Teknik och samhälle
Datavetenskap

Examensarbete
15 högskolepoäng, grundnivå

Exploring context awareness in mobile games

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Examen: Kandidatexamen 180 hp
Huvudämne: Datavetenskap
Program: Spelutveckling
Datum för slutseminarium: 2018-05-31

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Template: https://www.ieee.org/
conferences/publishing/templates.html

***Abstract*— Today mobiles are a standard, multiple sensors that gathers data about the user is embedded within those mobiles. But the use of this data is not as common as one would think in the mobile game market. To observe and analyse how an implementation of this data would affect a mobile game from a common genre such as time-passing games a prototype were built. This prototype could be seen as a reversed gamification using training data, in this case footsteps, in order to enhance the game and make it more interesting for the user. Findings of how the data could be integrated within the game in a way that would interest users more have been gathered through a survey and are discussed and presented.**

I. Introduction

The smartphones and the mobile games that comes with them today has gotten to a point where they are so common it is without question that they are going to stay relevant for a long time. But in order to stay relevant the developers need to come up with fresh ideas and new fun mechanics.

Another thing is that most people nowadays own a smartphone and many of the users use their phones to play games, but something that is rare is the use of context in today's mobile games.

We wanted to examine if real-life data would improve a time-passing mobile game. What would the users response be to such an integration and how the current integration could be improved or used differently.

There are other companies that have tried to make context-aware mobile games and their results have varied. Varied in such way that some of them took the market by storm, while others are just forgotten. According to this online article by Molina she claims that Pokémon GO [1] was the fastest mobile game to hit 10 million downloads which "*...reached the milestone two days earlier than Clash Royale...*" [2], which proved that it was a popular idea. But this games main focus point is its context-aware mechanics. With this we mean that without the phones knowledge of where the user are right now, the game would not work. Few games use some kind of context in the category of passing-time, games such as the platform runners, clickers games or jump games where you just want to reach as far as you can.

The purpose of this study is to examine whether a real-world connection between the users activity data and a mobile game can be used to improve a mobile game and how an implementation of the users data would affect the game. For this study, the focused area have been surrounding clicker games. A clicker game could easiest be described by saying the main feature is to click on the screen, from clicking you get some kind of resource that you spend on upgrading features. The reason for choosing clicker game is because anyone can play a clicker game, it requires little to no attention, meaning that there is a possibility to take the game concept a step further with a connection to the real-world. Our games core concept surrounds itself of mines, which goes well together with the real-world connection. This is because stones and minerals are things you can find in the real world in various locations, therefore this concept could be extended a lot in the future by introducing new ideas or bridging the idea with a location context.

An implementation of our idea has been made into a prototype. This prototype has been tested by users, both experienced and inexperienced, in order to get feedback on our idea.

Throughout this paper a discussion will take place were the advantages and disadvantages of implementing data about the users footsteps in a passing-time mobile game, in this case a clicker game, will be presented. We will also discuss some other ways we could of implemented the context to improve the prototype and make it more integrated within the gameplay. As of now the context is more like an extension of the prototype rather than a crucial part.

In the sections below the built prototype and its features get presented. Some tests have been performed where data about the testers and their thoughts about the prototype and real-life data was collected through a questionnaire (See Appendix 1). The collected answers are displayed and a discussion takes place later regarding the results. Lastly a summation, ending with some ideas of future work.

A. Background

Most people today own their own phone, which companies can profit from and thus keep evolving the phones by making them better with each generation. Phone owners can do so much, for instance play games, lifestyle tracking, and much more on their device. And with the current state of the phones where they are always connected to internet and where the phone always know where its user is, that information can be used to improve the applications that is used on our phone on a daily basis.

In order to talk about context awareness an understanding of what the notion of context means is necessary. Dey et al. are presenting their definition of context in [3], "*Context is any information that can be used to characterize the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.*". In this study the context were the users footsteps, which were needed to the users interaction with the prototype. This information were gathered about the user in order to influence the prototype. The influence were not a crucial part of the gameplay due to the current integration of the real-life data, but it still existed. However others have tried to define what context means, for example Bazire and Brézillon tried to define what context is in [4],

and stated " *...that a definition of context depends on the field of knowledge that it belongs to.*". In their research they find and discuss some determining factors regarding a definition of context. Another thing stated by Bazire and Brézillon was that " *...context stays a very ill-defined concept.*", which is similar to what Dourish stated in [5] which was that *"Context" is a slippery notion. Perhaps appropriately, it is a concept that keeps to the periphery, and slips away when one attempts to define it.*. Instead of trying to define the notion of context Dourish presented and discussed what "work" context is doing as it is used in simultaneous research in Human-computer interaction (HCI). Whether Dey et al. have been able to define what the notion of context is, considering that others claim that context is a slippery notion is something that could be further discussed. However, the interest of this study do not lay in trying to find or define a definition of the notion of context.

After an insight of what context is the question: What is context awareness (CA)?, can be asked. Well, as Dey et al. stated "*A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user's task.*".

What this means for mobile games is that a context within a game can be used to make it more unpredictable or more fun in the users eyes. Other people have done this for example Bell et al. [6] made a game called "Feeding Yoshi" that used the context of location to track different kinds of foods on a map that the player then had to walk too to collect points.

