Master Degree Project

UNIVERSITY
OF SKÖVDE

CAN FRIVOLOUS ELEMENTS INCREASE PLAYER RETENTION IN A SERIOUS GAME?

Abstract

The focus of this thesis is to examine if it is possible to increase player retention in a serious game simply by adding a number of game elements that do not aid in the games serious purpose. In order to study this two versions of a serious game called Frogsnap, one with these elements and one without, are examined. The results from this examination is that the game elements managed to increase the time participants interacted with the game, and how many levels they completed. But they did not increase the amount of data that the game collected, which means that they alone did not manage to make the game more efficient in completing its purpose.

Keywords: [Serious games, Retention, Motivation]

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1 Introduction

Digital games are rapidly becoming more and more common in just about every part of life. Usually most games are used only for the purpose of entertainment, but it is becoming increasingly common with games that serve other purposes (Susi et.al, 2007; Backlund et.al, 2010). These types of games are collectively known as Serious Games, and although they are traditionally used for either teaching, training, or changing a person's opinions or actions, there are ones used for entirely different reasons.

This study focuses on examining one such game: Frogsnap. Frogsnap was developed to replace a test used by researchers at the University in Skövde for an experiment with the goal of examining how early a humans intentions can be read based on their movements.

The main goal here however is not exactly exploring the game itself but rather if it is possible to get players to interact with the game for longer simply by adding game elements that do not aid the primary purpose of the serious game, such as additional challenges, enemies, and timers (Rollings & Adams, 2003; Schell, 2008). These kind of not necessary elements are in this study defined as frivolous element.

The research question in this study is therefore:

> "To what degree, if any, can frivolous game elements in a serious game be used to increase player motivation and retention".

This thesis begins with explaining the relevant background, including what a Serious Game is, Retention and Motivation, Gamification, Game elements, and exactly what constitutes a frivolous game element. After this there is a section that describes the Frogsnap game used in this study and the background that lead to its development. Following that there is a section that fully explains the problem this study seeks to solve, and the method chosen to help doing so. After that all the results gathered as a part of this study will be presented and discussed. And then the thesis ends with a summary of the conclusions resulting from the conducted study and a discussion regarding their validity and possibilities for further work within this field.

2 Background

This chapter will focus mainly on describing relevant concepts and terms for the study such as Retention and Motivation, Flow, Gamification, and Game elements. Before these things can be explored however it is important to discuss exactly what this study refers to when it uses the term Serious Game.

2.1 Serious Games

The term serious game is one that can be defined in a large number of ways, and in certain cases these definitions vary enough as to make them completely different. It can therefore be difficult to discuss the subject without first explaining exactly what is referred to when the term is used.

One of the more frequent definitions of serious games that can be found in relevant literature is a game (usually digital, but can be analog) that has a main purpose that is not simply entertainment (Susi et.al, 2007; Backlund et.al, 2010). This rather broad definition includes any game that is used for any purpose other than being entertaining, but usually when serious games are discussed the term focuses on games that aim to educate or persuade the players in one way or another. These subgenres of serious games are often called educational games and persuasive games, where educational games aim to teach the player about a subject and persuasive games aim to change the player's opinions or behaviors regarding a given topic (Michael & Chen, 2006; Bogost 2007).

Far more important for this study however is a type of serious game that does not get as much attention, the type developed with the goal of collecting data, so called scientific discovery games (Cooper et.al. 2010). This is a fairly unusual type of serious game but there are examples. Most notably of these is the game Foldit that was developed in order to use the gaming community to gather information about the structures of certain proteins (Cooper et.al. 2010).

2.2 Retention, Motivation, and Flow

2.2.1 Retention

Retention is a term describing a user's desire to continue interacting with an application or game after a certain amount of time (Harrison & Roberts, 2014). There has been a large amount of research done on the subject of player retention, but most of this research focus on long time retention over several months or years (Harrison & Roberts, 2014). Usually this research focus on massive-multiplayer online role-playing games (MMORPG) as these games are commonly subscription based and therefore require the player to be invested enough in the game to continue paying their subscription fee every month (Harrison & Roberts, 2013; 2014). This type of game is also designed to be played for long periods of time, upwards of several years, making them ideal for studying long time player retention.

There have been a number of studies conducted that try to determine what factors within the MMORPG genre contribute towards player retention and which ones lead to players quitting. Studies have been made on the effects of in game actions, demographic information, player motivation, and even whether or not a person's social network have an effect on a games retention rate (Harrison & Roberts, 2014).

Also within the area of social casual games have research been conducted to try and determine what factors play a part of increasing player retention. Some of these studies have shown that the most important aspect of creating retention is progression and not as is commonly believed social aspects. Other studies however have shown that the existence of a well-defined game community can have a noteworthy effect on retention (Harrison & Roberts, 2013; 2014).

After all this research there is still no common consensus as to what aspects of a game have the largest effect on its user retention and it is still a subject that needs to be studied further. One aspect of retention that has received very little attention is the subject of short term retention, and one that is even more unknown is how retention can be generated within serious games.

2.2.2 Motivation

Motivation can be defined as the desire to perform an action or task. An individual that feel compelled to act towards an end can be considered motivated, whereas an individual who feels no inspiration or desire to act is unmotivated (Ryan & Deci, 2000). Motivation however is not a two state phenomenon, different people may have a different amount of motivation to perform a certain action and there is also more than one type of motivation (Ryan & Deci, 2000). The most basic forms of motivation are: Intrinsic and Extrinsic.

- **Intrinsic motivation**
  Intrinsic motivation is defined as the experience an individual feels when they are performing a task or activity that the person in question finds satisfactory, rather than a activity only carried out in pursuit of a separate aim (Ryan & Deci, 2000).
- **Extrinsic motivation**
  Extrinsic motivation unlike intrinsic is not based on personal enjoyment in the task or activity carried out, but rather on the desire to receive a separate reward or to avoid punishment (Ryan & Deci, 2000).

This study will focus on intrinsic motivation, but it is still important to mention external motivation as it is not completely separate and may have an effect on the study's result.

2.2.3 Flow

Flow describes a concept that is not directly linked to motivation or retention, although it chares some similarities with both terms and is often seen as a way to generate them in an individual. The term flow refers to a state of focus on an activity where the person involved becomes so absorbed in the activity that they focus entirely on it and block out all other thoughts and impressions (Csikszentmihalyi, 1990). Flow emerges in a person when they are continuously faced with challenges that are matched very well with their abilities. If the challenge is too great for the persons abilities they may become anxious or frustrated, and if it is too far below the persons abilities then they may become bored (Csikszentmihalyi, 1990). For the experience of flow to be possible eight elements are required: The task at hand is possible to complete, it is possible to concentrate on the task, the goals are clear and obvious, feedback is immediate, the act is effortless in a way that allows the individual to perform it without difficulty, the experience is enjoyable and can be controlled, there is a lack of concern for the self, and lastly the individual loses track of time (Csikszentmihalyi, 1990). The fact that an individual experiencing a state of flow loses track of time is the main reason as to why flow is relevant to short term retention. A player that does not at all focus on time or how long a play session lasts and simply focuses on the game and the task at hand is theoretically more

likely to play for an extended period of time during a single session. As such attempting to introduce a state of flow in players engaging with a serious game designed to collect data over time can be seen as a good design choice when possible.

2.3 Gamification

Gamification is a concept that can be defined as the act of adding or using design concepts and elements usually characteristic for games in non-game contexts (Deterding et al. 2011). In other words gamification refers to making use of game design elements in applications or tasks that are not themselves games or are meant to serve as pure entertainment (Deterding et al. 2011). This is very closely connected to the term Serious Game (see section 2.1 Serious game) as both terms refer to using game characteristics to solve an problem not inherently related to games. Unlike serious games however, gamification does not necessarily mean that the finished application is a game, just that it uses game elements. This means that whereas a running application that rewards the user with a high score depending on how far they have managed to run does not qualify as a serious game, but can be seen as a gamification of a task (in this case running).

Usually a gamification solution is looked into in order to make a task more enjoyable for the individuals performing it in order to increase their intrinsic motivation and engagement (Deterding, 2011) which in turn can have positive effects regarding their performance. In order for this increase to be possible it is important that the gamification provides the user with three main elements:

- **Autonomy** which refers to the user's sense of will when performing a task. In order to increase user autonomy it is important to provide choices within the application, provide positive feedback on the users actions, and not control the instructions given to the user to tightly. This can lead to the user performing the tasks out of personal interest which in turn may lead to a higher sense of intrinsic motivation (Aparicio et al. 2012).
- **Competence** which refers to the users need to be faced with challenges to overcome in order to feel competent and efficient at the task. Giving the user opportunities to acquire new skills or learn something new, receive positive feedback, or be faced with challenges that are matched with their level of skill (see section 2.2.3 Flow) are all ways to increase the feeling of competition and competence and in turn increase intrinsic motivation (Aparicio et al. 2012).
- **Relation** which refers to the experience of feeling connected with other people through shared experiences or interests. Positive relations that create a sense of belonging and security can often act as a way to increase intrinsic motivation. Integration between social media and games is an interesting and potentially very potent way of generating more feelings of relation (Aparicio et al. 2012).

2.3.1 Game Elements

There is in truth no expansive list of game elements, nor is there a clear definition of what constitutes a game element and what does not. For the purpose of this study the definitions used will be taken from the works of Rollings and Adams (2003), and Jesse Schell (2008).

Rollings and Adams (2003) uses different game element categories depending on the different game genres. They do however still identify three game elements that are relevant for most games, these are: Rules/Challenges, User interface, and Interaction model.

- **Rules/Challenges**
  Rules and challenges are defined by Rollings and adams (2003) as the players goal within the game, and the ways by which they may achieve that goal. The challenges within a game is usually what makes them interesting to play and can take a wide variety of forms such as logical puzzles, reaction based challenges, or time trials (Rollings & Adams, 2003). The rules as mentioned define how the player may reach their goals and what they can do within the game world (Rollings & Adams, 2003). For example the rules may dictate what options the player have for moving in the game, or if they are capable of fighting threats or have to use stealth.

- **User interface**
  The user interface is defined as the way information is presented to the player and includes elements such as menus within the game, status indicators such as health bars or maps, and text boxes to mention a few (Rollings & Adams, 2003).

- **Interaction model**
  The interaction model includes the input device, the control scheme, and the games perspective. The input device is the device the player uses to control the game, this could be a keyboard and mouse, a gamepad, or something less common as a lightgun or dancemat (Rollings & Adams, 2003). The controlscheme defines how the chosen input device is used and what button or controls is used to perform actions within the game (Rollings & Adams, 2003). Lastly the perspective is the position from wich the player views and interacts with the game world. For example the player may take control over there avatar and view the world through their eyes, or see the entire world from above and control their avatar from the outside (Rollings & Adams, 2003).

Schell (2008) divides the most relevant elements of games into four categories: Mechanics, Story, Aesthetics, and Technology.

- **Mechanics**
  Mechanics as defined by Schell (2008) are very similar to Rules and Challenges but are far more general and can also include things such as the user interface and input method and perspective.

- **Story**
  The story is simply defined as the chain of events that take place throughout the game (Schell, 2008). This can include both stories created by development team for the game, but also stories that are mainly user generated.

- **Aesthetics**
  Aesthetics are according to Schell (2008) the main connection between the players and the game and include everything from how the game looks to the sounds and music within the game. It is important for a game to have a fairly consistent aesthetic throughout as to much mixing of different looks and sounds can make the game feel disjointed and not part of a whole experience.

- **Technology**
  Technology refers to what is necessary to play the game, this can be the pieces needed for a board game or more advanced technology such as computers, Virtual reality gear, or gamepads (Rollings & Adams, 2003).

