SERIOUS PLATFORM GAMES
A comparative study between a serious game and a conventional method.

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Abstract
A big problem in the world today is vaccine hesitancy (VH), a tool to combat this could be to use serious games (SG) as a tool for education. There has been some research into this field, these studies have mainly used a single game or looked at a series of games, and they have required quite a lot of interaction. A trivia can allow the player to focus on thinking rather than performing various tasks; even if both can be equally educational.

In this work a platform game was developed and used together with a questionnaire to test the knowledge of the common person in regard to vaccines and vaccine preventable diseases. 20 people participated in this study, 10 in a control group and 10 in the game group.

The results in this study show that there was no significant statistical difference between a serious platform game and a compendium when it comes to learning.

Keywords: vaccine, serious game, platform, first time parents

This paper is dedicated to my loving mother Britty Wahlman who has been supporting me all these years.

Thank you mother, I will always love you!
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1 Introduction

Health is a big concern for new parents, they want their child to be healthy and safe. This can cause serious health issues for the child if the parent decide to do their own research and put little or no trust in their doctor. There is a lot of information on the internet that is plainly wrong and even dangerous, and if a parent does not critically review the source the parent might decide to trust the source without fact checking.

One way to teach anyone interested in health is to use various serious games, but in such a big topic such as health it can be hard to find a game that focus on the question at hand. To the best of the researcher’s knowledge most serious games that handle the topic of diseases or various conditions focus on a single disease or condition. In this paper a serious game that focus on nine diseases that are covered by the Swedish child vaccination program was developed and used.

The motivation from a health perspective for this topic is the growing number of people that refuse to vaccinate, many of which claim vaccines causes autism even though this has been disproven and the paper by Wakefield, Murch, Anthony et al. (1998) the majority of them are citing was found to be fraudulent and the journal that published it retracted the paper.

Wattanasoontorn, Boada, García, and Sbert (2013) published a study that looked into over 100 serious games. They categorized the games into the following genres: action, adventure, exergame, mix, puzzle, quiz, RPG, simulation and strategy. One of the games this study talk about is L’Affaire BIRMAN (Les Diablotines, n.d.). L’Affire BIRMAN is an adventure game and the player is in control of a single character and the purpose is to help the player practice the technique of functional insulin therapy.

After looking through some of these ~100 games it was noticed that no game in the list was a platform games, with the possibility that some of the links that no longer were working or links that was not tested could have been a platform game. So it seems that platform games is an uncommon genre in serious games, especially when it comes to health. A study by Fuchslocher, Niesenhaus and Krämer (2010) the researchers developed a platform game, they call the genre “jump’n’run”. They describe the genre as following:

“The jump’n’run genre is characterized by jumping to and from suspended platforms or over obstacles.”

Fuchslocher, Niesenhaus and Krämer (2010)

With only a single platform game found, the motivation to use a platform game in this study is to see if there is a reason this genre is underrepresented. Another reason for choosing a platform game to look at is that only one study was found that explicitly used a platformer. So far to the best of the author of this study knowledge no one have been comparing a platformer with a compendium or any other traditional method for teaching.
2 Background

In this chapter background for serious games used in topics regarding health will be presented, related research will be presented and discussed, there will also be a short presentation and discussion about how modeling of infectious diseases spread can be achieved.

In today’s world one of the leading forms of entertainment media is digital games. Digital games stands together with motion pictures, TV and music as a pillar in today’s culture (Heron, 2012, p.29). What is the definition of a serious games? According to IGI-Global one definition of serious game (SG) is:

“A game designed for any purpose rather than entertainment. **Serious games** are considered useful to those who wish to use simulation for training and education e.g., flight simulations. They also make use of **games** engines, a good platform for development and play.”

(IGI-Global, n.d.).

Charsky (2010) define the term as: “Serious games use instructional and video game elements for nonentertainment purposes.” With these definitions it is possible to postulate that the goal of serious games are to create a relevant learning experience for a broad audience. Marsh (2011, p. 61) states that “interaction with serious games if for purposes other than, but may also include, entertainment.” this means that a serious game should offer something more than mere entertainment. But it is also important to make a game somewhat fun so the player feels like returning to the game. According to Marsh (2011) the engaging aspects are a great way to make learning more enjoyable; and motivational aspects are great way help people to learn.

Corti (2006) discuss several reasons for using serious games as a tool in learning. By using serious games it is possible to allow the player to experience something that could be too expensive, hazardous, or maybe even impossible to achieve in the real world. Games also allow the player repeatability, this means that the player can play the game more than once in case the player fails to understanding the content and/or meaning of the game.

Mitchell and Savill-Smith (2004, p.10) discussed that frequent gaming might lead to health and psycho-social issues and wrote “[…] observing children’s free play consistently pointed to children becoming more aggressive after having watched or played a violent video game (Funk 1992; Griffiths 1999).” However, they do not give the reader a definition for the word “violence” in their discussion. A more recent study show that there is a lack of evidence between violent games and a blunted neural empathic response in users of violent video games (Szycik, Mohammadi, F.Münte, T. te Wildt. 2017). Another study by Ferguson (2014) showed that videogames containing violent is associated with a decline in youth violence rates. With this in mind exposing both children and adults to serious games seem to be acceptable, but more research is needed. However in this report the assumption that games and thus serious games are a safe method of exposure and learning.

There have been a lot of public health approaches that tries to address the problem with vaccine hesitancy. One innovative way to educate the public about vaccines is the use of serious games (Ohannessian, Yaghobian, Verger and Vanhems, 2016). In the study by
Ohannessian et al. they look at sixteen serious games, none of which appears to be a platform game. The games listed in the study were categorized in one or two of five different categories:

““Avoid” asks players to avoid elements/traps/opponents; “match” asks players to match or to keep one or several elements in a particular state; “manage” lets players manage various resources to perform actions; “select” lets players select an in-game element by any input device; “shoot” lets players throw or shoot elements.”