Our prototype is built like a typical clicker game, it could be compared with games such as Clicker Heroes [7] or Cookie Clicker 2 [8]. The difference between our prototype and traditional clicker is that our prototype is using real-life data, more exact a footstep counter. The prototype is made with an implementation of user footsteps, how this can be further expanded will be discussed more in Section 7.A. Future Work. But we consider the user footsteps to be a good starting point for this prototype just to get some gears rolling for the testers. We also believe that combining users footstep data with a clicker game would result in a solution for our research question. The reason for this is because if a combination of footsteps and a clicker game would improve the game and result in a larger demand towards context being embedded within games there would be a reason for some mobile game developers to aim towards such implementations in other genres as well. It is most likely that all genres combined with context would not have a successful outcome. However, a clicker could be successful because when playing a clicker game, you do not need to pay full attention to what you do, neither to an activity such as walking which means that the user could enjoy both at the same time.

B. Vision of this Thesis

The aim was to implement a connection between the real-word data, footstep counts, into a "time killer" mobile game where the game would work just as fine without this data. This was done to see how it would affect the gameplay for the positive or negative. It also helped to get an insight in the users imagination of how to improve the game with an incorporation of the real-life data within game.

C. Research Aim and Research Question

1) Research Aim: With all this information that were gathered we hope that this will help future game application developers to make the decision of whether or not to implement context into their game/s. Even if the game/s they are making, traditionally do not use any context, this might still be considered after reading this article.

2) Research Question: The research question is: How would a game that is mainly focused on passing time, and do not depend on any real-life data be affected if it were to be implement to the game? This is something that are interesting to find out because a game such as a clicker game that do not have much of a point other than getting the player to keep clicking, could be given an actual point. The lifespan of a game might also be extended because the content would differ depending on how active the player is. There is always a risk that the implementation of real-life data instead could lead to ruin the fun factor or the addictive part of a clicker game.

D. Scope and Limitations

1) Technical Limitations: The game application are using training data and requires the user to have the Samsung Health [9] application installed on their phone, so the game can collect the data from the Health application about the users activity. The game is using the footstep counter for calculations that affects the different skills. The benefits increase as the more active the player is. This means that the prototype is limited to Android phones, and it also requires that the Samsung Health application is installed on the same unit as the newest version of the prototype. The Samsung Health application is not only restricted to Samsung mobiles any more, meaning that the prototype is working on all Android phones as well. This widened our testbase. It would also be possible to have tests that could be held over the internet or with users living far away by sending the APK-file of our prototype to testers.

The context of the prototype is very limited, so limited that it is refereed as a real-world connection in this study as long as the footsteps is used in the present way. The footstep counter is implemented into the prototype using Samsung Healths API. In this study any other form of context such as location or voice to control the game have not been attempted to embody with the prototype.

2) System Limitations: Our limitations within the system were that the resources we had were such as programs were limited to free versions and were needed to stay with what was available. One thing that was limited because of this was Unity's Collaborate feature, where you can simply share the work fast and simple. Instead we had to spend resources on setting up Github and handle eventual errors. This caused our game not to become as large as we initially foresaw.

There were no attempts made to get the prototype to work with other APIs other than Samsung Healths, the reason for this was because it were not necessary. With the Samsung Health API the research question were able to be answered. The prototype did not need to work with other APIs that collects training data nor be able to work on other platforms. This would of required a lot more time to implement but the end result would still be the same. So the time were instead laid on improving the existing prototype and the testing of it.

The prototype is running on Android phones exclusively. The prototype is made on API level 4.1 Jelly Bean which means that most Android phones are be able to run our prototype. But the Android phones that are currently running on a lower API level are unfortunately not able to start the prototype. However, the likelihood of someone not being able to start the prototype is minimal since over 90 percent as of May 2018 use an Android version of 4.4 KitKat or above [10].

II. Related Work

We consider games that work without any requirement of a context to it, to be more of the traditional mobile games. A few examples of these games could be games like clicker games or Side-scrolling games since it is rare for these kinds of games to ever use context. Pokémon GO and Turf [11] is two examples of games that could not work without the context aware element because that is the whole perception around these games. So when we looked in to related work we had a hard time because there is not much to be found that peeks our interests but in this article [3] by Abowd et al. they are making a game called *Feeding Yoshi*. Just as us, they are using context in their game to interweave the everyday life to a game, which they use Location based information to achieve. Their game is also so dependent of using context that if it were to be removed the game idea would not work, similar to Pokémon GO and Turf.

Sega Corp filed a patent [12], where they wanted the rights to a machine that collected different kind of training data and this data would then be used in games. They envisioned what the possibilities of using context in games back in 1995 could result in, so they actually wanted to build this machine. In today's age we have that machine in the palm of our hand and it is not being used to its full potential. Although all the resources for achieving Sega Corps goal to develop a game that is utilizing training data exists today, it is still not commonly used within mobile games. The phone is collecting so much data about its user all the time, and this data could be more involved in the games to make the game more interesting for the user. McCallum [13] describes approaches for development of games that focuses on keeping the player active, which is similar in some ways to Sega Corps envision. For Sega Corp to be able to collect training data it requires the user to be active. If the implementation of training data in a game is challenging and able to keep the users interest it could lead to the result of motivating the user to become more active.