As stated earlier this is by no means a complete list of game elements, but it is a starting point that makes it easier to discuss the concept more in depth and examine its relation to serious games and gamification solutions. As described in section 2.1 a serious game is any game that is used for a purpose other than simply entertainment. By this definition a serious game still needs to be a game, and can therefore be expected to feature most of or all of the game elements described above. A gamified application on the other hand is defined as an application that utilizes game elements (see section 2.3 Gamification). This means that the application is not a game and therefore does not necessarily feature more than a few game elements. Which elements are used can vary greatly between applications, some may choose to implement stories or technology intended for games, whereas others may instead choose to focus on adding game mechanics.

2.3.2 Frivolous Elements

In order to make the goal of this study clear one must discuss exactly what the term "frivolous elements" mean. The term was created for this study and therefore does not have any previous definitions, but is proposed here to mean: Any game element in a serious game that does not directly affect or contribute to the games explicit purpose. That is to say anything that has been added to a serious game that is not needed in order for the game to be used for its intended non entertainment purpose.

Adding frivolous elements into a serious game can in some ways be seen as, and is quite similar to, the process of gamification. The goal in both situations is to add and make use of game design aspects and game elements to make an otherwise potentially uninteresting task more enjoyable in order to make the user more motivated to finish the activity. The difference however is that gamification is based upon introducing game elements into non-game contexts, whereas frivolous elements by the proposed definition can only be added to serious games which are full-fledge games and already feature game elements on their own.

The process of gamifying a game may seem very strange, but due to the needs of some serious games it may be somewhat necessary. In some situations where a serious game solution is considered the requirements may prove it difficult to design a game that is enjoyable and engaging to play and still manages to perform its intended purpose. In these situations it might therefore be necessary to add game elements that do not aid the serious purpose, and perhaps even make the serious aspects of the game less efficient, in order to get users to willingly interact with it.

The problem that frivolous elements are intended to be used to counter is one that is somewhat unique to data gathering serious games and scientific discovery games, that is to say the problem of getting each participant to play for a long time, regardless of whether or not they necessarily like the game very much, in order to gather large amounts of data. Although there are similar phenomenon found in some commercial games, mainly mini games, Easter eggs, and achievements that do not directly tie into the games intended gameplay. Mini games are found in some commercial games and usually consist of a small extra game that does not have anything to do with the main game (Frazer et.al. 2007). These additions do not usually serve any real purpose within the main game and only exist as a way for the players to waste some time. Similarly achievements (small rewards given to players for completing some often menial task) and Easter eggs (hidden bits of content that usually does not affect gameplay) are rarely necessary for a game to function and does not affect the game to any large degree but only exist as a way to get players to interact with the game for a slightly longer period of time (Weinel, Griffiths, & Cunningham, 2014).

3 Frogsnap

This section will focus on the game Frogsnap that in many ways lays at the heart of this study. In short Frogsnap is a serious game developed to replace an earlier experiment designed to study if an individual's intention can be predicted based on the earliest part of an action. In order to answer this the earlier experiment examined a specific movement, that involved the participant moving their hand straight forward and then either to the right or the left, to see if there were any differences in the early parts of this movement based on whether the participant was going to move to the right or the left at the movements end. This movement is replicated as a main mechanic in the Frogsnap game and gathering data on this particular movement is the games serious purpose.

In the following sections each part of the Frogsnap game and its development will be described in more detail, starting with a description of the concept of Intention as that is what the game was developed to examine. Following that will be a description of the earlier experiment that the game was developed to replace, and finally after that there will be a detailed description of the Frogsnap game itself.

3.1 Frogsnap background

This section introduces and briefly describes the earlier research and results that have led to the development of Frogsnap and this study. It also brings up terms and concepts that are very relevant to that research and have had an impact on this study, but are not fully relevant to the work described in this study nor a main focus. For there to be an understanding of why and how this study have been conducted this earlier research and concepts must be explored.

3.1.1 Intention

Intention can be described as a plan of action an agent chooses and commits itself to in order to achieve a goal. An intention therefore includes both the goal itself and the means of achieving it (Vernon et.al, 2016). That is to say an intention is composed of both what a person is planning on doing, and how they plan to do it. An intention is fully formed in a person's mind before they begin the actual action, therefore it is possible to predict an individual's behavior by determining their intention (Scutti et.al, 2015). This ability to read another person's intention is something that humans are capable of doing quite naturally and is a key part of human social interaction (Vernon et.al, 2016; Scutti et.al, 2015). Robots and computers however still lack many of the cognitive features that allow humans to make these predictions and are therefore not as efficient when it comes to determining what action another agent is about to perform (Vernon et.al, 2016; Scutti et.al, 2015).

Traditionally, research done regarding this subject have been conducted within the fields of psychology and neuroscience, but as technology has advanced it has become increasingly common that intention is studied within the fields of computer vision, robotics, and human-robot interaction (Scutti et al, 2015). Research conducted within these fields have revealed that intention can be inferred from body motions, without any other feedback. This is possible due to the fact that humans exhibit different kinematic patterns (differences in movement speed, velocity, acceleration, etc) depending on their intention (Ansuini et al., 2006, 2008; Sartori et al., 2011). For example the way a person grasp a bottle varies slightly depending on whether or not that same persons intention is to pour from the bottle, throw it, or pass it on to another person (Ansuini et.al, 2008). Studies have also show that it is possible to determine

an individual's intention early on by observing the first part of the agent's movement (Stapel et.al, 2012).

3.1.2 Earlier Experiment

Although a great deal of research have been conducted regarding how intention can be determined by observing the early parts of a movement, there is still a fair amount of uncertainty regarding exactly how soon a prediction can be made and to what degree. In order to begin answering these questions Alberto Montebelli and Martin Tykal (2017) conducted an experiment with the research question:

> After the onset of the plan of action leading to the goal, how early will its associated intention be fully revealed?"

In order to answer this question Montebelli and Tykal (2017) asked 16 participants to perform a simple task 10 times while using a robotic arm that recorded their movements (see figure 1). This task was to reject a cup of horrible coffee by moving it either to the left or to the right.
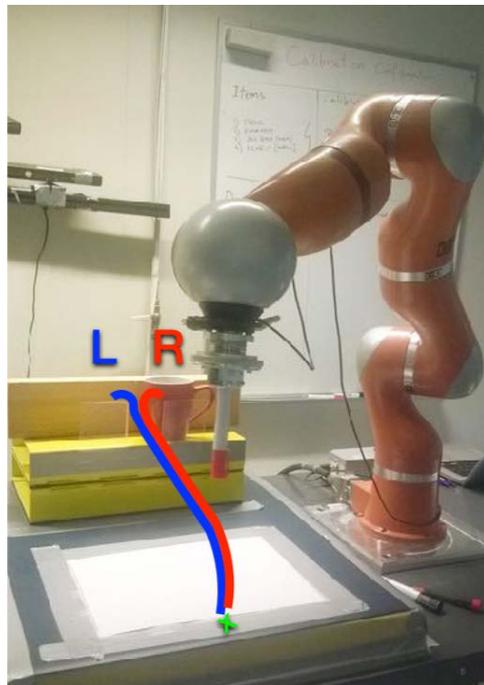
Figure 1   Robotic arm

In the experiment the cup was accessible through a narrow opening in the panel placed between it and the participant (see figure 2). The setup was designed in such a way that the cup could only be moved in one direction depending on which side of the opening it was placed. This ensured that the participants could only have one viable intention at the start of the movement and therefore would not make any changes to it during the actual movement itself. The side the cup was placed on was decided by a random sequence for each participants 10 repetitions.
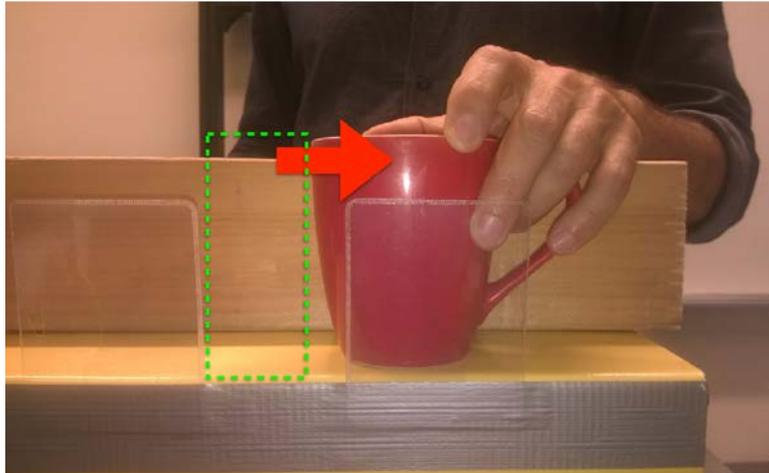
Figure 2   Rejection of coffee to the right.

During the experiment the participants were asked to use their non-dominant hand, and extra care was taken to avoid the installation of conflicting behavioral biases. This was in particular the reason for there being a backstory for the experiment involving coffee as the instruction to energetically reject a bad cup of coffee is far more natural than instructing the participants to reach for the window and then push the object behind it (Montebelli & Tykal, 2017).

In order to gather as much data as possible during the experiment the robotic arm that was used collected not only accurate pose measurements, but also how much force/torque being applied by the participant (Montebelli & Tykal, 2017). During the experiment the robotic arm was also kept in a gravity compensating state which allowed it to smoothly ant effortlessly follow the participant's movement. Due to all participants having taken part in an earlier experiment they were all familiar with the robot and had no issues using it.

Figure 3   Recorded movement.

The preliminary results gathered from the experiment show that a generalized simple criterion for early differentiation of the two actions that is valid across the entire population could not be extracted (Montebelli & Tykal, 2017). Individual patterns however quickly became clear in several participants (Montebelli & Tykal, 2017).

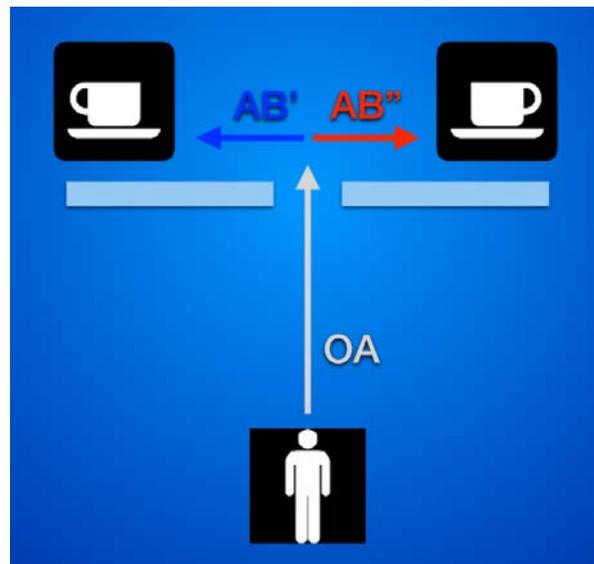Despite the fairly promising results gained from the experiment it was found to have some major flaws. The experiment itself was found to be quite boring by most of the participants and few of them would be willing to repeat it a larger number of times. It was also rather cumbersome to setup and perform which made collecting data time consuming. These issues made the experiment unsuited for a larger study where a far larger amount of data would have to be collected. In order to address these issues a decision was made to try and develop a game that could substitute the experiment as a data gathering tool.

3.2 Frogsnap

Frogsnap is the name of the serious game developed during the spring of 2017 with the goal of continuing the earlier experiment conducted by Montebelli and Tykal (2017). Seeing as the game was developed as a replacement for the earlier experiment described the two share many similarities, but are also different in a number of ways.