(Ohannessian et al., 2016)

Another study that looked at a lot of games was written by Wattanasoontorn et al. (2013), they looked at 108 different health oriented serious games from 2004 to 2012, and none of these is designated as a platformer. This study state that they expect that 3D and online connectivity will dominate the serious games health market, if handheld devices get increased capability with PC-like functionality, they also expect real time interactions between patient and therapist which will make a powerful tool for both recovery and treatment for the patient.

The study by Wattanasoontorn et al. (2013) categorize all 108 games in three different classifications when it comes to the purpose of the game. Focused on entertainment (FE), focused on health (FH) and Focused on health acquisition and medical skills (FM).

FE are games that require some body part to be moved so wellness is an obtained bonus. The study give the game Dance Dance Revolution (DDR) as an example. DDR is an exercise game where the player uses a dance mat to control the game.

Games in the FH category have the goal defined as “health” but the game is a tool used to gain knowledge and/or skills. An example of a game from this category is called Fatworld (Persuasive Games, n.d. b). The first paragraph from the website of Fatworld state: “Fit or Fat? Live or Die? You Decide. Fatworld explores the relationships between obesity, nutrition, and socioeconomics in the contemporary U.S.”. Persuasive Games also created a game called Killer Flu (Persuasive Games, n.d. a), they describe their game as “Killer Flu was created as an attempt to explain how flu really mutates and spreads, and how challenging it can be for a deadly strain to affect a large population geographically.”.

The last category FM are defined as “the game has serious use for health purposes regarding a need of a virtual viewpoint or simulation to avoid or alleviate the risk, safety, budget, etc.” An example given is a virtual dental implant training simulation program. No information about this program was found.

One platform game found was a Swedish game by Trygg-hansa called “Eldrace” (The fire race). This game was not included in the study by Wattanasoontorn et al. (2013), and it was not included in the study by Ohannessian et al. (2016). This game is a web-based platform runner, where the objective is to evacuate a house as fast as possible, by avoiding obstacles such as smoke clouds, furniture, fires and possessions such as books and teddy bears, see Figure 1. The game is timing how fast the player can escape a burning building, the player is tasked to jump over obstacles and pits, and to avoid picking things up. It also tell players to run under smoke (Myndigheten för samhällsskydd och beredskap (MSB), 2014).
2.1 Definition of health

Health can be defined as the well-being of a person’s body but health can also include your mental state, the body may be in perfect condition, but the mental state of the individual may be less than optimal. The World Health Organization (n.d.) defined health in a broad sense as the state of complete physical, mental and social well-being and not only that the individual if free from any illness and/or debility (Wattanasoontorn et al., 2013). They also write the following:

“Other definitions simply require being free from illness or injury”

(Wattanasoontorn et al., 2013)

The Oxford University Press in their “Oxford Living Dictionaries” define health as follows:

“The state of being free from illness or injury.”

(Oxford University Press, 2017)

2.2 Related research

There have been a few papers published regarding serious games, vaccines, and vaccine preventable diseases, resulting in a thin research field. One of these papers created a game that focus on the smallpox virus and the social history of the smallpox vaccination. In it the player is among other things tasked to recreate Jenner’s first experiment with cowpox early in the game (Goins, 2013). This paper does not have a conclusion on how well the game worked, what audience it target nor does it talk about how the study was conducted. The paper feels rushed and incomplete.
Another paper has made a systematic review of 16 different free-to-play serious games (Ohannessian, Yaghobian, Verger and Vanhems, 2016) that focus on the topic of vaccines. This paper shows that there are a variety of sub-genres, the paper lists the game genres as:

- **Shoot**, here the player can throw/shoot elements.
- **Manage**, the player has to manage various resources to perform actions.
- **Select**, the player can select an in-game element with any input device.
- **Avoid**, the player is tasked to avoid certain elements/traps/opponents.

This paper concluded that serious games are an innovative tool that could serve public health purposes, particularly the spreading of infectious diseases and vaccination. It suggests that the long-term impact of vaccination-related serious games should be evaluated to better prove their efficiency and utility. A problem with this study however was that only two games were evaluated by the researchers:

“Only two games, however, “Grippe.0” and “Flu Buster”, were evaluated to see whether the games reached those objectives”

(Ohannessian, Yaghobian, Verger, and Vanhems, 2016, p. 4481)

The objectives for Grippe.0 was Prevent, diagnose and control influenza, and for Flu Buster the objectives were “Survive a school day without getting sick”. The other 14 games had various objectives such as controlling a disease or to avoid having unvaccinated students at school. The study didn’t look into the impact on the long-term for these two games either, the reason was lack of time, resources and specific methodologies.

A study published in Smart Innovations, Systems and Technologies Vol. 38 focused on a health policy simulation model of smallpox and Ebola. To conduct this study the authors Kurahashi and Terano developed a model to simulate both smallpox and Ebola based on infectious diseases studies using agent-based modelling. They wanted to know how to prevent an epidemic not only using the mechanisms of the diseases themselves but also what impact the healthy policies had (Kurahashi, Terano, 2015).

The study concluded that the vaccination availability per day and the number of medical staff available are crucial factors to prevent the spread for a mass vaccination strategy, but they also found that even small quantities of vaccinations per day, about 10% of the population are vaccinated per day was enough to stop the spread in many cases. It also showed that even if half of the population were vaccinated, using public commute would not help in preventing the spread of the disease. Here two thirds of vaccinations per day was required every day to prevent the spread.

They also mention that further research that will be done will take new types of infectious diseases in account and that a trade-off between various policies will be evaluated as a serious game.

A study from 2013 found that using game-based E-Learning was a lot better than using “scripts” to learn about the subject. The study said:

“The students in the GbEl group achieved significantly better results in the cognitive knowledge test than the students in the script group [...]