Our idea could be seen as a reversed gamification. Pereira et al. describes gamification as follows, "Gamification is an informal umbrella term for the use of video game elements in non-gaming systems that aim to improve user experience and user engagement." [14]. In our case the aim is to improve the user experience and engagement of the user by using user footsteps in a mobile game. Reversed gamification can as well be used to describe Sega Corp envision of their machine mentioned earlier. This signifies that the reversed gamification is not a novel idea, because it have been envisioned and executed previously. Games like Pokémon Heartgold [15] proves that the company Nintendo also have envisioned and executed this idea. Enchanting their games by incorporate the users footsteps as a way to influence the games. The way Nintendo did this was by releasing a pedometer that were compatible with their games. This pedometer called Pokéwalker recorded every time a step was taken and the maximum amount of steps it could record were 9,999,999 steps. Which wild Pokémon and items that would appear within the games got influenced by the daily step count. The user were able to transfer a Pokémon to the Pokéwalker from Hearthgold in order for that Pokémon to gain experience for each step.

III. Method

A. Methodological background

In this section our method of choice for answering the research questions in section 1.C.2, is being presented and discussed.

The method we were following in order to solve this problem is Design Research. Developing a prototype in order to improve a specific area with a known problem is the main aim with Design Research. Zimmerman et al. were discussing research through design in HCI in [16]. They stated that "*...the term design research is generally used to refer to the upfront research practitioners do to ground, inform, and inspire their product development process. However, in the design research community... the term design research implies an inquiry focused on producing a contribution of knowledge.*". With our prototype which is described in section 4.B, the aim was to gain more

knowledge and understanding about the known problem which were our research question presented in section 1.C.2 in order to find a solution.
In section 3.C.1 our adaptation of the process of the design research method is presented. Design Research is discussed more in depth in Peffers et al. [17].

B. Research Setting

There is a lot of thoughts behind the idea of our game prototypes core concept being a mining game. The fact that the game is about mining works together with the training data because in a real mine you also need to work. The mines is also a good concept for a game like this because it could be anywhere, by this we mean that there is earth right underneath us and with a phone in your hand you can walk anywhere you want. By being in different places this also means that what is underneath you changes constantly. So the possibilities for future work is possible and doable.

C. Research Approach

1) Adaptation of the research process: This is our adaptations of the research process:

- Problem Identification and Motivation: Given the information presented in the first section the problem that have defined is that real-life data nor context awareness is used as frequently in mobile games as one might have thought, considering that plenty of resources for implementing and using context awareness exists.

- Define the Objectives for a Solution: Our objectives for a solution is to create a passing-time mobile game which takes in real-life features like data about the users steps. The footstep data is an extension of the prototype we developed, meaning that the prototype would function just as good without the footstep data. This prototype helped us to understand the thoughts that our testers had on real-life data being used in mobile games and it also help them think of how they wanted to see context being used.

- Design and Development: The prototype of a time passing clicker mobile game was developed in Unity game engine using C-sharp scripts. That project have been imported to an Android Studios project. It is in the Android project where the way of retrieving the users footstep data was implemented. The Android project passes the data on to the Unity prototype where the data is being used in different calculations within the Skills.

- Demonstration: To gather data regarding the prototype and the testers smaller tests were executed where the testers were asked to fill in a questionnaire (See Appendix) after the test were performed. The testers were given the task to test our prototype and at the same time think of various ways of using real-life data such as footsteps or context awareness in mobile games. The prior knowledge about clicker games variated among the testers, this was taken into consideration when the evaluation and analyse of the collected data took place. The interest laid more in gathering qualitative data and when the results started to repeat themselves, the testing of the prototype continued with users that had another knowledge level regarding clicker games than the current testbase. This was done to avoid the snowball effect.

- Evaluation: To evaluate the tests that had be performed during the demonstration of our prototype data was gathered about the prototype and it is users by letting the testers fill in a questionnaire. The questionnaire was divided into 3 sections where one section was concerning data about how active the user is. The second one contained questions about the users thoughts of the prototype and the third and last section was regarding the users thoughts about playing a mobile game while being active.

- Communication: This activity phase are reflected in the Result and Discussion sections and this was the final phase of the project. These sections includes the presentation and the discussion of the results that were gathered during the Demonstration and Evaluation phases.

D. Questionnaire

Our questionnaire featured 3 pages of different questions to help us get a better picture of who the testers were and their thoughts about our prototype. Some of the questions were simple “write what you think” kind of questions while others were questions where it was required of the tester to answer on a 5-mark scale. This scale was based on the Likert scale which Tullis and Albert explained in [18]. The questions that use this scale starts with a “1” which means “strongly disagree”, a “3” means to “neither agree or disagree" and lastly a “5” which means they “strongly agree” with the question. The reason for the use of this scale in the questionnaire was mainly because of the simplicity of its use.

This questionnaire were given to the testers after they had been given the opportunity to play around with the prototype for as long as they needed. Something that is was important to have in mind when handing out the questionnaire to the testers were their anonymity. A loss of anonymity could possibly result in corrupted data. Corrupted data in this case could be if the tester was not anonymous then there could be a risk of him answering differently. Tullis and Albert talk about this in their book [18] and how the loss of anonymity could perhaps lead to the conclusion of this research to change.