As mentioned in section 3.1.2 the main issues that the earlier experiment ran into was that it was not very enjoyable nor particularly easy to set up. These where the main issues that Frogsnap sought to solve, while still being able to collect the necessary data required to answer the original experiments research question. This need to both be scientifically accurate and enjoyable to play posed a serious design problem, as it limited the number of options that where available regarding input types and mechanics, and also meant that the game had to include a very specific hand movement (see figure 3) as a player input. In order to get around this issue it was decided to split the game into two different parts or level types:

- **Data gathering levels**
  Data gathering levels (see figure 4) are the levels in the game that are used to collect the data required for the study the game was designed for. This means that they are the only truly important part of the Frogsnap game as they are the only parts that work towards achieving the games purpose. By necessity this unfortunately means that they are not particularly interesting from a gameplay perspective as they cannot have any variation other than the location of the fly (left or right side).

Figure 4   Data gathering level

- **Entertainment levels**
  Entertainment levels (see figure 5) unlike the data gathering levels do not gather any

information from the player's movements. This allow there to be far more variation in their level design and content.

Figure 5 Example of an entertainment level

Dividing the content in Frogsnap into two level types was one of the only possible ways to make the game entertaining while still ensuring that it was capable of collecting the relevant data. But this decision also had some drawbacks. Mainly the fact that for the game to be able to collect any substantial amount of data there would have to be a fairly large number of data gathering levels in the game, and these would need to be placed between entertainment levels. This may make it quite difficult or players to enter a state of flow (see section 2.2.3 Flow) as the data gathering levels never increase in difficulty. This means that between entertainment levels that scale in difficulty and become harder to complete as the player becomes more skilled there are very simple levels that will not provide any type of challenge and can be completed by a player with only a small amount of skill. It is possible that the continued interruption of data gathering levels may prove frustrating for some players as they do not provide any additional challenge, and this frustration may end up making them quit playing.

In order for the game to be able to collect the necessary data it was decided that it would be developed to be used on a touchscreen device.

The following sections will examine the Frogsnap game from the perspective of the different types of game elements described in section 2.3.1 and then finish with a discussion regarding frivolous game elements (see section 2.3.2 Frivolous Elements) in Frogsnap.

3.2.1 Mechanics and Rules and Challenges

The mechanics in Frogsnap are intentionally very simple as the goal is for the game to be as accessible to an as large as possible user base that can vary greatly in previous game experiences and skill. The main mechanic in the game is simply to use the frog's tongue to catch flies. This is done by the player dragging their finger from the frog to the fly and avoiding any obstacle in the way, such as straw barriers or red flies. Once the player catches the fly the level is completed and the an option shows up that allows the player to either replay the level, move on to the next level, or quit the game and go back to the games start screen.

These are the base mechanics in the game, there are other mechanics implemented as well but they are not needed for the game to fulfill its purpose and are therefore considered frivolous and covered in section 3.2.5 Frivolous Elements in Frogsnap.

As described in section 2.3.1 Game Elements a games challenges is what makes a game interesting to play (Rollings & Adams, 2003). The main challenge in Frogsnap takes the form of a maze, the player's goal is simply to navigate the maze and reach the goal fly at the end. As a simple additional challenge in the game the goal fly does not necessarily spawn at the same location every time a certain level is played. The rules of the game, that is to say the means by which the player may complete the challenges (Rollings & Adams, 2003) are quite simple. The player must keep their finger on the screen and move it through the maze, if they remove their finger from the screen the frogs tongue resets and they must redo the entire maze from the start. If the frog's tongue touch a straw barrier or a hostile fly the player fails and must restart the level.

3.2.2 Technology, Interaction Model, and User interface

As described in section 2.3.1 Game Elements technology and interaction model refers to what equipment is needed to play a game and how that equipment is used (Rollings & Adams, 2003; Schell, 2008). As the purpose of the game was to collect data on hand movements it was necessary for the game to use some kind of technology that allowed the game to be played using this movement. In the beginning of the games development several different possibilities were considered such as using VR gear or motion sensitive gloves, but due to time and financial restrictions these ideas were quickly discarded. Instead the choice was made to develop the game to be played on a touchscreen device. In the beginning smartpads were considered, but due to worries that the screens would not be large enough for the intended hand movement to be possible to execute a larger touchscreen based computer was used instead.

A games user interface can be described as how information about the game is given to the player (Rollings & Adams, 2003; Schell, 2008). The user interface in Frogsnap is a very simple one consisting mainly of menus that can be used to navigate the game and text boxes in the tutorial levels that give the player information on how to play the game. Outside of this there are only a few graphical user interface elements such as simple animations during the tutorial levels and a timer bar later in the game that shows the player how much time they have to complete the level. The user interface was intentionally kept very simple so that there would not be any confusing elements in the game that could confuse the player or make it harder than necessary to navigate the game.

3.2.3 Story

Story as a game element can be summarized as the chain of events that take place during a playthrough of a game, this includes both the events designed by the developers and the ones that are created by the players (Schell, 2008). In Frogsnap there is no developer designed story, and there are a number of reasons for this. Firstly there is the fact that the game was developed by a small team during a relatively short amount of time which made implementing a story somewhat difficult. It was also always seen as a very low priority due to how the finished game was intended to be used. In its current state Frogsnap is intended to only be used in controlled or semi controlled environments where the users interact with the game for a single session. As such adding a story into the game was seen as something that could potentially be problematic due to the fact that it would take time away from the user actually playing the game and thereby hindering the game from collecting any data. It was also considered that there might be a possibility that a user that did not enjoy the story would quit playing even if the found the games mechanics entertaining. So after weighting the potential benefits of adding a story into the game against the drawbacks the decision was

made to not add any structured story into the game and instead only add a context that could be easily interpreted by the player, which in this case means making the player avatar a frog and the goal flies (frogs eat flies).

3.2.4 Aesthetics

Aesthetics as described in section 2.3.1 Game Elements refer to how a game looks, sounds, and in a way feels (Schell, 2008). This can vary greatly from game to game and some games can try to mix different kinds of aesthetics in order to create a more unique experience. Due to Frogsnap's intended use as a data gathering tool however several restrictions existed regarding the games aesthetics. Firstly due to the fact that there was a possibility that music and sound could affect the users and thereby the data collected from them the decision was made to not have any sound whatsoever in the game. Similarly it was of great importance that the data gathering levels were completely symmetrical. This meant that there could be no changes in the graphical aspects that did was not applied to both sides of the level. It also meant that animations were kept to a minimum in the game and that the water background had to be changed to a static single color.

3.2.5 Frivolous Elements in Frogsnap

There are a number of frivolous elements implemented in the Frogsnap game. All of these exist exclusively in the entertainment levels, which are themselves considered a frivolous addition to the game, and serve no other purpose outside of making the game more entertaining to play.

The full list of frivolous elements in Frogsnap is as following:

- Unique entertainment levels (see section 3.2 Frogsnap) between every data gathering level.
- Bonus flies that function as a secondary goal for players. These bonus flies were added as a way to increase player autonomy and need for competence (see section 2.3 Gamification). As the player is not required to collect the bonus flies in order to advance to the next level within the game they serve as a additional challenge for more competent players that desire additional challenges. The fact that they are not necessary also means that the players themselves must decide whether or not they wish to collect them and may choose to not do so if they please.

Figure 6 Bonus fly.

- A ranking system that gives the player a rank of 1-3 on every entertainment level based on how many of the bonus flies they gathered. The ranking system was added as a way to give players that choose to interact with the secondary goal of collecting bonus flies feedback on how well they were performing within the game, as is suggested by Aparicio et al. (2012). The ranking system was also intended to act as a relation element (see section 2.3 Gamification) were players could see how well they had performed during their play session and save the results to social media. However due to time restraints this feature was unfortunately not implemented.

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Figure 7 Ranking system in Frogsnap.

- Hostile flies that function as an obstacle. The hostile flies were added into the game simply as a means to add some additional challenge and do not serve any other purpose.

Figure 8 Hostile fly.

- A timer that function as an additional level of difficulty in later stages by inducing a fail state when reaching 0. The timer was added into the game as a way to increase the challenge, but also to increase the players autonomy and need for competence (see section 2.3 Gamification) as it in combination with the bonus flies forces the player to choose whether or not they feel competent enough to engage in the secondary goal of collecting all the bonus flies or if they rather just complete the main goal of reaching the goal fly in time.

Figure 9 Timer.

- And lastly additional tutorial levels introducing every new mechanic. Although these are not necessarily frivolous elements themselves they serve no other purpose outside of introducing the other elements presented in this list.

As mentioned in section 2.3.2 Frivolous Elements all these additions are not in any way necessary for the Frogsnap game to function nor serve its intended purpose. All they do is add an additional gameplay layer. The cost of this layer however is that the game becomes somewhat less efficient. If a player completes 20 levels in the Frogsnap game without the frivolous elements then they will have completed 19 data gathering levels, whereas if they complete the same amount of levels with the elements implemented they will only have completed 9. Due to the frivolous elements requiring their own tutorial levels the total amount of data gathering levels completed by a player will be reduced by 3 if they complete the game

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as the data from these levels cannot be used. This means that for the frivolous elements to be considered a worthwhile investment they will need to greatly increase the amount of time each player spends playing the game.

4 Problem

As mentioned, a large amount of research have been conducted within the field of game studies with the goal of enhancing the effectiveness of serious games (Frazer et.al. 2007; Tashiro, 2009; Bellotti et.al. 2010). Effectiveness in this case refers to how capable a serious game is in achieving its intended serious purpose (Bellotti et.al, 2010). As various serious games have been developed with different goals there is no universal measurement regarding what constitutes an effective game. If the game is a learning game (see section 2.1 serious games) then it can be considered effective if it manages to teach its players about the subject it was developed to teach (Frazer et.al. 2007; Tashiro, 2009) and if it is a persuasive game (see section 2.1 serious games) it can be considered effective if it manages to change the opinions and actions of the players in regards to the subject that the game was intended to educate individuals on (Bellotti et.al. 2010). When looking at scientific discovery games (see section 2.1 Serious Games), which lay at the heart of this study, effectiveness refers to how much useful data the game is capable of collecting about the subject it was designed to study (Cooper et.al. 2010). In the case of Frogsnap the game can be considered effective if it is capable of gathering more data regarding participants intentions (see section 3.1.1 Intention) than the earlier experiment that the game was developed to replace could gather (see section 3.1.2 Earlier experiment). Another important aspect of effective serious games is cost, both concerning money and time. Even if a serious game or gamification solution can be used to achieve a certain goal, it cannot be seen as effective if the cost of doing so is greater than it would be if conventional methods were used. The vast majority of research on how serious games can be made more effective however has focused on teaching, training, or persuasive games often with the assumption that the results can be applied to most other types of serious games. This however is not always the case, and this unspoken assumption has in turn led to there being a very small amount of documented research regarding how to maximize effectiveness in scientific discovery games or other serious games that do not have the goal of teaching the player anything nor affecting their perspective on a given subject.

The goal of this study is therefore to attempt to increase the knowledge regarding best design practices for serious games when it comes to maximizing their effectiveness in regards to data gathering. In order to accomplish this the study will aim to answer the question:

> "To what degree, if any, can frivolous game elements in a serious game be used to increase player motivation and retention".

It is important to mention that whereas this study will mainly focus on player motivation and retention, it will also look into how much useful data is gathered from the experiment as a serious game that does not perform its primary function is inherently useless. This also means that even if the frivolous elements added to the game does increase player enjoyment of the game, and how long they play they cannot be seen as a successful addition if they decrease the amount of data collected.

4.1 Aim

The aim of this study is to examine what impact the addition of frivolous game elements in a serious game can have on the length of time a player chooses to interact with the game in a single session, and also on their willingness to play the game again in the future. A secondary aim of this study is to also evaluate the serious game Frogsnap's usability in gathering the data

it was designed to collect. The reason for this secondary goal is twofold, firstly it is necessary to ensure that the game serves its purpose as a serious game before the study can claim to examine how retention can be increased in one. Secondly the Frogsnap game is still under development and is still intended to be used in the larger study that it was developed for, and as such needs to be evaluated.

