE

Game Experience Questionnaire - GEQ

Please evaluate the questions with the measurement below

Not at all	Slightly	Moderately	Fairly	Extremely
0	1	2	3	4

	QUESTIONS	Version 1	Version 2
1	I was interested in the game's story.		
2	I felt successful.		
3	I felt bored.		
4	I found it impressive.		
5	I forgot everything around me.		
6	I felt frustrated.		
7	I found it tiresome.		
8	I felt irritable		
9	I felt skillful		
10	I felt completely absorbed.		
11	I felt content.		
12	I felt challenged.		
13	I felt stimulated.		
14	I felt good.		

TEZ FOTOKOPİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☐

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : .....
Adı : .....
Bölümü : .....

TEZİN ADI (İngilizce) : .....
.....
.....
.....
.....

TEZİN TÜRÜ : Yüksek Lisans ☐ Doktora ☐

1. Tezimin tamamı dünya çapında erişime açılsın ve kaynak gösterilmek şartıyla tezimin bir kısmı veya tamamının fotokopisi alınsın. ☐
2. Tezimin tamamı yalnızca Orta Doğu Teknik Üniversitesi kullancılarının erişimine açılsın. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐
3. Tezim bir (1) yıl süreyle erişime kapalı olsun. (Bu seçenekle tezinizin fotokopisi ya da elektronik kopyası Kütüphane aracılığı ile ODTÜ dışına dağıtılmayacaktır.) ☐

Yazarın imzası ..... Tarih .....