IV. Technical Infrastructure

A. Samsung Health API

The API that the prototype is using is Samsung's application called Samsung Health. As of writing this the application was not long ago made available for all Android mobiles. The decision to go with this Samsung Health API over other health applications like Google Fit [19], were made because it works on close to all android mobiles. After some research about the Samsung Health API the findings were that an integration of this API to an Android Studio Project is done with ease, this information further strengthen our believe that Samsung Health was a better choice. Since Samsung Health is available for all Android users and has as of writing this, over 100 million downloads which was more than the Google Fit API with 10 million downloads on Google Play Store, it was a clear choice.

When the application is started up it displays a live update of the users footsteps in the main activity of the Android project. The users footsteps are being retrieved in the main menu of the prototype from the Samsung Health API. When the user then starts the game by pressing the start button it transition over to the Unity activity, the current amount of footsteps get sent to the Unity activity. This means that the prototype only get an update of the footsteps ones every time it starts up. An implementation that retrieves the data once the game is running and not only in the main menu do not currently exist.

B. The Game Description

In this section the prototype of the game will be explained in detail.

For the game to work as intended it is required for the user to have Samsung Health installed on their android phone. Samsung Health application collects the footsteps count through the phones sensors and stores them and there from the prototype retrieves the footsteps.

The footsteps is used as a multiplier within the game, and for now it is just used combined with the skills.

To calculate the increasing prices of all the upgrades a popular formula is used. The formula is being used in most clicker games and it is structured like this:

$$Price = BaseCost(Multiplier^{Owned})$$

This formula means that to calculate a new price, the base cost must be multiplied by some kind of multiplier. In clicker games this multiplier usually stay around 1.07 to 1.15. Our multiplier is as of writing this at 1.07, we decided to go as low as possible because we did not want the increase to scale too high. Lastly we use the level of the upgrade that we want to calculate the new price for as a power to Multiplier.

In an online article called Numbers Getting Bigger: The Design and Math of Incremental Games [20] written by Alexander King, he talk about these formulas and their impact on a clicker game. The information was used to help us get a better understanding and deeper knowledge about how to properly tweak the multiplications for the game.

1) Games Functionality: Please note: The prices will vary from version to version, the current numbers in the pictures below is as of writing this. There are a lot of different mines in the game that the player can unlock and every mine contains different stones, these stones give certain currency when mined. Once a mine is bought, you can swap however you would like between the mines.

Fig. 1: How the game looks when first starting up.

The game starts off within a simple Stone mine and a base pickaxe for the player. This means that every click the player will do simply rewards him with 1C as you can see in Figure 1. The Stone mine is the base mine so this does not give any bonus for the player to mine in.

Fig. 2: Shows that we are in the Gravel mine and its bonuses, miner is still not bought.

The first mine that is unlockable is the Gravel mine. When in Gravel mine the background changes so that it now displays the new mine with other stones. There is now also an option to employ the miner that is working in the Gravel mine. He will work in this mine and collect passively currency for the player for the rest of the game. If you look at Figure 2 you can now see that the labels at the top also been updated to display what mine we are currently in and also how much bonus we are getting when we are "working" in this mine.

Fig. 3: Miner has now been bought, it is shown he is generating currency passively for the player.

In the Figure 3 it is shown that the player has purchased a miner in the Gravel mine. This will result in a passive generating of 0.2 currency when the miner is first purchased in the Gravel mine. After the miner has been bought, the miner can be upgraded by pressing the new button called "Research".

To unlock further mines so that the player can be able to collect even more currency you will firstly need to hire a miner of the same type as the mine (shown just above). Secondly the miner needs to reach a certain research level and this can be achieved by paying for research. This will cause the miner to get smarter, resulting in more value collected out of the rocks that he mines, also known as the passive income. Lastly the pickaxe must also have reached a specified level before you can progress and unlock a new mine. This is shown a bit more clearly in Table 1 below.

Table 1: Display mines that were implemented and some general information about the mines. The formula used to calculate research upgrade cost and how much the upgraded worker will generate follows as:
$newNumber = startingNumber(multiplier^{Level})$

Rarity	Stone/ gem Miner	Starting buy cost	Base generated per sec	Research/ upgrade cost %	Upgraded generated per sec	Requirements to be purchased
1	Gravel Miner	100	0.20	Formula*	Formula*	NaN
2	Granite Miner	1000	0.25	Formula*	Formula*	Pickaxe level: 5 & Previous mine unlocked & previous miner level: 5
3	Metal Miner	5000	0.30	Formula*	Formula*	Pickaxe level: 10 & Previous mine unlocked & previous miner level: 5
4	Obsidian Miner	12 000	0.38	Formula*	Formula*	Pickaxe level: 20 & Previous mine unlocked & previous miner level: 5
5	Gold Miner	30 000	0.50	Formula*	Formula*	Pickaxe level: 40 & Previous mine unlocked & previous miner level: 5

The miners will constantly work, so they will provide the player with a passive bonus increase which gets updated once every second. If you want more and faster currency then you as a user need to work hard as well. This means that the player also has to click. With a better pickaxe comes more currency out from the rocks, so the player has to keep upgrading their pickaxe to get more currency with each click.