4.2 Method

4.2.1 Prototypes and hardware

For this study two versions of the Frogsnap game was produced and used in order to study what effect the addition of frivolous game elements have on retention and motivation in a serious game. The reason two versions of the game was used in the study is to enable a comparison between a version with frivolous game elements and one that lacked all such elements in order to examine if there was any difference in the length of time the participants interacted with each version, and how much they enjoyed doing so.

Both versions of the game functioned in the way described in section 3.2 Frogsnap and featured the exact same mechanics. The only differences between them is the amount of frivolous game elements included.

- **Base version:**
  The base version of the game does not feature any frivolous elements whatsoever. This means that it, outside of menus and a single tutorial level, only consist of a large number of identical data gathering levels (see section 3.2 Frogsnap). This version of the game is used to gain a base measure of how long a participant is willing to repeat the data gathering movement before they grow bored of it.
- **Experimental version:**
  The experimental version, unlike the base version, feature a number of frivolous elements. This version of the game is used in order to gather data on how long the players choose to interact with the game with the addition of the frivolous elements. This data can then be compared with the data from the base version in order to answer the study's research question.

The hardware that was used to play the two versions of the game during the experiment was the same and consisted of a Lenova touchscreen computer. This is the same computer that was used during the main development phase of Frogsnap, and also the platform it was designed for. The game itself was developed with the Godot engine, using the engines built-in proprietary coding language. Outside of this additional hardware also included: a video camera, two SD cards (16 and 32 GB respectively), a USB stick (8 GB) for transferring data, and a laptop.

4.2.2 Participants

As the finished game is intended to be used on a very broad user base it is important that it can be played by individuals of different ages. Due to this there were no specific requirements on the participants themselves. Despite of this however some efforts were made to recruit individuals with varied amounts of previous experience with digital games and from different age groups. Some effort was also made to recruit individuals who were not Swedish natives in order to ensure that the game could work on a more international level. A majority of the participants in the study were however still Swedish native speakers and as such their test

were conducted in Swedish. A few of the participants however required the test to be performed in English.

In order to recruit participants for the study two methods were used. One method of recruitment was to make posts in relevant student and University of Skövde social media groups. The other method, that was used to recruit the majority of the participants, was direct recruitment. This method consisted of asking individuals in the area the tests were taking place in if they were willing to partake in the experiment. Due to the location the test was in the same building where many of the school's information technology faculty have their offices many of the participants were recruited from this group.

It is well worth noting that even though some efforts were made to gather a somewhat diverse test group in terms of gender, age, and nationality it was not a major focus in the study. These efforts were also only added onto the existing pool of possible participants available at the University of Skövde. The reason that convenience sampling (Patton, 2015) was used in the study was mainly due to time restraints and due to the fact that the Frogsnap game requires a special kind of computer to be played that cannot be easily moved without risking damaging the computer. As such the choice was made to focus recruitment only on the most readily available pool of possible recruits (students and faculty at the university) and try to find a diverse test group within that pool.

4.2.3 Procedure

The test carried out as part of this study were performed individually and all of them were carried out in the same office at the University in Skövde (see figure 10). The participants were divided in to two groups, one for each game version described in section 4.2.1 Prototype and Hardware. Every other participant was put in the experimental group to ensure that there would be the same amount of people in each group. In order to avoid any external motivation (see section 2.2.2 Motivation) that could affect the result, no reward or other type of compensation was offered to any of the participants.

Figure 10 test room

At the beginning of each test the participant was given a short description of what the test would entail. They were informed that they would be playing a simple game and would be recorded while they played, and that there would be a short interview after the play session.

Each participant was informed that they would need to sign a consent form after the test, and that if they regretted their participation after having performed the test they did not need to sign the form and all data collected from them would be deleted. Due to what was being explored in the study, the participants could not be given any more information before the test in order to avoid introducing any biases. Following this introduction to the test the participant was given some instructions on how to play the game (where to stand and how to interact with the game). They were also asked to complete at least five levels within the game, after which they could stop playing at any time. The reason that the participants were not asked to complete a larger number of levels or given any clearer instructions on how exactly to play the game was to introduce a greater sense of autonomy in the participants (see section 2.3 Gamification). If the participants were instructed on exactly how to play the game correctly and then asked to simply complete a large number of levels the test would simply have examined their willingness to follow instructions and not whether or not the addition of frivolous elements affected their retention or motivation to continue playing the game. After this, assuming the participant had no questions, the camera was set to record and the participant was left alone in the office with the game. Once the participant decided that they were done playing they opened the door to the office and the camera was turned off.

Following the play session was a short semi structured interview (Patton, 2015) that focused on gathering data regarding how the participant experienced the game and the test (see section 4.3 Gathered data for more information). After the interview there was a debriefing session where the participant was fully informed about the purpose of the study, what data was collected, and how this data would be used. They were then given a chance to ask any questions they might have and only after this where they asked to sign the consent form that acknowledge that they had willingly and knowingly participated in the study and allowed their data to be used.

4.3 Gathered Data

The data collected from each of the participants during the tests described above consisted of:

- The total time the participant spent playing the game.
- The total number of levels completed during this time.
- The number of completed data gathering levels, and how many of these that could be considered useful in gathering the desired movement data.
- And lastly how much the participant enjoyed playing the game, and whether or not they would be willing to play it again.

The method chosen to gather this data consisted of a combination of observations, semi structured interviews, and the game itself. In order to ascertain whether or not the collected data showed statistically significant differences between the two test groups an unpaired two-tailed t-test was performed on each individual data category.

In the following sessions how each data gathering part of the chosen method was used and what kind of data it focused on obtaining will be described.

4.3.1 Game gathered Data

As the Frogsnap game was created in order to gather data it is only logical to actually use that data in this study. The game gives each new player their own user ID which makes it very easy to know which participant the data belongs to. The data recorded by the game is:

- How many levels each participant completes.
- How many attempts they made during these levels (failed and successful).
- Each individual interaction the player makes (hand movements).

Once this data is processed it is also possible to use it to ascertain how many data gathering levels the participant completed. This type of data is also very important as it is the type of data the game was created to collect which makes it possible to examine whether or not the Frogsnap game can be used for its intended purpose.

4.3.2 Observations

In order to make sure that the data collected from the game was valid, and to also gather additional data regarding how the participants interacted with the game, observations were used. Observations are quite common in game related research as it makes it possible to see exactly what occurs during the experiments and find potential failure points and gather additional data that were not necessarily intended (Patton, 2015). The method also avoids a common problem with interviews and questionnaires which is that information may be lost or corrupted due to the informant misunderstanding the question or changing their answers to better fit what they believe is the desired results. Since observations only document exactly what happens during the experiment and is not affected by any misunderstandings (Patton, 2015; Unger & Chandler, 2012).

In order to maximize the amount of data collected all test sessions were recorded, and these recordings were then observed and analyzed. In order to not affect the participants or introducing any biases the author was not present in the test room during the experiments which made direct observations impossible, so the video recordings are the only available observation data.

4.3.3 Interviews

Quite late into the study the decision was made to add a short interview session to the end of every test. This interview was semi-structured (Patton, 2015) where the participants were asked a number of questions and if an answer was worth investigating deeper follow-up questions were asked. The purpose of the interviews was mainly to gather additional data regarding how the participants experienced the game, particularly how much they enjoyed it and whether or not they would be willing to play again. As the interview part of the study was added quite late it was not researched enough or performed as well as it could have been which meant that it did not collect as much data as could have been hoped for. But seeing as it was never data necessary to answer the study's research question this was not seen as a major problem.

4.4 Ethical Considerations

As this study involves people there are some ethical issues that must be taken into consideration. First and foremost due to the study involving human test subjects it was very important that all of them were treated in a respectful and professional manner. Outside of

this the Swedish Research Council (Vetenskapsrådet) have several guidelines for conducting tests with human participants.

The council recommends that each participant should be informed of the purpose of the study they are asked to be a part of before any test takes place. This is to ensure that the participant can make an educated decision as to whether or not they wish to take part in the study (Vetenskapsrådet, 1990). Unfortunately it was not completely possible to follow this recommendation is this study as the goals of the study required that the participants did not know what was being tested as to not introduce any intentional or unintentional biases. The participants were however briefed on what the test would entail and given a short rundown of the test before they agreed to participate. They were also given a full debriefing regarding the study's goals after the test was concluded and before they were asked to sign anything regarding their participation. This leads into the councils second recommendation, that all participants should be informed before the test that their participation is completely voluntary and that they can choose to stop the test at any time or withdraw their consent (Vetenskapsrådet, 1990). This recommendation was embraced fully in this study and each participant was informed before any test and also given a number of opportunities to stop the test, they were also given contact information by which they could withdraw their consent after the test should they change their mind about their participation at a later date. Thirdly the council states that extra care should be taken that all participants personal information should be handled in such a way that no unauthorized individuals can get access to it, and that everyone partaking in the study should remain anonymous unless anything else has been agreed upon (Vetenskapsrådet, 1990; Lankoski and Björk, 2015). In order to ensure this no personal information was stored in such a way that it could be connected with an individual, and all data was kept under constant supervision and was never handled in such a way that it could be accessed by anyone without consent. Lastly the data gathered from the tests are only allowed to be used in the study that the participants agreed to take part in and should never be used in any other work without the participant's direct consent (Vetenskapsrådet, 1990).

Also because a video camera was used to record all test sessions it was necessary to inform all participants that they would be recorded and have them sign a consent form (see appendix A) after the test was concluded. Aside from these considerations there were not really anything else worth mentioning as the game itself did not include any elements that could be seen as problematic or would make it unsuited for anyone.

4.5 Limitations

In this study no data was gathered on the effects frivolous elements may have on long term retention due to time constraints. This limits the amount of useful data that can be gathered as there is no way to confirm what each participants says or does during the test and interviews during subsequent tests. Also due to time restrictions it was not possible to test the game on a large amount of people to ascertain if there is any differences in the results of different age groups or whether previous gaming experience affect the results.

5 Pilot Study

Before conducting the study's main experiment, a smaller pilot study was carried out. The aim of this pilot was to evaluate the game and procedure at that point and see whether or not they were sufficient enough to be used to gather the decided data, and if that data could be used to answer the study's research question. There were also some secondary goals which included testing how many data gathering levels could be used between entertainment levels, and if looping the game could function as a way to keep players engaged for longer. The pilot was also used to evaluate if the built in tutorials in the game were enough to teach new players how the game functioned.

5.1 Prototypes

During the pilot study three separate versions of an earlier prototype for the Frogsnap game were used to achieve the pilot goals. These versions were identical to each other except for the number of data gathering levels being used in each version.

- **Version 1** had no entertainment levels and consisted entirely of a series of data gathering levels.
- **Version 2** had one data gathering, or tutorial, level between every single entertainment level.
- **Version 3** had one data gathering level, or tutorial, between every other entertainment level.

Due to the different numbers of data gathering and entertainment levels in each game version the total number of levels in each version was slightly different. This does not mean that there were any unique levels that existed in any version that did not exist in any other, except for Version 1 which as mentioned did not feature any entertainment levels whatsoever. What it does change is how many levels that need to be played in Versions 2-3 before the game begins looping earlier levels. There was a total of 20 levels before the loop in version 2 and 15 levels in version 3.

Figure 11 Data gathering level in the pilot versions.

5.2 Equipment

During the pilot study the same Lenova computer mentioned in section 4.2.1 Prototype and Hardware was used as this is the hardware the game was designed for and was planned to be used in the study's main experiment. Additional equipment included a video camera for recording the test sessions, a SD card (16GB), and a laptop for storing and processing the gathered data.

5.3 Participants

A total of 9 participants took part in the pilot study, they were all students at the University in Skövde and between 21-26 years of age. All of these participants were also male and highly experienced with digital games. The vast majority of the participants were also right hand dominant, with only a single person being left hand dominant.