(Boeker, Andel, Vach, and Frankenschmidt, 2013)
The game used in study by Boeker et al. (2013) was an adventure game and not a platform game, but it shows the potential of e-learning over scripted learning, scripted learning refers to "a written script", my interpretation of a written script is a hand-out form for example a lecturer. In this study the group that was learning the traditional way by reading a script was the control group and the group that played the game was the "GbEl" (Game-based E-learning) group. A reference group was also used, this group could use either of the two methods. To evaluate which method if any was better at teach the participant about the subject a single-choice test with 34 questions was used.

Their data showed that the students that played the game were more confident in their knowledge in comparison to the script group. The group that played the game also displayed they had the most fun playing the game that the researchers used, this can be seen in figure 5 in their paper.

The game used in this study was an adventure game and not a platform game, but it shows the potential of e-learning over scripted learning, scripted learning refers to "a written script", in this paper interpretation of a written script is a hand-out form for example a lecturer.

A paper from 2014 by Buchinger and da Silva Hounsell discuss a serious game called “Sherlock Dengue 8 (SD8)” which is a game about Dengue fever the paper discuss the design of a game where it has to fulfill and balance collaborative, competitive and pedagogical requirements but also be fun for the player and playable to as high of an extent as possible. Buchinger and da Silva Hounsell recognizes that there is little guidance to how a game in this domain should be designed, but there are many aspects and tips that can be used from usability theories. Tips and ideas from normal pure entertainment games could also be used when designing or developing a serious game.

The game include an achievement system as well as a ranking system. The reason SD8 implemented an achievement system was to incite re-playability the same reason is used for the ranking system; but it was also used to incite competition. The ranking system have a global ranking that show the pairs with the best score but it also have an individual school ranking that isolate each players score and groups the player by school level. The ranking-and achievement system can be used to expose the player to information they otherwise may have missed or ignored. There is plenty of players that enjoy “achievement hunting” where the goal is to gain every achievement that exist in the game. This however can cause the player to disregard the information so they can start hunting for the next achievement, it is however according to Buchinger and da Silva Hounsell (2014) a valid way to make the game more interesting and fun. The same could be argued for a ranking system, where the information loses focus and a higher score becomes more important.

The study conclude that even if a dengue fever vaccine isn’t available at the time, prevention should be taught as it is the best way to containing the infection growth. They also noticed that their envisioned version of the game became more robust (just competitive and just collaborative) and thus the game could be used for further researched into these distinct ways of play when it comes to teach to find and analyze the benefits and drawbacks of each one. In their conclusion the authors doesn’t discuss how well the information was absorbed by the players (Buchinger, da Silva Hounsell, 2014).
Fuchslocher, Niesenhaus, and Krämer (2010) uses a platform game in their study, in this game the player takes the role of an avatar that have diabetes. They developed two versions, explicit and implicit. In the study the explicit version is described in the following way: “In the explicit version, the player is directly confronted with the avatar’s diabetes disease within the introduction of the characters, the game’s story and the gameplay.”. The implicit version does not have any clear references to diabetes.

2.3 Different game genres

There are a lot of different genre when it comes to games. In this section a few of them will be briefly described. These genres are partly defined with the help from lecture notes by Hanna (n.d.). These genres are not only available in under the serious game genre but also for pure entertainment games.

2.3.1 Action games

Action games emphasize physical challenges, these challenges require good eye-hand coordination and motor skill to overcome. These games are often centered around the player, who is in control of most of the action.

2.3.2 Platform games

Platform games are games that often are set in a 2D vertical or 3D environment. The player have to navigate the environment by running and jumping between platforms and many times avoid obstacles and/or defeat enemies to advance. Super Mario Bros (Nintendo R&D4, 1985) is a famous example of a platform game. The goal is to navigate a variety of stages and avoid enemies and environmental hazards such as pits.

This is the game genre that will be used in this study. The reason for this is that only one study in chapter 2.2 used any kind of platform game. Can the results in this study shed any light on why this genre is underrepresented or will the results show that platform games can be useful tools for the player when learning about a particular topic? More details about this choice can be found in chapter 2.4.

2.3.3 Adventure games

The player often takes the role of the main character in the game and is tasked to solve various puzzles to progress in the game. Depending on the game story and other content can either be in or out of focus. Visual novels which as a subgenre to adventure games are games that often have a heavy story, an example of a visual novel would be Steins;Gate (5pb. Inc, Nitroplus. (2014) while adventure games such as King’s Quest (Sierra On-Line, 1984) is more focused on puzzle solving.

2.3.4 Puzzle games

The definition Hanna (n.d.) gives to puzzle games is the following: “Puzzle games often require the player to solve puzzles or problems and can involve the exercise of logic, memory, pattern matching, reaction time, etc.” and one of the examples lists is Tetris (Pajitnov, 1984).

2.3.5 Role playing games (RPG)

In RPGs the player are often given flexibility in terms of character development. These games started out as video games based on pen and paper games such as Dungeon and Dragons (1974). One of the most popular RPG game series to date is the Final Fantasy
(Square, 1987) series, games in this series is still being releases with the latest installment of
the series released 2017.

2.3.6 Simulation games
These games often aim to simulate physical activities such as flying an airplane, playing soccer
or other sports. Often a high level of realism is wanted in these games. But some simulation
games focus on management as well. A famous simulation game is Sim City (Wright, 1989)
which also is very popular to this day.

2.4 Why a platformer?
The author of this paper decided to go with a platformer for a number of reasons. One of
these reasons was that the related research (see chapter 2.2) only use a platform game once.
However, this platform game was not used as a learning tool in the study. Previous research
showed a lack of platformer games. Therefore, it could be interesting and beneficial to see if
these games can be used to teach the player about a particular topic.

Fuchslocher, Niesenhaus, and Krämer (2010) wrote the following in their study: ““Balance”
is a jump’n’run game (also called “platformer”) which refers to a very well-liked game genre
within the teenage target group.” This shows that the genre is popular outside of serious
games, which is another reason for the use of a platform game rather than a more common
genre in this field.