Table 2: The skills and their effect and lasting time.

Skills	Short description	Lasting duration	Cooldown
Skill 1	(2 + step bonus)x currency for the pickaxe.	20 seconds	1 minutes
Skill 2	(2 + step bonus)x currency for the miners.	20 seconds	2 minutes
Skill 3	Changes the update timer of the miners from 1 second to (0.8 - step bonus). Minimum 0.4.	20 seconds	3 minutes

The skills that we have in the prototype right now is shown in Table 2. All of these skills are using the players footsteps to change the power or the skills strength. For the two first skills the footsteps are divided by 1000. This is

done because we wanted every 1000 footsteps to be worth 1 footstep point. When the footsteps have been divided, they get rounded up to an integer in order to avoid that the points is a float number.
This will also give the user a goal of going an extra 500 footsteps just to get the next point. The skills are as of writing this designed to work with 6000 footsteps to get the maximum effect. This was made because of how many footsteps the average person walks a day varies a lot from different sources that was looked into. One source were Withings released data [21] from a panel of its pedometer users in 2014 that showed the following results:

- United States: 5,815 footsteps
- France: 6,330 footsteps
- Germany: 6,337 footsteps
- United Kingdom: 6,322 footsteps

This showed us that most people only walk an average footsteps of 6000 a day and that is why we wanted our skills to make the most impact at this number during the prototype. But according to this Swedish "health guide" website [22], they recommend that it is best for our health to walk a minimum of 10 000 footsteps a day. If the numbers were to increase it would be more of a challenge for the user because he would have to walk more than what he normally do in order to get out the most from the skills.

V. Result

This Section will show our results from the questionnaire (Full questionnaire can be found in Appendix).

19 users participated in the tests used to evaluate the prototype. The conduction of the tests started with us briefly presenting the prototype and the general concept of it. Because of the absent of a tutorial explaining the basic concepts of the game, the conductor of the testing was the one preforming the explanation of the prototypes concepts to the user. The user was then able to play around and test out the game. The testing did not have any guidelines that the user was supposed to follow, instead the user were able to play the game with free hands. During the test the conductor observed and in order to assure that the important parts for instance the skills got tested, he hinted to the tester to test them out. When the user felt like he had enough of testing out the game, he was handed an questionnaire, see Appendix. The questionnaire was answered anonymously.

A. Results from our form

Question 1. Are you currently playing any context aware game?

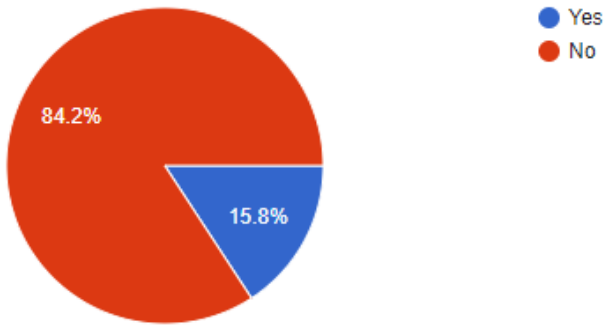

Fig. 4: The graph illustrates the fraction of respondents who play context aware games.

Question 2. Do you think you would play a mobile game that is using real-life data such as the users footsteps while doing your regular exercise or going out on your regular walk/run?

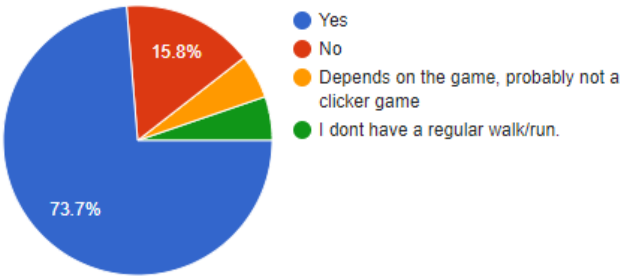

Fig. 5: From 19 responses we get to see if the testers think they would want to play a game with real-life data when active.

1) Likert scale results: Question 3. Did you like the game idea? (Clicker game using step data)

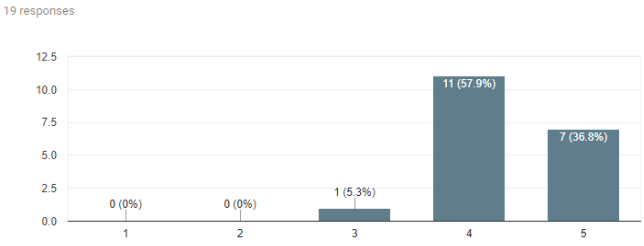

Fig. 6: The testers tells us if they like the idea of our game. (1 means they strongly disliked it, 5 means liked very much)

Question 4. Prior knowledge of clicker games?

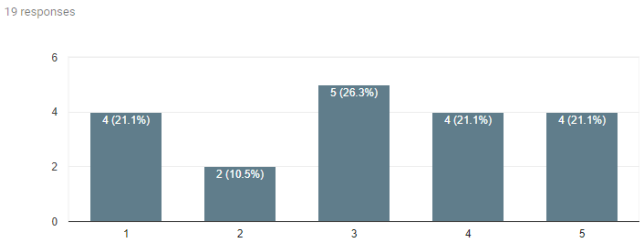

Fig. 7: Shows the prior knowledge the testers have regarding clicker games (1 means they had no previous knowledge, 5 means they had much previous knowledge).