5.4 Pilot Test Session

The structure of the pilot tests were very similar to the one described in section 4.2.3 Procedure and differed mainly in a few minor ways related to it being less efficient as the method at that point was untested. This was also the first time that the test room was used and as such there were some experimentation regarding how the room should be setup (see figure 12)

Figure 12 Test room from camera pov

Each participant in the pilot study performed the test individually and were alone in the test room during the entire play session. At the beginning of each test the participant was given a short description of what the test would consist of: a short play session where they would try the game Frogsnap, followed by an interview. They were also informed that they would be recorded during the session and asked to sign a consent form allowing the recordings to take place and be used in the study. Lastly before the test started the participant was asked about: their age, whether they are right or left hand dominant, and how much experience they have with digital games.

Due to the in game tutorials being one of the aspects tested in the pilot study the participants were not given any information as to how the game was played, they were only instructed to use their dominant hand, where to stand during the test, and how to start the game. After

being given these instructions the participants were given an opportunity to ask any questions they may have at that point. Following this they were asked to complete 5 levels in the game, after which they could stop playing at any time. The camera was then turned on and the participant was left alone in the room for the rest of the play session.

Once the participant was finished playing the game the camera was turned off and the participant was asked a series of questions regarding their experience with the game, whether or not they would be willing to play the game again, and if there was any parts of the game that they found more or less enjoyable. After the interview the participant was thanked for their participation in the study and the test was concluded.

5.5 Results

5.5.1 Compilation of data

Data on player retention, in the form of time and number of levels played, was collected through observing the videos recorded during the tests and the data collected by the game. Through this it was possible to obtain the exact number of levels each participant played and for how long they choose to interact with the game.

Table 1 Pilot study results.

Participant	Total number of completed levels	Number of data gathering levels completed	Time spent playing the game	Prototype Version
1	6	5	1min 46sec	Version 1
2	10	9	2min 11sec	Version 1
3	7	6	1min 52sec	Version 1
Version total:	23	20	5min 49sec	Version 1
Version average:	7.66	6.66	1min 46sec	Version 1
4	22	9	3min 2sec	Version 2
5	29	12	6min 12sec	Version 2
6	26	10	4min 25sec	Version 2
Version total:	77	31	13min 39sec	Version 2
Version average:	25.66	10.33	4min 33sec	Version 2
7	18	4	4min 15sec	Version 3
8	19	4	4min 4sec	Version 3
9	9	1	2min 53sec	Version 3
Version total:	46	9	12min 12sec	Version 3
Version average:	15.33	3	4min 4sec	Version 3

As can be seen in these results the participants on average interacted noticeably longer with the game when playing the two versions that had the frivolous elements implemented, and as a result also completed a larger number of levels. This increase also led to players completing

more data gathering levels in Version 2, but a decrease in data gathering levels when playing Version 3. It is worth noting that the number of levels completed in Version 1 can to some degree be because of the participants being asked to complete 5 levels minimum during the test as two of the participants trying that version stopped playing around that point and also mentioned upon exiting the test room that they believed they had finished at least 5 levels. Without this requirement they may have stopped earlier. Most of the participants testing Version 2 and 3 also managed to complete all the levels that were in their respective prototype version, and played a few more levels after they begun looping.

5.5.2 Compilation of Post-Interviews

All the interviews conducted during the pilot study and reported here were conducted in Swedish, but the results will be presented here in English.

Firstly the results from the ranking questions in the interview will be presented. These questions required the participant to rank their experience with the game from 1-6 regarding: How enjoyable they found the game, how bored they felt playing during the test, and how challenging they thought the game was. In figure 13 the group average to these questions are presented.
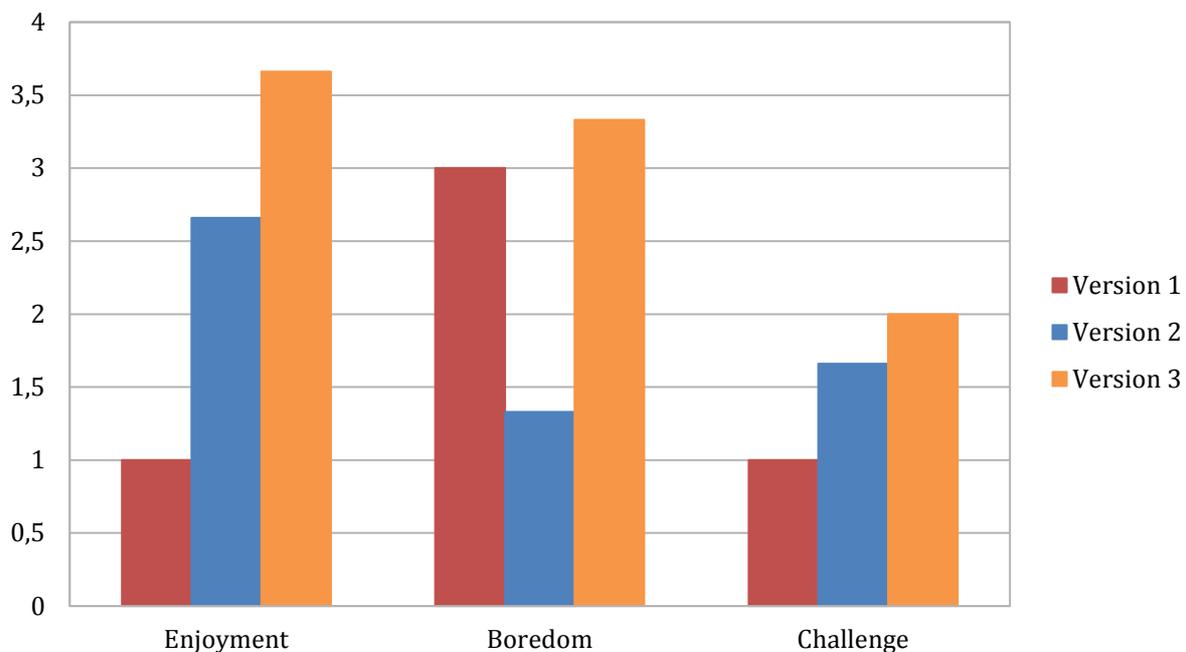

Figure 13 Results from interview.

Based on these results there is some differences between the three versions. Firstly the participants found the version without frivolous elements less enjoyable than the versions with the elements implemented, although not very much so. Version 1 and 3 was also found to be more boring to play than version 2, but due to the small number of participants it is not entirely known why this was the case. There is also a very small change in how challenging the participants found the different versions, but overall they all found the game very easy. Interestingly Version 3 was ranked the highest in all categories which is somewhat paradoxical as that means it was found to be both the most enjoyable and the most boring to play.

Adding to these results the remaining questions from the interview highlights some other differences between the versions. First of all no participant that played Version 1 reported that

they had any desire to play the game again. Version 2 however had two participants respond that they would be willing to play the game again, and version 3 had one participant answering that they would play again and one stating that they would play it again if there was new content added.

All five of the participants that managed to complete all the levels in Version 2 and 3 noted during their interviews that they stopped playing due to noticing that the levels had started looping. Lastly several participants complained that there was some type of bug in the tutorial levels that stopped the game from responding to their actions. Upon closer inspection of the video recordings this was found to be caused by the computer registering the participants holding down their finger on the screen as an attempt to right click, which the game has no response to. Some participants mentioned that even without this problem the first tutorial level was somewhat unclear, but all of them eventually figured out how the game was played without any outside help.

5.5.3 Conclusions

From the results gathered in the pilot study, limited as they were, it was possible to draw some conclusions. First of all it would certainly seem the addition of frivolous elements managed to increase the amount of time that users choose to interact with the game. It was however also possible to conclude that this effect was only present as long as the user was continuously greeted with new content as they were playing. Once the new content ran out and the game reverted back to already played content the participant quickly lost interest in continuing playing. It was also possible to conclude that the addition of a data gathering level between every entertainment level was not so intrusive as to disrupt the experience. And minimizing the number of data gathering levels did not massively affect how much the participants enjoyed the game, it did however massively impact how much data that could be gathered from the prototype which hinders its functionally as a serious game.

During the pilot tests it also became apparent that there was a major problem with the hardware that could have a negative effect on the study's main experiment. This problem occurred, as mentioned earlier, due to the hardware registering the participants holding down their finger on the screen as an attempt to right-click which caused the game to not function properly. The solution to this issue was simply to turn off the right-click function in the computers settings menu, which solved the problem adequately.

Lastly there were some issues found with the test setup itself. Most of these problems were rather minor, but put together they had the possibility to affect the experiment negatively. Examples of these problems include: the computer screen not being cleaned properly causing it become sticky, participants receiving slightly different information due to there not being a standardized briefing or debriefing, and making sure that the collected data was handled properly. Outside of these minor issues however the pilot study indicated nothing that would appear to make the chosen method unsuited for the task of answering the study's research question.

6 Experiment

As mentioned in section 4.2.1 Prototypes and Hardware two similar versions of the Frogsnap game where developed in order to test if the addition of frivolous game elements had any noticeable effect on how long the participants choose to interact with the game, and how much they enjoyed doing so.

6.1 Prototypes

The prototypes used in the main experiment consisted of on base version and one experimental version of the Frogsnap game:

- **The Base version** of the game is very similar to version 1 in the pilot study and contain no frivolous elements whatsoever. It consists only of a start menu and a long sequence of data gathering levels. This version was used to gather data on the effectiveness of the base game itself in order to compare to the experimental version.
- **The Experimental version** on the other hand contained all the available frivolous elements (see section 4.2.1 Prototypes and hardware for more information). Due to the pilot study showing that the best compromise between player enjoyment and data gathering the choice was made to place one data gathering (or tutorial) level between each entertainment level. The number of entertainment levels was also increased which put the total number of levels available in the experimental version at 92. The purpose of the experimental game version was to gather data that could be compared to the experimental version in order to see how retention and motivation was affected.

There were also some changes done to the game following the pilot study that are worth mentioning. First and foremost the exact layout of the data gathering levels was altered slightly with the "barrier" width being reduced to roughly one third of its previous size (see figures 4 and 11). Also during the pilot tests one participant accidentally pressed the "reset user ID" that was present in the main menu which caused some minor problems. This function was very useful during the development of the game, but as it had no function in the experiment it was removed. Another minor change was to move the Timer bar that indicates how much time the player have to complete the later levels in the game. The timer was moved from the right side of the screen to the top side, and changed slightly to fit in better. This change was made partly because some participants mentioned the timer being covered by their arm while playing, but mostly due to it causing the data gathering levels to not be perfectly symmetrical. This could have caused the players to form some biases which in turn could jeopardize the games functionality as a data gathering tool.

6.2 Equipment

The equipment used in the main experiment is the one mentioned in 3.2.1 Prototypes and hardware, and is the same as the same equipment used in the pilot study. Except for the addition of a second larger SD card (32GB) that was added as a way to ensure that there would be no problems with recording the videos during the tests, and as a failsafe should the other card for some reason stop working correctly.

6.3 Participants

The participants in the study's main experiment where divided into two equally sized groups: the base group, and the experimental group. Below the entire list of all the participants that took part in the study will be presented with their demographical information and which group they were part of. ID refers to the user ID the participant was given in the game version they tested. ID 1 and two was given to the same participant because of the game being restarted and consequently giving the participant a new user ID. The participants with the ID 9 and 9B were removed from the study due to problems with their tests.

Table 2 All participants in the study.