The Jump’n’run game used by Fuchslocher, Niesenhaus, and Krämer (2010) and the game
developed for the study in this paper share similar game mechanics. The player has to
navigate a level that is built with various platforms and obstacles to reach the end of the
level.

The study by Fuchslocher, Niesenhaus, and Krämer (2010) had 20 participants and it was
more focused on self-care rather than teaching about diabetes and how to best care for
yourself if you have diabetes. Which gives another reason for using a platform game. There
are no platform games that teach the player something. Therefore, a study that uses a
platform game could help determine if this particular genre is suitable for teaching people
about a particular subject.

2.5 Modeling infectious spread
One way used in medical research is to model the spread of a disease. One common way to
simulate the spread of a contagious disease is the SIR (susceptible, infected, recovered)
model. This model is a standard epidemiological model that computes the theoretical
numbers of people infected with a contagious illness over a period of time in a closed
population (Goeyvaerts, Willem, Kerckhove, Vandendijck, Hanquet, Beutels, Hens, 2015).
SIR is the most classical model for contamination modelling “Den mest klassiska modellen
för smittspridning är SIR-modellen.” (Tilevik, 2016). In the quote above, Tilevik is saying:
“The most classical model for infectious spreading is the SIR-model.”

Nesse at Arizona State University describe the SIR model like this:

“The SIR models the flows of people between three states: susceptible (S),
infected (I), and resistant (R). Each of those variables represents the number
of people in those groups. The parameters alpha and beta partially control how fast people move from being susceptible to infected (alpha), and from infected to resistant (beta).”

(Nesse, n.d.)

Another way to simulate spread is to use cellular automata (CA). One model used is a little different than traditional CA, it allow each cell to hold a variable number of hosts rather than just a single static host per cell (Fu, Milne, 2004).

If the goal is to teach however, a simulation model might make little sense to the participant (see Figure 2) if the participant does not have any previous knowledge in the field, a game such as a visual novel or an adventure game might be better suited. A possible problem with many of these games is that the game is tailored around a particular topic, and when the topic change it could require that the game is redesigned to fit the new setting or at the very least the content to be redesigned, which could require a lot of rework of the software. Redesigning could require new mechanics to be designed, new art, music, story and levels might also have to be redesigned. If the game is about for example Ebola, and a new game about the measles will be developed the base might still be used but the information in the game is probably not usable. This is a problem overall with serious games, and it is probably a problem that never will be solved.

![Figure 2](image)

**Figure 2** A screenshot from the application GLEAMviz (2017)
3 Problem

A high immunization ratio is important for global health and to keep vaccine preventable diseases at bay. The World Health Organization (WHO) published a global vaccine action plan that span the period 2011 – 2020, this plan was endorsed by 194 member states (World Health Organization, 2013).

WHO state the following in their global vaccine action plan:

“Overwhelming evidence demonstrates the benefits of immunization as one of the most successful and cost-effective health interventions known. Over the past several decades, immunization has achieved many things, including the eradication of smallpox, an accomplishment that has been called one of humanity’s greatest triumphs. Vaccines have saved countless lives, lowered the global incidence of polio by 99 percent and reduced illness, disability and death from diphtheria, tetanus, whooping cough, measles, Haemophilus influenzae type b disease, and epidemic meningococcal A meningitis.”

(World Health Organization, 2013, p.5)

One innovative way to teach people about the importance of a high immunization ratio is to use serious games. In this paper a platformer game has been developed that was used to answer the research question in this paper that is the following:

“What are the effects on vaccine preventable diseases learning when using a serious platform game compared to a compendium?”

The hypothesis is the following:

“The developed platform game will have a statistically significantly better result with respect to learning when compared to the compendium provided.”

One reason for this hypothesis is that some levels forced the players to redo the level and thus have a chance to re-read some of the information given in that particular level. Another reason is that a game could be seen as more fun and thus also encourage the player to finish reading all the text.

The null hypothesis is that there is no statistical significance between the game and compendium. In this study this means that there would be no difference in how well the material is learned when comparing between the game developed and the written compendium.

In short the null hypothesis in this paper is the following:

“The developed platform game will not have a statistically significantly better result with respect to learning when compared to the compendium provided.”

The target group will be “everyday people”, the age group will be men and women in the age group 20 – 40, they are also yet to be first time parents, and the test-subject should not work in a medical field.
3.1 Vaccines

An outbreak of the measles in the United States in 2014 caused a contentious discussion about child vaccinations, more and more parents express their concern about the safety regarding vaccinations and health. This concern is many times caused by the parents’ research or exposure to misinformation found in books, the internet and other non-medical sources (Glanz, Kraus and Daley, 2015). This have been one of the sources that have caused a major problem in the world regarding public health. This problem have made more people hesitant to vaccinating themselves and/or their children. It is however important to keep the immunization rates high to prevent outbreaks, regarding for example the measles. Glanz, Kraus and Daley wrote:

"In the case of measles, approximately 95 % of the population needs to be immunized to prevent outbreaks."

(Glanz, Kraus and Daley, 2015, p. 2).

As of March 15, 2017, measles have infected eight people in Stockholm, Sweden. Most of these cases have not had the measles vaccine, some of the cases their vaccination status was uncertain (1177 Vårdguiden, 2017). Sveriges Television (2017) mentioned ten infected individuals.

3.1.1 Adverse event reports

It is important to understand that an adverse event report (AER) describes the reactions that have manifested themselves close to the date when a vaccine was given. This means that the reaction could have happened even if the individual never received the vaccine. The report has to be analyzed thoroughly before any conclusion can be made regarding any potential connection to the vaccination. If an adverse event occur it is important to report it immediately (Medical products agency, 2016).