2) Combined data for clearer visualization: Table 3: Answers from multiple questions displayed in a combined table Questions:

- Prior knowledge of Clicker games?
- Did you think that the game was difficult to understand?
- Did you feel like the footsteps had any effect on the game?

Prior knowledge (Larger number means better knowledge)	Difficult to understand (Larger number means easier to understand)	Footsteps effect on game (Larger number means greater effect of footsteps)	Total number of people
1	2, 2, 3, 3	3, 4, 4, 5	4
2	2, 3	2, 4	2
3	2, 4, 4, 5, 5	2, 3, 3, 3, 5	5
4	2, 3, 3, 5	2, 3, 3, 4	4
5	2, 2, 4, 5	2, 2, 4, 4	4

Considering the answers for the following question were either, yes, no or other. Some of the "other" answers did not really work that well with a diagram so the answers people entered to these questions were made into two new tables. These new representations of the data can be found in Table 3 and Table 4. The way these Tables are structured is like this: The first column in Table 3 is showing what the testers entered as their level of prior knowledge to clicker games. A higher number suggests that they believe themselves to have very good prior knowledge while a low number suggests that they are new or never heard of clicker games. In the next column we see what every person of the respective prior knowledge level answered. The third column is structured the same was as the second column, but instead is now an representation of how big the effect was of the footsteps and from what prior knowledge the answer came from. Last column shows total number of testers in each prior knowledge level.

Table 4: Correlation between the following questions. Questions:

- Do you think a mobile game that is using real-life data such as the users footsteps would be THE reason for you to walk/run/exercise?
- Estimated hours trained a week?

Hours/week	Total number of people	Yes	Maybe	No	Not THE reason but it would add to it
0 - 1	5	2	2	1	0
1 - 3	9	4	3	1	1
3 +	5	1	1	3	0

In Table 4, the data collected from the two questions: *Do you think a mobile game that is using real-life data such as the users footsteps would be THE reason for you to walk/run/exercise?* and *Estimated hours trained a week?* were combined to get an improved portrayal of the data gathered. The first column display the amount of hours per week the tester estimates they are active. Second column shows how many testers that were in each group. The last 4 columns display the answers from the first question with a number representing how many answered that specific answer.

The questionnaire contained a few more questions beyond the ones that is currently being presented in this section. We excluded these questions because they are similar to some that already is presented and the answers from them are similar too. The reason for the inclusion of those questions in our questionnaire were to examine if the two similar questions were answered differently, if they were it would of been interesting to analyse the reason/s behind it, but this were not the case. To see all of the questions, see Appendix.

The question below was a follow up question to another question regarding if the user felt like the footstep data had any effect on the game.

Question 7. If not, how could it be used in a better way?

These quotes provided some interesting ideas of how the footsteps could be used in a better way. Quote 1: "*Maybe use the footsteps as a requirement to unlock new mines, or have footsteps as an alternative currency source*"
Quote 2: "*You can for example use the footsteps as a currency to buy different items in the game. You can also have something to make every footstep count as a click which will make it more engaging to just go out and walk.*"
Quote 3: "*Maybe disable the miner feature that gives money over time and replace that with foot steps etc. In that way the game is less like a regular clicker and more like a special one.*"
Quote 4: "*Shown more that the game used it for its calculations, or displayed like a goal when you are close to unlocking next 'step point'.*"
Quote 5: "*It could be used in combination with quests.*"

VI. Discussion

A. The Prototype

We are pleased with the current prototype, but it is not perfect. In fact it is actually far from perfect, but the features and actual implementation of the footsteps has made us see the flaws and strength of using real-life data. And this was the goal of this prototype.

When the development of the prototype started, something that was important for us was to think ahead. Thinking ahead in this case means that the code that was written was made generic to some degree so that the code can be reused in the scripts even if it was decided to remake the whole user interface or some of the games core features. This is something that turned out good and thanks to that, future changes to the prototype could also be applied with ease.

One thing that did not turn out as expected was the current way of integrating the footsteps within the actual game. As of now the footsteps is integrated more as an extension of the game rather than being a part of the core functions of the gameplay. A better way of implementing the footsteps so that they serve a purpose to the actual gameplay could be using them as optional goals to reach in order to make progress. For example for a user to progress and be able to buy a new mine it would result in the user having to walk a certain amount of footsteps. It could be made as an optional feature so that the user could choose between paying extra ingame currency without having to walk or pay less currency and having to go for a walk to reach the goals amount of footsteps.

Another thing about the prototype that we see as a con is the importation of Unity in an Android Studio project. There was not enough resources to gather knowledge about how to implement Samsungs Health API straight into a Unity project, due to a lot of lost time early in the project. Therefore we went with the solution that were well documented and that we had gained some knowledge about, which were of how to make Samsung Health work along with an Android Studio project [23].

Some minor things that was found out during the first demonstration of the prototype was that some things was not as clear regarding the user interface. Some people did not realise that there were different mines or which one was currently active. So before starting out with our tests, some improvement was made on the feedback that was given which resulted in a more clearly presentation of which mine were currently activated, but the game is still a prototype that are in need of more bug fixes and improvement regarding things like the design, ease of use and gameplay.