ID	Age	Gender	Dominant hand	Experience with digital games	Version tested
1+2	26	Male	Right	Very experienced	Experimental
3	40	Male	Right	Experienced	Experimental
4	30	Male	Right	Very experienced	Experimental
5	43	Male	Right	Unexperienced	Experimental
6	38	Male	Right	Some experience	Experimental
7	45	Female	Right	Experienced	Experimental
8	45	Male	Left	Very experienced	Experimental
10	49	Male	Right	Experienced	Experimental
11	56	Male	Left	Some experience	Experimental
12	22	Male	Right	Very experienced	Experimental
13	24	Male	Right	Very experienced	Experimental
14	28	Male	Right	Experienced	Experimental
15	28	Female	Right	Unexperienced	Experimental
16	21	Female	Right	Very experienced	Experimental
1B	24	Male	Right	Very experienced	Base
2B	36	Female	Right	Unexperienced	Base
3B	22	Male	Right	Very experienced	Base
4B	22	Male	Right	Very experienced	Base
5B	20	Male	Right	Very experienced	Base
6B	24	Male	Right	Very experienced	Base
7B	21	Male	right	Very experienced	Base
8B	23	Male	Right	Experienced	Base
10B	24	Male	Right	Experienced	Base
11B	24	Male	Right	Experienced	Base
12B	22	Male	Right	Very experienced	Base
13B	57	Male	Right	Unexperienced	Base
14B	42	Female	Left	Some experience	Base

A total of 27 participants volunteered and took part of the study. Out of these the vast majority (22) were male, and only 5 were female. Noticeably the overwhelming majority of the participants were also right hand dominant, with only a small minority of 3 individuals being left hand dominant. Ages between participants ranged from 20-57, but most of them were in their twenties. It is also worth mentioning that most of the participants were quite experienced with digital games, with only a few reporting that they had very little previous experience.

6.4 Experimental Test Session

The session setup that was used in the study's main experiment has already been described in section 4.2.3 Procedure. The tests consisted of the participant being alone in a test room and playing one of two versions of the Frogsnap game based on which group they had been placed into.

Once a test had been concluded, a short interview followed that aimed to gather data regarding the participant's enjoyment of the game, and whether or not they would be willing to play it again in the future. The same questions used in the pilot study were applied during these interviews, but one more ranking question was added to gauge how much the participant focused on the game during the test. The full interview protocol can be seen in appendix B.

There were some minor changes made to the test structure based on perceived weaknesses during the pilot study. Firstly a point was made to clean the computers screen before every test to ensure that it did not get sticky. Secondly it was decided that asking the participant whether they were left or right handed was unnecessary as this would be obvious in the recordings. Also all questions were moved to the interview at the end of the test rather than asking the personal information questions before the play session. Lastly in order to fix the problem with the computer registering the participants holding down their finger on the screen as an attempt to right-click, the right-click function was simply turned off in the computers settings menu. This did not completely fix the issue but it worked well enough to continue with the experiment. Also in order to avoid there being any major differences between the tests a test protocol was created and followed, this can be seen in appendix C.

7 Results and Analysis

7.1 Compilation of Data

All the data gathered from the game itself was cross checked with the video recordings from the tests to ensure that it was accurate. This data was then compiled and summarized into a table (see appendix D) and means were calculated for the two groups: The base group that played the base version of the game, and the Experimental group that played the experimental version of the game. A simple unpaired T-test was then carried out on the different categories of data, time spent playing, total levels played, and data gathering levels played, to ascertain whether or not the results were statistically significant. Bellow the results from these three categories will be presented and discussed individually.
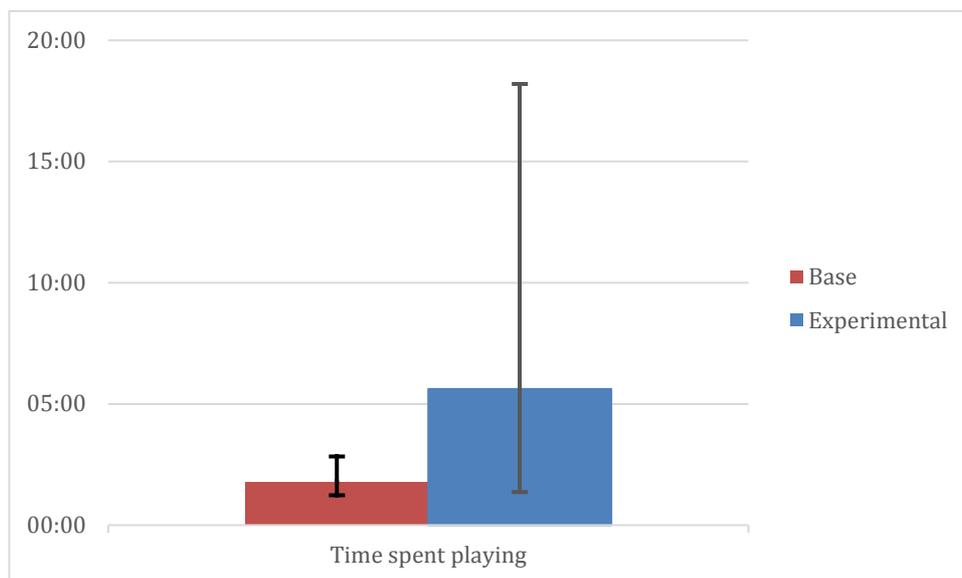

Figure 14 Time spent playing the game

Firstly the results gathered regarding how long the two groups interacted with the game (presented in figure 14) shows that on average participants in the base group played the game for about 1 minute and 48 seconds, and that the longest time a participant spent playing the game was 2 minutes and 50 seconds and the shortest time was 1 minute 14 seconds. Whereas participants in the experimental group on average played for 5 minutes and 37 seconds, with the longest play session lasting 16 minutes and 50 seconds and the shortest being 1 minute 22 seconds. This shows that there is a quite substantial difference in the time participants in the two groups choose to interact with the game with the experimental group on average playing for almost three times as long as participants in the base group. Conducting a T-test on the collected time data gives a p-value of 0.012 which would indicate that the results are very statistically significant.
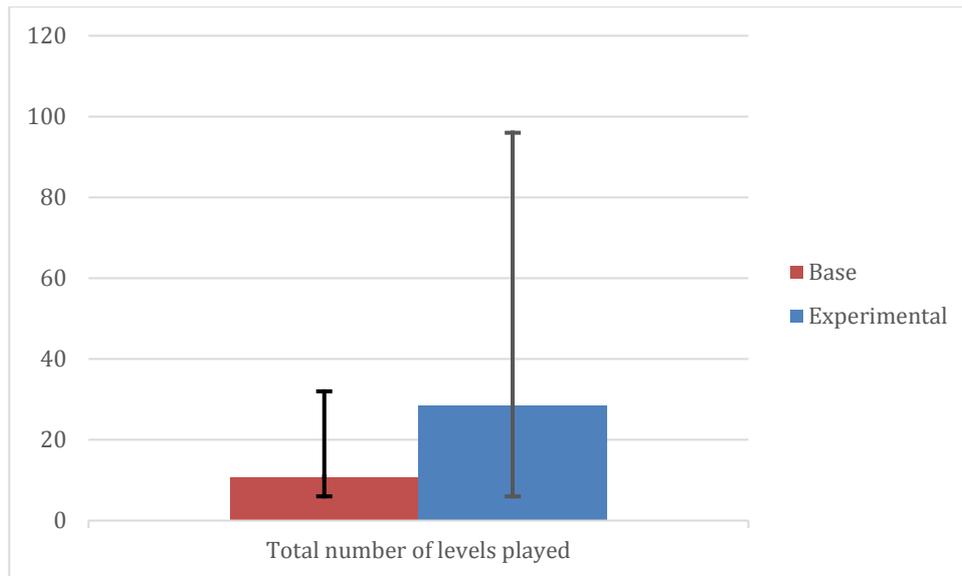
Figure 15 Total levels played

Following the time differences between the two groups it is logical to assume that there would be a difference in the total number of levels the participants managed to complete (presented in figure 15). Which is exactly what the results show. Participants in the base group on average completed 10,8 levels before quitting whereas participants in the experimental group on average completed 28,4 which is once again a rather noticeable increase. The largest number of levels completed by a participant in the base group was 32 whereas the largest number of levels completed by a participant in the experimental group was 96, which constitutes all the levels in the prototype and a few replayed levels. In both groups the smallest number of completed levels was 6, in the base group there were four participants completing this number of levels and in the experimental group there was one. Conducting a T-test on the total number of played levels return the p-value 0.049 which would make the results statistically significant.
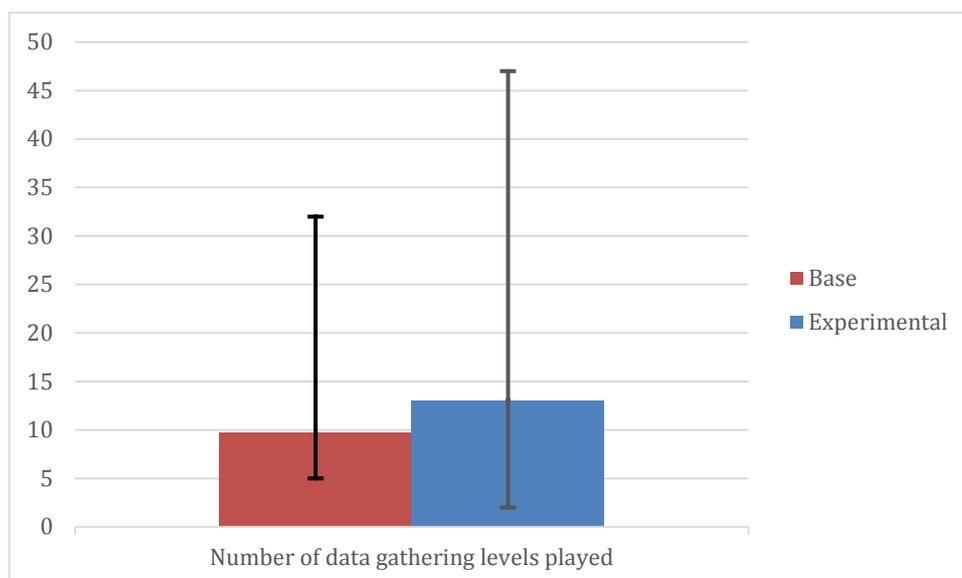

Figure 16 Data gathering levels

Lastly are the results for how many data gathering levels each group completed (presented in figure 16). These results show that despite participants in the experimental group on average

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spent more time and completed more levels, they did not greatly improve on the number of data gathering levels completed compared to the base group. The base group finished an average of 9,76 data gathering levels with the highest recorded number being 31 and the lowest 2. Whereas the experimental group completed 13,07 and had a much greater spread with the participant completing the most data gathering levels finishing 47 and the participant finishing the least only completing 2. A t-test conducted on these results returns a p-value of 0.46 which clearly shows that there is no statistical significance regarding the difference in number of data gathering levels completed between the two groups.

7.1.1 Comparison between the Groups

The collected data shows that there is a statistically significant difference in how long participants in the two groups choose to play the game. As a result of this there is also a significant difference in how many levels they completed. The results however clearly show that this did not end up effecting how many data gathering levels completed by the two groups to a statistically significant degree. This means that despite participants in the experimental group on average interacted with the game for longer periods of time and completed more levels, they did not end up contributing more data towards the games serious purpose. Which as mentioned in section 3.2 Frogsnap was to collect information regarding small differences between two similar hand movements. It is however worth noting that while reviewing the video recordings it was noted that participants in the base group on several occasions made unnecessary movements during data gathering levels, which would make the data gathered invalid. This behavior was not as frequently observed in the experimental group. The reason for this behavior is unknown at this point, but it may have been out of boredom or experimentation to see if they could make something different occur within the game. Regardless as this fell outside of the scope for this study and due to time constraints it was unfortunately not possible to fully explore this behavior, but it was still seen as worth mentioning.

7.2 Compilation of Post-Interviews

As mentioned at several points the play sessions in the tests were followed by a short interview that outside of gathering information regarding the participants demographic also sought to explore how the game was experienced. This interview consisted of 4 ranking questions where the participant was asked to rank certain aspects of their experience from 1-6. The aspects explored was:

- How much the participant enjoyed playing the game.
- How bored the participant felt during the test.
- How challenging the participant found the game.
- And lastly, how focused the participants was on the game during the test.