3.1.2 The Swedish child vaccination program

In Sweden every child can be vaccinated for free against ten serious illnesses – prior to 2010 it was only nine different illnesses – these illnesses are:

- Diphtheria
- Tetanus
- Pertussis
- Poliomyelitis (polio)
- Haemophilous influenza type b (Hib)
- Pneumococcal disease
- Measles
- Mumps
- Rubella
- Human papillomavirus (HPV) – This disease is not part of the study.

Basic information about each disease can be found in Appendix A - . The text found in Appendix A - will be the text used in both the game and the compendium the control group will use. This will allow the only varying variable to be how they learn. HPV is worth mentioning in this paper though, mainly because only females are vaccinated at this point in time.
Here is a short summary of HPV: Human papillomavirus (HPV) is a group of 100 related viruses. The name HPV comes from the warts (papillomas) some of the viruses in this group can cause. Some of the HPV viruses can also cause cancer in both men and women. HPV is transmitted through intimate skin-to-skin contact. The HPV-vaccine is given to girls in the fifth or sixth grade, and supplementary vaccination should be offered to girls up to the age of 18 (Folkhälsomyndigheten, 2017b)

If the child is immunocompromised the parents can be offered to vaccinate the child against chicken-pox, rotavirus and influenza. Children with a risk of contracting tuberculosis will also receive a single dose of Bacill Calmette Guérin vaccine at 6 months (GlaxoSmithKline (GSK), 2014).

3.2 Method

3.2.1 Before and during the pilot study
Prior to the pilot study the method consisted of playing the game or reading the text and afterwards answer the questionnaire provided in Appendix B. This was thought to be enough but after the first participant had done the experiment it was clear that this wouldn’t be enough. The author of this paper was not comfortable with comparing objective data against subjective data, a comparison between these two can be problematic, due to the fact that they may be incompatible. An example of objective data would be heart rate, the heart rate can be measured. An example of subjective data would be pain, it cannot really be measured accurately, not even by person experiencing it. In short, subjective data is relative, as pain is relative to the person experiencing it.

Since this participant already had played the game it was decided to not record the result, the data would have no baseline other than the answer if the participant had any previous knowledge, the reply given to the question was a “no”. A baseline in this study refers to a result prior to learning about the subject. In the pilot study participants was asked to test the game and then answer the questionnaire rather than answering the questionnaire, play the game and then answer it again.

3.2.2 Pilot study
Prior to the first participant in the pilot test, there was only a single questionnaire the player and reader should answer. This however could not be used to measure how much the player had actually learned. It was decided to let the participant answer the same questionnaire twice, once before playing the game or reading the compendium and a second time after playing the game or reading the compendium. They could not know if an option they selected was correct or not. So the usage of the same questionnaire twice should not have been a problem since the participant never learned their results prior to finishing the final questionnaire.

Without this change the analysis would have been based on what the participants had told the researcher about their pre-existing knowledge in the topic, which is a subjective opinion and not an objective one. To make it as objective as possible the best way would be to do the questionnaire twice, the first time for a baseline, and the second time to see if the participant had learned anything.
3.2.3 The new method

To evaluate the research question: “What are the effects on vaccine preventable diseases learning when using a serious game compared to a compendium?” a quantitative method was used. The age group of the participants in the study were between the age 20 and 32, the gender of each participant was also recorded. Each of the participant was put into one of two groups, the first group was the control group, and this group read the compendium (see Appendix A - ). The second group played the platform game. Both mediums contains the exact same texts.

Before playing the game or reading the compendium each participants was asked to answer a questionnaire (see Appendix B - ) with a few question about a few of the vaccine preventable disease in the child vaccination program, anyone with a score higher than 50 % of the total possible score was excluded. This number was chosen because it was deemed an appropriate number for this study.

The participants that played the game, played on average for 30 minutes. There was no information about how to play the game prior to starting the game, the first thing that happened in the game was that the player was told how to control their character. The game itself have nine levels that each contain information from the compendium throughout the level.

After finishing the game the participant was asked to answer same questionnaire again. The reuse of the questionnaire allowed for a better analysis of the results. For example if a participant had a near exclusion score before playing, but had a very low score after playing the game it could mean that the participant was only guessing the answer(s) in the questionnaire.

The participants that read the compendium, read the entire text on average in 15 minutes, and after reading the text the participant were asked to answer the questionnaire again.

Statistiska centralbyrån (Central Bureau of Statistics, CBS) (SCB, 2014) display statistics for “young” and “old” average age for first birth, the youngest age listed was 24.0 and the oldest was 32.4 for women and for men it was 26.8 and 35.2. The participants did not have to be parents, nor did they need to be in a relationship with plans for a child in the near future. The only requirements was that they were in the age group specified above and either were first time parents or have never been parents.

The reason the test subjects were in the age group 20 – 40 was because the average age of first birth is around this age. Potential parents often want the best for their child, and if the parents end up on vaccine opposing websites that often contain inaccurate and/or questionable information, their view on vaccinating their child might go from an obvious “yes” to a very firm “no”, and this can be damaging both for the child and the community they live in.

To know if a participant should be excluded, every participant answered a short questionnaire about vaccine preventable diseases. If they answered to many questions correctly they were excluded from the study. Another reasons for exclusions would be if the participant could not give informed consent.
The data was collected with a questionnaire. The player answered the same questionnaire before and after the play session. It was important to find enough test subject that could play the game, a low number makes it problematic to generalize the results. The definition of enough in this paper was 15 to 30 people.

3.2.4 What is a quantitative method?
A quantitative method emphasizes objective measurements and statistical analysis of the data collected through questionnaires. The method deals with numbers, logic and an objective stance. The numbers are unchanging and objective once they are collected. The data is often collected using one or more structured research instruments. The result are based on larger sample sizes that are representative of the population. With a quantitative method the research and its experiments are easily repeatable.

The focus was on gathering numerical data (score) that was determined by how many correct answers the participant successfully identified. This data was used to calculate and present an average score for each group.