The making and evaluation of the prototype had some pros, for instance it opened up for new ideas regarding the use of the footsteps and how they instead could be used in other ways to impact the gameplay more effectively.

Overall we are pretty pleased with the prototype although it is not flawless, because it has served its purpose to let the users show us the different ways of how the data could be used to improve a mobile game. And also various ways of how this data could be implemented to effect the game in different ways. These ways are being mentioned in the section below where a discussion of the gathered data takes place.

B. The Gathered Data

Data was gathered from 19 different testers and this is were the result of the information that were collected is being presented.

In Figure 4 from our results, it shows that the majority of our testers currently is not playing any game that uses context awareness nor real-life data. The few percent that is playing, are all playing the same game, Pokémon Go. A lot of the testers who answered that they were not playing right now, still said that they previously played Pokémon Go. Other than Pokémon Go, context aware games seemed really unusual for our testers suggesting that the marketing for this genre of games is not as large as other more common mobile genres. Even though the majority of our testers currently is not playing a game that use some kind of context or real-life data, it is clear that it is not because they do not like these types of games (See Figure 6). We believe that the reason for it is because the variation of game genres using context/real-life data is not broad enough. Figure 5 shows that these answers justifies what were just stated, because from out of our 19 testers, 16 of them answered that they would play a game like ours while they were out walking/running.

When the questionnaire were made, we thought that the answers would be able to be combined from different questions to find a pattern between them. The questions that were thought to have a pattern were included in Table 3. If you look at Table 3, the testers were divided into the different levels of knowledge regarding clicker games that they assumed they corresponded with. The only pattern that could be seen is that the people who claimed to have higher knowledge of clicker games they understood our game easier, because they were the only ones that gave that question a score of 5. Afterwards the testers were asked about what they thought regarding the footsteps affect of the game and more scores of 2 were given from the testers with higher knowledge while no one who had prior knowledge of 1 gave any score below 3.

Something that were not a surprise was the answers to this question: Do you think a mobile game that is using real-life data such as the users footsteps would be THE reason for you to walk/run/exercise?
When we correlated the answers with data about how active the testers were in Table 4, it showed that the more active testers would not have a game using step data as the reason to exercise, but several of the less active testers would. This is because the users that already are active most certain have a reason of their own to why they exercise, while users that do not exercise have not found their reason.

The testers liked the idea of having a real-world connection between the users footstep data and the game, but even though they liked it they also thought that it could be used in a better way. For example: A lot of the testers said that they would of liked the footsteps idea more if you had to reach a certain amount of steps in order to progress. Quests were also popular among the testers suggestions where you would need to reach different goals to get an reward. In other words they wanted a extrinsic rewards system in combination with the steps, which Ryan et al [24]. say is the most common reward system. Extrinsic reward system mean that the rewards that you get is simply numbers or cosmetic, you play because you want to get the highest score or highest amount of money.

That there is always a risk that the implementation of real-life data instead could lead to ruin the fun factor or the addictive part of a clicker game was mentioned earlier. Any conclusion on this matter could not be drawn based on the performed tests. A reason for this is because the test sessions did not last for a long enough period of time in order to observe and compare weather the addictive part or fun factor got affected. Another reason for this is that there never were any comparisons of the prototype with the implemented real-life data and a prototype without the data. A version of the prototype without the integration of the real-life data were never developed. This is because the possibility that many factors about or of the game would be affected by the implemented real-life data is large.

To answer the research question we observed and compared the gathered data and concluded that an implementation of real-life data or even context awareness within a game is something that would be appreciated by users and possible be improving a game, because the gathered data hinted towards it. However the testbase was petite and the overall results might have varied with a larger or different testbase. Another reason for this conclusion is because of the several ways the real-life data or context could be used to make a mobile game that belongs to a common genre/s more unique. In section 5.A there are some quotes regarding examples of how the data could be used in multiple ways. These ways could be used for other types of contexts and/or real-life data to improve a game considering that many of them were quite generic. For instance using the data within quests, achievements or even rewards could work for other context as well. For location based games it could mean if a user discovers a new location or it is the fifth time he visit the same one he would get some kind of reward or achievement. This is something that will need to be implemented and tested out in order to determine whether or not these examples are good and if they really would improve a game. There is also a chance that these examples would only improve a game within a particular genre. Several of the testers was fond of the idea of combining physical activity with a clicker game, however as of now the implementation do not affect the gameplay a lot. If the implementation was integrated more within some of the core features of the gameplay it might lead to an enriched effect and could give a relaxing game an enhanced purpose. That could also result in that more users would get motivated to become more active. As for now the gathered results still indicated towards users becoming a bit more motivated to be physical active, at least for a brief period of time.

C. The size of our test group

Even though the test group was kind of petite the amount of gathered data was enough to draw the conclusions. As Tullis and Albert stated, a larger test group is not necessary, while it might increase the level of confident, it is fully possible to have a satisfying test group with 20 to 30 testers. Despite that the results might have differed if we targeted a younger or older test group, considering that our testbase consisted mainly of testers within the ages of 20-30 years old.