The results from these questions are summarized and presented bellow in figure 17 and can be seen fully in appendix E.
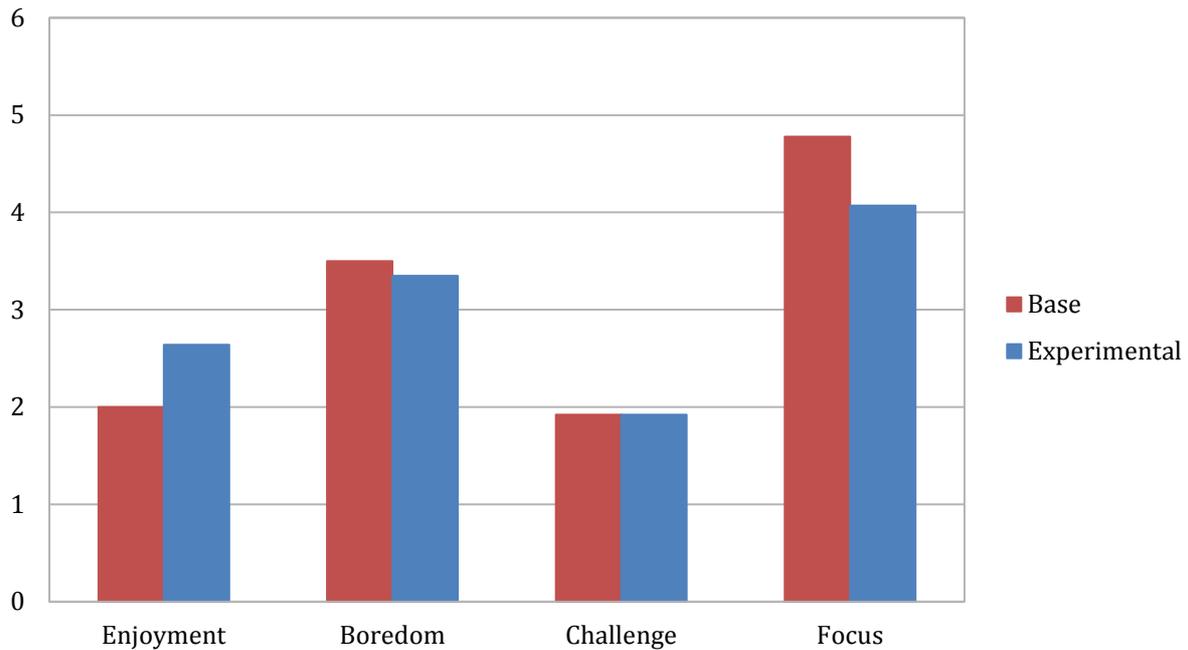
Figure 17 Results from post-test interview ranking questions.

From these results it quickly becomes clear that there was very little difference in how participants experienced the two versions of the game. When it comes to how enjoyable they found the game both groups found it roughly the same with the base group ranking it at a solid 2 and the experimental group ranking it at 2.64. When it comes to boredom the base group thought their version was slightly more boring at 3,5 compared to the experimental versions 3,35. This is however an almost completely insignificant difference. Both groups ranked how challenging they thought the game was as 1,92 and several participants mentioned that they found the game to easy and that the main challenge was simply to understand the games mechanics. When it comes to how much participants in the two groups ranked their focus on the game during the tests the base group had a slightly higher 4,78 compared to the experimental groups 4.07. All in all these results show that there was almost no difference in how the participants thought of the two game versions based on these criteria.

7.2.1 Willingness to Play Again

One part of the interview where the two group's answers differed a great deal is whether or not the participants would be willing to play the game again. In the base group only 1 of the 14 participants responded that they would be willing to play the game again, whereas 8 responded that they would not be willing to do so. The remaining 4 participants in the group responded by stating that they might be willing to play the game again, but only if substantially more content was added.

In the experimental group however 7 out of the 14 participants responded that they would not be willing to play the game again, whereas all of the remaining 7 stated that they would be willing to play again at another point. These results would indicate that the addition of frivolous elements had an impact on the participant's willingness to replay the game in the future. Although due to time restraints it was impossible to focus on long term retention in this study which means that these results cannot be verified as the participants were never asked a to play the game a second time.

The higher number of participants in the experimental group compared to the base group that responded that they would be willing to play the game again in the future would indicate that the frivolous elements may have had an effect on retention (see section 2.2.1 Retention) over several sessions. This increase in willingness to continue interacting with the Frogsnap game also indicates a higher amount of intrinsic motivation (see section 2.2.2 Motivation) in the experimental group as there were never any rewards offered to the participants and as such any reasons to continue playing would likely be motivated by their own desire to continue playing the game. It is possible that the reason that some participants that did not play for a long period of time or finish a large number of levels during their test session still responded that they would be willing to play again is that they would prefer to play the game in short intervals, similar to how some individuals enjoy playing mobile games. As there were no follow up sessions in this study however these results cannot be verified and it is possible that the participants would not actually be willing to play the game again but simply responded that they would be.

7.2.2 Feedback on Improvements

Outside of gathering information regarding what the participants thought of the two game versions, the interview also aimed to gather data regarding what parts of the game that worked well and which did not. The feedback obtained from these interview questions vary greatly and included some participants liking or disliking the graphics or wanting music in the game, to more mechanic based opinions. Some trends quickly became apparent in the various answers given by the participants.

First and foremost it became perfectly clear during this part of the interview that the instructions and tutorial levels within the game where not good enough. A rather large number of participants reported that they did not understand the instructions within the game and as a results had great troubles grasping the games mechanics. Due to this some participants became very annoyed at the game and chose to quit early out of irritation. This fact could also be observed on the video recordings, and it would seem that participants who quickly understood the game played for longer than those who did not.

Another reason that was mentioned several times during the interviews was that many participants thought that the game lacked any real challenge and therefore quickly became bored, and as they did not know that additional challenges would be added later in the game, choose to quit. This would be supported by the flow theory (see section 2.2.3 Flow) which states that a person becomes more engaged and absorbed in a game that matches the challenges within with their skill level. As most participants were quite experienced with digital games it can be assumed that the game did not match their skill level correctly. Some feedback regarding how the challenge could be increased in the game included adding moving obstacles, introducing the timer from the beginning, and potentially making it so that the player cannot cross the frogs tongue making it very difficult to move go backwards in the game which would make it into more of a puzzle game. It is also worth noting that most of the participants in the experimental group stopped playing during a data gathering level and not an entertainment level. This might once again have something to do with flow theory as it is possible that the participants as they grew more competent at the game found the continuing addition of low challenge data gathering levels to be frustrating as they did not match their current level of skill which in turn made them quit. This would also be supported by the concept of competence (see section 2.3 Gamification) that states that player need to feel that their sills are being tested by the game or they may easily grow bored.

Lastly a few participants mentioned that due to the games simple mechanics and level layouts, it should be quite possible to create a procedural level generator that can create new semi random levels every time somebody plays the game. This could possibly be a very excellent idea as it would eliminate the need to make individual maps to increase the number of data gathering levels included in the game. It would also make it possible for players to interact with the game for very long periods of time without replaying content they have already seen. This is an aspect whose effect would certainly be interesting to explore in the future.

7.3 Interpretation of Results

Looking at the results from this study it becomes clear that a statistically significant increase in how long a player chooses to interact with a serious game and subsequently how many levels they complete, can be achieved by adding frivolous game elements to it. It also becomes clear however that this does not automatically result in the serious game serving its purpose more efficiently. The purpose of the Frogsnap game is to gather data regarding movement patterns which it achieves through data gathering levels. As there was not a statistically significant difference in the number of data gathering levels players completed when frivolous elements were applied, they cannot be said to have resulted in the Frogsnap game becoming more efficient.

There were no noticeable differences between participants of different ages, gender, dominant hand, or previous experience with digital games. Although due to the test group being rather small and many of the participants sharing many similarities this may not be true for a more general population.

The frivolous elements used in this study did not appear to greatly affect how the participants experienced the game and did not increase their enjoyment of it. A reason for this may be that many of the game elements where rather rudimentary and underdeveloped leading to there being a lack of challenge in the game. This in turn was, together with inadequate tutorials, the main stated reason for participants ceasing to play and being unwilling to play the game again. As such it would seem to be of utmost importance to ensure that any serious game utilizing frivolous elements have good instructions and tutorials and some degree of challenge from the beginning to minimize player frustration and boredom.

7.3.1 Conclusions

This study set out with the goal of answering the research question:

> "To what degree, if any, can frivolous game elements in a serious game be used to increase player motivation and retention".

In that regard it can be seen as having succeeded to an extent. The results from this study shows quite clearly that the addition of frivolous game elements into a serious game can be used to increase player retention to a statistically significant degree. It also shows however that this does not necessarily lead to players finding the game more enjoyable nor rewarding and does not guarantee that they will be motivated to continue playing for long periods of time, although the results would indicate that it increases player willingness to return to the game in the future. Lastly the study has also managed to show that an increase in player retention does not automatically result in a more efficient serious game. There was only a small increase in how much data the game version with frivolous elements managed to collect compared to the version without these elements. This change was also too small to be statistical significant.

As it did not decrease the amount either it can still not be said to have made the game less efficient, but more studies will have to be conducted to research that subject.

Due to the relatively small group of participants in this study none of the results can be seen as being conclusive, and should only be seen as an indication of what a true answer may be. With that said there seems to be a clear connection between frivolous elements and player motivation and retention. And it would be of great interest to see more research done on the subject in future studies as it may be a way for developers to increase the efficiency of their serious games in a relatively cost efficient manner.

8 Conclusions

8.1 Summary of Results

In this study an experiment was carried out with the help of 27 participants in order to examine what effect frivolous game elements could potentially have on a serious game's ability to generate user retention and motivation. The experiment consisted of a series of tests where the participants, divided into two equal sized groups, interacted with two versions of the game Frogsnap. One version did not include any frivolous elements and consisted only of what the game needed to serve its purpose. The other version, however, included a number of different game elements that did not directly contribute to the game's purpose.

The data collected from these tests show that there is a statistically significant increase in the amount of time participants choose to play the version with frivolous elements compared to the one without. This extended time also led to the participants in that group finishing more levels overall compared to the other group. These results are somewhat similar to the ones found in other studies (Deterding, 2011; Deterding et al. 2011, Aparicio et al. 2012) that showed that the addition of game elements can increase player motivation, which can sometimes lead to better retention. Those studies however was conducted within the field of gamification not serious games and mainly focused on measuring motivation and did not truly explore retention nor what effect the increased motivation had on the applications effectiveness. Which leads to the study's second point. Even though the addition of frivolous elements increased the short term user retention this increase did not manage to significantly affect the number of data gathering levels completed by the participants. Due to this the game cannot be said to have been made more efficient by the addition of frivolous elements.

8.2 Discussion

Now that the results from this study, and the conclusions made from these results, have been presented it is of utmost importance to discuss whether or not they are reasonable and valid. The first thing worth noting is that the vast majority of participants in this study were individuals recruited from the faculty and student body at the University of Skövde. This combined with the fact that only a single game was tested means that the results cannot be generalized to all populations and game genres (Lankoski and Björk, 2015; Patton, 2015). With that said this study still serves to give some indication as to what effect adding frivolous elements into a serious game may have on retention and motivation.