3.2.5 Steps in the experiment
Both the pilot study and the actual experiment have the same structure, the pilot study only helped with finding issues with the questions and bugs in the game. Below in Figure 3 the steps taken by the participant is shown.

![Flowchart of the experiment for each participant.](image)

When the participant arrived the first thing that happened was that the participant was briefed about the purpose of the study and their part in the research. They were told that the participation in the study is voluntary and they can quit at any time, and that the researcher will not pressure them if they wish to quit. They were also told that the data recorded would only be used in this experiment and no other experiments. They were also told how the experiment would be conducted, for example that they would be observed out of view by the researcher. The consent to partake was given orally by the participant, there was no recording of their acceptance to participate.

Before a participant either read the compendium (see Appendix A - ) or play the game they were asked to answer a questionnaire (see Appendix B - ). This questionnaire took roughly ten minutes to complete for most participants. They could not see if they scored any points in any of the questions of the questionnaire.

After the questionnaire was completed they were presented with either the compendium or the game, depending on which group they were in. If the participant were selected for the game, they were asked to play the game from start to finish once.

After the play/read session, the participant was asked to answer the same questionnaire again without any waiting period. The questionnaire was blank and they had no access to
their previous responses. After the questionnaire was completed they could not see the results, but if they asked they could be told the result. Telling them this information would not influence the results in any shape or form.

The answers from both questionnaires were recorded in an excel document that was used to calculate the average score, standard deviation, and median for each group. With the answers from the post-questionnaire a T-test was used to see if there was any statistical significant difference between the two methods of learning.

In Figure 4 what the researcher of this paper did is shown.

![Flowchart showing each step taken by the researcher with each participant.](image)

**Figure 4** Flowchart showing each step taken by the researcher with each participant.

During the observation the researcher was merely observing the participant out of view to see that the experiment was conducted without any help from the outside, such as opening google to look something up.

The debriefing was quick and did not involve anything that could affect the research. The participant was asked if they wanted to know how they did. Most participants were interested in their results.

After the participant left, the researcher recorded the answers from both questionnaires in excel.

### 3.3 Discussion about the method

One problem with this method is that if the questionnaire is answered at home for example, the test-subject may use the internet to cheat on any or all of the questions, this will skew the result. Another problem with the game is that the player may ignore the information and focus on beating the game.

On the positive side, using a game rather than a written text might make the experience more entertaining and thus the test-subject may spend more time learning. In this paper there will be no research done in regard to any subconscious learning that happens while playing purely for entertainment.

The reasoning behind the first test was to have a baseline of the participant knowledge prior to playing the game or reading the compendium. This test also served as a gateway to exclude participants that had too much knowledge. The reasoning behind using a quantitative method is because the collected data will be objective rather than subjective, the author will only compile the data into diagrams and tables, so the data is not subjected to
any unintentional bias. The major reason however, was that the research question more or less demanded this method rather than using a qualitative method.

USC Libraries (2017) write the following about quantitative methods:

“Quantitative methods emphasize objective measurements and the statistical, mathematical, or numerical analysis of data collected through polls, questionnaires, and surveys, or by manipulating pre-existing statistical data using computational techniques. Quantitative research focuses on gathering numerical data and generalizing it across groups of people or to explain a particular phenomenon.”

USC Libraries (2017)

This reinforce the reasoning on why a quantitative method was to be used in this paper. The data will be objective, of course the opinion of the participant matters since they can decide to give a false answer because they for some reason do not agree with the scientific community. However, the data would still be objective, it is still “only” numbers. The strengths of using a quantitative method is that it allow for a much greater objectivity and accuracy of the results, with the premise that the subjects are honest and take their participation seriously. Quantitative methods also allow for summarization of vast amount of data.

This method have its limitations though, even though a quantitative method is very efficient and able to test a given hypothesis it may miss contextual details, the data collected is sometimes very narrow and might even be superficial. The results are also limited in that they only give a numerical description rather than a detailed narrative description, and provide a less elaborate account of human perception. The method is quite unnatural as well since the research is often done in an artificial environment that allow for higher level of control of the experiment. This may yield results that would not normally be found in the “real world”.

### 3.4 Artefact

To be able to evaluate the research question a small and simple platform game was developed. The task of the player was to complete the different levels in the game, each of which contain information about different diseases.

A few levels had questions at the end of the level where the player was asked a question and have to decide to jump down the hole they think was correct. The holes are labeled with a single letter starting with A. If the player jumped down the correct hole, he proceeded to the next level. If the player jumped down a hole that is not the correct answer for the question asked, the player is taken back to the start of the level.

Each level has enemies, the square at the bottom of the screen is an enemy (see Figure 5). There is also coins that the player can collect, the collected amount is set to zero at the beginning of each level. The coins serve no real purpose other than giving the player a feel that they are not just playing the game to read texts. Each level also have a varying amounts of signposts that contain information. The information these signposts contain are the same text that the compendium contains. Other elements in the game were stationary red squares with yellow crosses that caused the level to restart if the player touched them.
The reasoning behind choosing a platformer was mainly that to the best of the researcher’s knowledge, only one platform game has been used to convey health information, but that game did not compare itself against traditional teaching techniques. The design of the game was to keep it mostly simple, with a few exceptions, the game tries to resemble the old Super Mario Bros. game from 1985 on the Nintendo Entertainment System. This design has been around from at least 1985 and has worked for a lot of entertainment games. Even if the level design can be complex the core is very simplistic, move from point A to point B.

### 3.4.1 Design of the Artefact

The artefact for the research done in this paper was a platform game where the player navigates through levels looking for signposts. These signposts will tell the player various information about vaccine preventable diseases. The levels also have collectables in the form of coins, these do not serve any particular function other than being collected. At the start of each new level the coin-counter is set back to zero, it is mainly in the game to give the player something to do while moving between signposts. Another element in the levels are the enemies, they can only move back and forth horizontally, so they are very limited. If the player is touched by an enemy at any time during the level s/he will return to the start of the current level, the same will happen if the player falls down a hole in the ground.