VII. Conclusion

The prototyped gave us good feedback from the tests. However the implementation of the footsteps were not as good as first envisioned. As of now it is not embedded in the core concept, which could lead to other results or findings. A good thing that came from the tests on the prototype were the ideas from the testers. These ideas were ways of implementing the footsteps in a new way that could impact the gameplay for the better or worse. Overall the prototype served its purpose which was to spark ideas of how to improve the real-life data in the game.

Research question: “How can the data be used to improve a mobile game and what effects will an implementation of this data have on the game?”. The questionnaire helped gather multiple quotes that showed the users ideas of how to exploit the data within a game in various ways. Some of the ideas suggested using the data as a way to make progress in the game, while others proposed that the data could be used as rewards in order to improve the prototype and make it more unique. The results shows that users would of find the prototype more interesting if the data had been embedded within the gameplay instead of it being a extension. It was also made clear that the concept of a context aware game

was unfamiliar thing to the testers. Other than Pokémon GO, context aware games seemed really unusual for our testers which points to a low marketing for this genre of games. Something that our data did not show was if the fun factor or the addictiveness were affected. The reason for this was because our test sessions were not held under a long enough period of time for this data to be determined.

A. Future Work

We believe that there is more work that can be done in this area. From the data that were collected from 19 testers proved to be insightful and interesting. But more tests could be held to ensure that the results remained the same. The tests could also be held over a longer period of time, in order to observe if the addictiveness and the fun factor would be affected by the implementation of the real-life data. During the tests plenty of suggestions and ideas from the testers of how the prototype could be improved were collected. These ideas could be implemented and tested to see of the results were to change. If a prototype were built with a stronger connection between real-life data and the games core concept then that could result in new outcomes.

The implementation of the training data could also be stretched even further. Example of this is in our prototype, we limited the footsteps to 6000 steps, which is what a user walks in average a day. If the number were to be increased to challenge the user it could affect the fun factor or even the games lifespan.

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Appendices

First page of Questionnaire

Clicker Miners Questionnaire

Questions about you.

*Required

1. **Gender** *
   Tick all that apply.
   - [ ] Male
   - [ ] Female

Exercise

Some information about how active you are.

2. **How often do you exersice weekly?** *
   Mark only one oval.

	0	1	2	3	4	5	6	7
Days/week	◯	◯	◯	◯	◯	◯	◯	◯

3. **Estimated hours a week:**
   Tick all that apply.

	Less than 1	More than 1 less than 3	More than 3 less than 5	More than 5 less than 10	More than 10
Hours/week	☐	☐	☐	☐	☐

4. **What kind of exersice do you do?**
   Tick all that apply.
   - [ ] Gym
   - [ ] Running
   - [ ] Walking
   - [ ] Swimming
   - [ ] Cycling
   - [ ] Soccer
   - [ ] None
   - [ ] Other: _____

Mobile gaming

Some questions about what mobile games you like to play.

Questionnaire page 2

5. **Prior knowledge of Clicker games:**
Mark only one oval.

	1	2	3	4	5	
None	◯	◯	◯	◯	◯	Expert

6. **How much time do you think you spend playing mobile games every day?**

_____
Example: 8.30 a.m.

7. **What kind of games do you normally play on your phone?** *
Mark only one oval.

- ◯ Trivia
- ◯ Platform Runner
- ◯ Puzzle
- ◯ Adventure
- ◯ Action
- ◯ Arcade
- ◯ Card
- ◯ Board
- ◯ Casino
- ◯ Casual
- ◯ Education
- ◯ Racing
- ◯ Role Playing
- ◯ Sports
- ◯ Simulation
- ◯ Strategy
- ◯ Word
- ◯ Music
- ◯ None
- ◯ Other: _____

8. **Are you currently playing any context aware game?**
Mark only one oval.

- ◯ Yes
- ◯ No

9. **If yes what game/s and do you play it mainly because it is context aware?**

_____

_____

_____

_____

_____

Questionnaire page 3

The Game

10. **Did the game seem hard to understand from the beginning?**
Mark only one oval.

	1	2	3	4	5	
Very hard	◯	◯	◯	◯	◯	Very easy

11. **Did you like the game idea? (Clicker game with step data)**
Mark only one oval.

	1	2	3	4	5	
No	◯	◯	◯	◯	◯	Very much

12. **Did you feel like the foot steps had any effect on the game?**
Mark only one oval.

	1	2	3	4	5	
None	◯	◯	◯	◯	◯	Very much

13. **If not, how could it be used in a better way?**

14. **If not, how could it be used more efficiently?**

15. **Do you like the idea of context aware mobile games? Why/why not?**

16. **Would you like to see more mobile games where context awareness is being used, on the market?**
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____

Exercising while playing mobile games

17. **Do you think a context aware mobile game would be THE reason for you to walk/run/exercise?**
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____

18. **Do you think a mobile game that is using real-life data such as the users steps would be THE reason for you to walk/run/exercise?**
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____

19. **Do you think you would play a context aware game while doing your regular exercise or going out on your regular walk/run?**
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____

20. **Do you think you would play a mobile game that is using real-life data such as the users steps while doing your regular exercise or going out on your regular walk/run?**
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____

21. **Do you think mobile games that is using real-life data such as the users steps would motivate people to exercise more?**
Mark only one oval.

- ◯ Yes
- ◯ No
- ◯ Other: _____