A secondary problem with the recruited participants that must also be brought up is that many, if not most of them, are academics who may at some point have carried out studies similar to this one which may have led to them trying to be as helpful as possible. This could have resulted a degree of participation response bias (Dell et.al. 2012) in the participants, which is to say it is possible that they tried to give the answers that they believed where sought after instead of their true opinions. As this was a known potential problem however steps were taken to try and minimize these effects. These steps included trying to give instructions and ask questions as neutrally as possible and not give any indications to what the desired results were. Whether or not this approach worked or not is difficult to tell at this stage. Future work in this subject should try and be as anonymous as possible to avoid inducing biases into the test participants.

Another aspect of the study worth discussing is the fact that as a secondary goal the Frogsnap game was to be used to collect the data it was designed for. This can be seen both as a strength and a weakness of the study. On one hand it means that some decisions had to be made that may not have been ideal for examining the research question in this study, such as asking all participants to finish at least 5 levels. This may have had an effect on the results and without these restrictions the collected data may have been different. On the other side however, this secondary goal also meant that the game was used to collect the data it was designed for in a manner that represents how it would most likely be used in reality. This means that the results gathered in this study may more accurately represent differences in retention that would be present in a study where the game tested is used for its original purpose.

It is also well worth mentioning that the very fact that the game was played as part of a test may have led to different results then the ones that would have been acquired if the game was simply played for no external reason. Due to it being a test some participants may have been willing to put up with elements of the game that would normally have made them quit playing simply to be helpful. There is also the fact that the game was played on a rather unusual computer platform which may have had an effect on how the game was perceived, either a positive or a negative one.

8.3 Future Work

As mentioned earlier in this report there is a rather large lack of research regarding how retention can be increased in serious games, especially ones that do not fall into the learning/teaching or persuasive categories. As such there are a number of possibilities for further studies within this field.

Firstly it would certainly be a good idea to conduct a similar test as the one described in this work, but with an upgraded version of Frogsnap, or an entirely new game, and on a far bigger scale. It would be of interest to examine both a larger number of participants to get a clearer answer to the question posted in this study. But also to examine how the results change if the participants are asked to interact with the game over a longer period of time, such as days or even weeks, to see if there is any effect on long term retention. For such a study it would potentially also be possible to port the Frogsnap game to mobile devices and/or smart pads in order to experiment with the possibilities of releasing the game to the public to maximize the amount of data collected.

Equally interesting would be to perform a more substantial study with the aim to explore how different types of game elements may affect user retention and motivation. In this study a number of different elements have been applied, but there is very little distinction between them and it was never a focus to examine them individually. Such a study could certainly have its uses as it would make it far easier to develop more compelling serious games.

Also as mentioned several times throughout this report the work described here has been entirely focused on scientific discovery games or data gathering games, and not the type of serious games that aim to teach or change opinions or actions (educational or persuasive games). It would however still be of great interest to study how the similar application of frivolous elements into games with this kind of goal may affect their usability and whether or not it is possible to increase their effectiveness by these relatively simple means.

Finally it could be very interesting to continue to work with the Frogsnap game used in this study and attempt to implement it in a larger scale experiment that aims to explore the research question the game was originally created to answer (see section 3.1.2 Earlier Experiment). This work would potentially not only provide valuable information regarding human intention and how it can be perceived and predicted by computers, but also give a greater insight into how serious games can be used as data gathering tools, which is a role they currently are not commonly used for.

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Appendix A - Consent Form

Consent Form of Participation in Research Study
University of Skövde

You are invited to participate in a research study that is part of the being carried out by master student Jakob Löwenberg in the Master program in informatics, in the area of Serious Games. All information about the research and he study is presented below.

Principal investigator:	**Supervisors:**
Jakob Löwenberg	Björn Berg Marklund (bjorn.berg.marklund@his.se)
a14jaklo@his.se	Jenny Brusk (jenny.brusk@his.se)

Voluntary participation
Your participation in this research study is voluntary. You may choose to not to participate and you may withdraw your consent to participate at any time. You will not be asked for any explanations if you decide not to participate to withdraw from this study.

Description of the research
The *overall research plan* is to perform a series of studies (such s the present one) to investigate aspects of player motivation and retention in serious games. The *aim of the research* is to better understand how to create effective serious games, and how intention applies to individuals and the general population.

Method to be used
Your participation will involve playing a digital game in front of an active camera. After the activity a interview will take place, and following that a debriefing session, where the investigator will answer questions and explain to you any specific detail about the study and how your data will be analyzed. The game in the study have a casual theme, there are no intense violence, blood and gore, sexual content and/or strong language element in it.

Data to be collected
During the whole activity a camera will record a video of you playing. The video will be captured and stored for further research. Additionally the following data will be captured and stored for further research: input data for movement, numbers of levels completed, and answers from the interview regarding enjoyment of game.

Usage of collected data
The collected data will be used and handled according to the *Forskningsetiska Principer inom Humanisk-Samhällsvetenskaplig Forskning* [Principals for Research Ethics in the

Humanities and Social Science] guidelines. The collected data will only be used for non-commercial research purposes. Your data will be stored in a hard-drive that is only accessible by the principal investigator, he will handle and keep it physically under his possession to ensure unauthorized persons will not have access to the data.

Consequences and risks

There are no known consequences or risks associated with this research, however you might feel a discomfort regarding being watched by a camera. In order to minimize that discomfort we emphasize that all data are anonymously collected and will never be public disclosed without your consent.

Potential benefits

There are no known benefits to you that would directly result from your participation in this research. This research, however, may help increase understanding regarding best design practices within the field of serious games, and regarding intention and robotics.

Protection of confidentiality

All data is anonymously collected. Your identity will not be revealed in any publication resulting from this study. We will never publicly disclose your data, i.e. videos, movement data collected from the game, pictures and answers to questions, without your consent. In the eventuality that you do not want your data to be publicly disclosed and we need a picture of you in a scientific manuscript, we will contact you in advance and ask for authorization to use your picture. We will not use the picture if you do not explicitly agree with it. We will do everything we can to protect your privacy.

Contact information

If you have any questions or concerns about this study or if any problems arise, please contact Jakob Löwenberg (a14jaklo@his.se) at the University of Skövde.

Consent

I have read the consent form and have been given the opportunity to ask questions.

⬜	**I give my consent to participate in the study.**

Participant's name	Participant's signature	Jakob Löwenberg
(print form)		Investigator

Date:_____ A copy of this consent form should be given to you

Appendix B - Interview

User ID:

1. **Age:**

2. **Sex:**

3. **Right or left hand dominant:**

4. **Experience with digital games:**

Questions:
1. Rank how enjoyable you found the game on a scale from 1-6 where 1 is not at all an 6 is very enjoyable

1	2	3	4	5	6

2. Rank how bored you felt during the test on a scale from 1-6 where 1 is not at all an 6 is very bored

1	2	3	4	5	6

3. Rank how challenging you found the game on a scale from 1-6 where 1 is not at all an 6 is very challenging

1	2	3	4	5	6

4. Rank how much the game held your focus on a scale from 1-6 where 1 is not at all an 6 is completely

1	2	3	4	5	6

5. Would you be willing to play the game again?

6. Anything you found more or less enjoyable/ interesting about the game?

7. Any other thoughts about the game or test in general?

III

Appendix C - Test Protocol

Start of day:
- Ensure there are enough release forms
- Ensure camera works
  - Check battery
  - Check memory
  - Setup camera
    - Ensure correct camera placement
- Start Lenova computer
- Insert USB
- Turn of right click

Pre test:
- Clean touchscreen
  - Quick wipe off
- Check camera
  - Battery
  - Memory
  - Placement
- Start Frogsnap game

Test:
- Welcome participant
- Inform participant of how the test will be conducted
  - They will be alone in the room
  - All they need to do is play the game and follow the instructions
  - Complete a minimum of 5 levels, can then stop playing whenever they choose, just stop playing and open the door
  - After the play session there will be a short interview
  - Inform them the entire session will be recorded
    - focus will be on screen not participant
    - Standard handling of personal information, no one will view the footage except the research team, participant will be anonymous.
    - Inform participant that they will need to sign a release form after test
- Show the participant into the test room
  - Show them the computer and where to stand

- ◦ Inform the participant how the game is played
  - ▪ Touch the frog then move towards the fly
- Check if participant have any questions
- Inform participant that they may begin playing once the camera is started and you have left the room
- Start camera
- Leave room
- Wait outside until participant opens door
- Stop camera recording
- Ask participant if they experienced any problems during the test
- Conduct interview
- Inform participant of the study's goal
  - ◦ To collect data on certain hand movements in order to see if there are any small diferences that can be used to determine intention.
  - ◦ To examine if frivolous elements can be used to increase player retention and motivation in a serious game
- Ask participant to sign release form
- Thank participant for their participation

Post test:
- Ensure data was collected properly during the test
  - ◦ Did the camera record?
  - ◦ Is the frogsnap data fine?
- Check camera battery
  - ◦ if low charge battery
- check camera memory
  - ◦ if low change SD card
- restart frogsnap game

End of day:
- Take down camera
- Exit frogsnap game
- Turn right click back on
- Make duplicate of data files on computer
- Remove USB
- Transfer test recordings to computer
  - ◦ make duplicates
- remove recordings from SD cards
- Recharge camera battery
- Turn of Lenova computer
- Ensure test room is locked

Appendix D - Collected data (videos and game)

	Total Levels:		Data levels:		Time:	
Participant	Base	Experimental	Base	Experimental	Base	Experimental
1	9	13	8	6	00:02:06	00:02:35
2	6	96	5	47	00:01:50	00:13:38
3	7	6	6	2	00:01:20	00:01:22
4	6	45	5	21	00:01:16	00:08:59
5	8	8	7	3	00:01:15	00:02:36
6	15	29	14	13	00:01:31	00:03:54
7	9	16	8	6	00:01:14	00:03:20
8	12	8	10	3	00:01:33	00:05:40
9	6	15	5	6	00:01:45	00:10:31
10	6	25	5	11	00:01:46	00:03:01
11	32	10	31	4	00:02:50	00:01:36
12	10	7	9	3	00:02:24	00:01:23
13	15	92	14	45	00:02:34	00:16:50
14	44	28	43	13	00:09:02	00:03:12
T-Test 1	0,092679706		0,8538827		0,033042704	
T-Test 2	0,049920484		0,467182239		0,012748267	
Mean:	13,21428571	28,42857143	12,14285714	13,071429	12:02 AM	12:05 AM
Mean 2:	10,84615385		9,769230769		12:01 AM	

VI

Appendix E - Collected Data (Interviews)

Participant	Enjoyment 1-6	Boredom 1-6	Challenge 1-6	Focus 1-6	Willing to play again	Version played
1	2	4	4	6	Maybe	Base
2	1	4	2	6	No	Base
3	1	4	1	6	No	Base
4	4	3	1	5	Maybe	Base
5	3	2	1	6	Yes	Base
6	1	4	1	5	No	Base
7	1	2	2	6	Maybe	Base
8	3	4	2	3	No	Base
9	3	5	4	5	Maybe	Base
10	2	2	3	4	No	Base
11	2	4	1	4	Maybe	Base
12	1	5	1	3	No	Base
13	2	3	2	5	No	Base
14	2	3	2	3	No	Base
Mean:	**2**	**3,5**	**1,92**	**4,78**	**1Yes / 8No / 5Maybe**	**Base**
15	1	6	1	5	No	Experimental
16	2	2	2	5	Yes	Experimental
17	1	3	2	4	No	Experimental
18	5	1	5	6	Yes	Experimental
19	2	4	1	2	No	Experimental
20	3	2	2	6	Yes	Experimental
21	3	1	1	6	Yes	Experimental
22	1	4	2	2	Yes	Experimental
23	2	5	2	3	Yes	Experimental
24	5	2	2	5	Yes	Experimental
25	2	6	1	2	No	Experimental
26	3	4	1	2	No	Experimental
27	2	5	3	4	No	Experimental
28	4	2	2	5	Yes	Experimental
Mean:	**2,64**	**3,35**	**1,92**	**4,07**	**8Yes / 7No**	**Experimental**