At the end of some levels, there was a question with a set of possible answers, if the player answered incorrectly s/he was returned to the beginning of the level otherwise the player was moved to the next level. In the last level when the player entered the goal at the end of the level the game restarts and the player can play through each level again. The game is very lacking in graphics, and there is no sound effects or music in the game. These missing elements can affect the learning, either in a positive or negative way. The level design is also a little lacking, the researcher is not a level designer and if the level design can affect the learning experience is unknown, but it could be a factor. The player is a square (see Figure 5), that is controlled with the players keyboard. The controls are left-, right-, and the up arrow key. The left- and right arrow key move the players either left or right and the up arrow key causes the player to jump. The game is lacking a countdown timer for each level,
so there is nothing that prevents the player from staying on a single level for extended periods of time.

3.5 Ethical consideration

Four rules will be in effect during each experiment that will safeguard the individual on an ethical level (Vetenskapsrådet, 2002). The first rule is that the researcher shall inform the test-subject about their part in the research. Their participation is voluntary and they can end their participation at any point during the experiment. The test-subject is also informed about all the relevant information that may influence their willingness to participate.

The second rule requires the researcher to collect the test-subject’s approval, if the test-subject decide to read the compendium or play the game they have given their approval.

The third rule states that each test-subject shall have the right to decide if, for how long and on what conditions they shall participate. They shall be able to discontinue their participation at any point without any negative consequences.

The fourth rule states that a participant shall not be exposed to tortious pressure or be influenced by the researcher in regard to their decision to participate or end their participation.

In this study these rules were presented orally before the pre-questionnaire test was conducted.

In the study by Boeker et al. (2013) each participant was informed orally about the nature of the study. They were also informed that their participation was entirely voluntary and that the topic in the study would not be in any written examination during that semester; this means that there would be no consequence of participating or not participating. The students were also informed that they could use the "other type of training" they did not use in their training week, directly after the study.

At the end of the week an assessment was made, this assessment was anonymous and the student could decline to participate. By participating the student agreed on the anonymously analysis of their data. The university ethics committee agree with this oral agreement, according to Boeker et al. (2013) a formal written consent prior to the study was not possible.
4 Result and analysis

This chapter will discuss and analyze the results from the experiment discussed in chapter 3.2. In Figure 6 the average total score for 20 participants is shown, the game group had ten participants and the control group also had ten.

![Average score before reading the compendium or playing the game](image)

**Figure 6** Each category had ten participants. [G] = Game, [C] = Compendium.

In the game group the average value for correct answers was 5.00, the average for incorrect answers selected was 2.00, with a median of 0.5, and a standard deviation of ~2.74. For the control group that read the compendium the values are 6.30 and 1.63 with a median of 1, and a standard deviation of ~2.49. Figure 6 shows that the knowledge in both group are similar. The questions asked can be seen in Appendix B - . After each group had either played or read the text, they were asked to answer the questionnaire in Appendix B - .

In Figure 7 these results can be seen, the average score for correct answers in the game group went from 5.00 up to 18.70, and the average of incorrect answers went up from 2.00 to 3.30. The cause of the raise in wrong answers could be because during game play focus on learning could be lost and the player instead put his or her focus on completing the game rather than retaining knowledge gained during game play, the participant read the answer incorrectly, or the participant made a guess.

In this study an unpaired T-test was used to see if there was a significantly statistical difference between the two groups. Since the number of participants was ten in each group there will be a discussion involving randomized data using the calculated average and standard deviation, the random numbers have normal distribution.

4.1 The actual data

In Figure 9 it is possible to see that the control group had a bit more knowledge in the subject before they read their text, there was cases in the control group were we had participants that scored zero points. In the post-questionnaire for the control group, it is possible to see that even though some of the participants had a lower score around 14 points, with an extreme outlier of four points, knowledge had been gained. Where as in the game group the lowest score was 16 points, without any extreme outliers.

The average score in the pre-questionnaire for the control group was 6.3 (~21.72%), with a standard deviation of ~1.83 (1.8288). For the game group the average score was 5.0 (~17.24%), with a standard deviation of ~2.5 (2.4608). After both groups had either played the game or read the text the results for the participants had improved. The control group had an average score of 17.2 points (~59.31%) and the game group had a median of 18.5 points (~63.8%).

The score of both groups are similar, but that is only half of the picture, to see if there still is a difference between the two methods the unpaired t-test was used, in Figure 8 the formula used to calculate the T-value can be seen. The T-test showed that there was no statistical significant difference, this means that the null hypothesis could not be rejected.

- \( p(0.05) \)
- degree of freedom (18) = 2.10
- \( t = -0.73 \) (0.7227)
The formula used to calculate the T-value.

\[ t = \frac{|X_1 + X_2|}{\sqrt{\left(\frac{S_1^2}{n_1}\right) + \left(\frac{S_2^2}{n_2}\right)}} \]

**Figure 8**  The formula used to calculate the T-value.

As seen in Figure 9 the two groups have a result that is quite even both in the pre- and post-questionnaire, but relying on only this data can be dangerous.

![Box plot showing data comparison](image)

**Figure 9**  Results from the study with 20 participants.

Table 1 show a section of the critical values used in a T-test, in this study p is 0.05, with a degree of 18. What this means is that in 5% of the cases the result was purely random. So if the unpaired T-test gives a result that is lower than 2.10 (see Table 1) the null-hypothesis cannot be rejected. If the T-value higher than 2.10 the null-hypothesis can be rejected. The T-test in this study gave the T-value ~0.7 (0.7227), and this value is lower than the critical value of 2.10, so the null-hypothesis cannot be rejected.

**Table 1** Critical values of Student’s t distribution with ν degrees of freedom (df).

<table>
<thead>
<tr>
<th>df/ν</th>
<th>0.05</th>
<th>0.025</th>
<th>0.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>2.11</td>
<td>2.46</td>
<td>2.90</td>
</tr>
<tr>
<td>18</td>
<td>2.10</td>
<td>2.44</td>
<td>2.88</td>
</tr>
<tr>
<td>19</td>
<td>2.09</td>
<td>2.43</td>
<td>2.86</td>
</tr>
</tbody>
</table>

The data used in the T-test can be seen in Table 2, and the T-value is listed in the bottom row. Detailed data for each participant is available in Appendix C - for the pre-questionnaire, and Appendix D - for the post-questionnaire.
Table 2 Detailed information how the T-value was calculated.

<table>
<thead>
<tr>
<th>Unpaired T-test</th>
<th>Game</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>18.7</td>
<td>17.2</td>
</tr>
<tr>
<td>STDEV</td>
<td>2.626785</td>
<td>6.014797</td>
</tr>
<tr>
<td>n</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Variance</td>
<td>6.9</td>
<td>36,1778</td>
</tr>
<tr>
<td>X1</td>
<td>18.7</td>
<td></td>
</tr>
<tr>
<td>X2</td>
<td>17.2</td>
<td></td>
</tr>
<tr>
<td>S^2,1</td>
<td>6.9</td>
<td></td>
</tr>
<tr>
<td>S^2,2</td>
<td>36,1778</td>
<td></td>
</tr>
<tr>
<td>n1</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>n2</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>X1-X2</td>
<td>1.5</td>
<td></td>
</tr>
<tr>
<td>S^2,1 / n1</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>S^2,2 / n2</td>
<td>3.617778</td>
<td></td>
</tr>
<tr>
<td>S^2,1 / n1 + S^2,2 / n2</td>
<td>4.307778</td>
<td></td>
</tr>
<tr>
<td>SQRT</td>
<td>2.075519</td>
<td></td>
</tr>
<tr>
<td>X1+X2/SQRT (T-value)</td>
<td>0.722711</td>
<td></td>
</tr>
<tr>
<td>df</td>
<td>18</td>
<td></td>
</tr>
</tbody>
</table>

4.2 Analysis
In this chapter the data collected will be analyzed. There will be a sub-chapter that will have an analysis of when data is getting skewed by participants knowingly. One sub-chapter will discuss why the result looks like it does and another will talk about the participants.

4.2.1 Why does the result look like this?
After the study was completed and the T-test was done, the result showed that there was no statistical significant difference between the two groups. The reason for this might be because the game and the text contained the exact same information. There was no deviations between the information other than that inside the game the information came in smaller snippets that were placed on signposts, rather than presenting all of the text at once.

The hypothesis was the following: “The developed game will have a statistically significantly better result compared with the compendium provided.” In this study, the null hypothesis cannot be rejected and thus the hypothesis above cannot be supported, this means that the hypothesis has to be rejected.
4.2.2 The participants

The participants were selected by convenience sampling to fit the follow:

The target group will be “everyday people”, the age group will be men and women in the age group 20 – 40, they also are yet to be first time parents, and the test-subject should not work in a medical field.

The reason for this this selection was that according to Statistiska Centralbyråns (2014) this is the age when people usually get their first child, and thus it is possible to assume that an interest in health usually grows. This is so the parent can in their own mind do what is best for the child’s health, even if it may not always be the case.

It is worth noting that most participants were in the age range 20-24 though, there is no real reason for this however other than convenience of asking university colleges and friend, since all participants meet with the researcher. How this may affect the results is hard to speculate about, but if one assumption would be made, that participant with low game literacy would not necessarily perform worse but the play session could take longer, this should not affect the results.

Due to the sample selection the assumption can be made that almost every participant had high gaming proficiency, meaning they were accustomed to playing games on one or more platforms. This could affect how well they played the game, but it should not affect how well they remembered the information in either method.

The gender distribution in this experiment was 50% males and 50% females. In the age group 20-24 there was 30% males, and 70% females. This was the largest group with 13 participants. The second largest group was the age group 25-29 with 6 participants. The gender distribution in this age group was ~83.33% males, and ~16.66% females. The age group 30-34 had 1 male participant, and the last age group 35-40 had zero participants. Worth noting is that any potential effect from age and/or gender was not analyzed.

4.2.3 When data is getting skewed

One important thing to consider is how to deal with potentially participants that cannot take their own participation seriously. In this study there was one participant that did not take the participation seriously. It is hard to know if a participant is serious or not, but in this case the participant said it didn’t take its participation seriously from the start.

As seen in Figure 10 the data was compiled with one participant excluded, the excluding factor was that this participant explicitly told the researcher that the involvement was not serious and the answers given was just randomly selected. This participants scored four points in the pre-questionnaire and four points in the post-questionnaire. The average post-text correct score excluding this participant was 18.67 compared to 17.20 if the participant was included. The standard deviation changed from ~6.01 to ~4.06 when the individual was excluded. The average incorrect score remained the same at ~3.7, the median remain the same at 4, and the standard deviation for these incorrect answers went up from ~2.05 to ~2.13.
This is hard to discover unless a participant explicitly tells the researcher, but it is worth considering and it also show why clear exclusion criteria can help mitigate some of these problems. In this case a plus/minus zero result would not normally warrant an exclusion since it show that the method did not work for a particular individual. Worth noting is that the participant was not excluded in the presented results in chapter 4.1. When the participant was excluded the T-value went to ~0.02 from ~0.73. However, the impact of this single participant is minor, and does not affect the result nor the T-test in a negative way, the null hypothesis could still not be rejected.
5 Conclusions

In this chapter a conclusion will be presented based on the analysis made in the previous chapter. This chapter will summarize the analysis, hold a discussion revolving around the analysis and present future work.

5.1 Summary

The study found that it was not possible to reject the null hypothesis:

“The developed platform game will not have a statistically significantly better result with respect to learning when compared to the compendium provided.”

This was both unexpected and interesting, the findings from this limited sample size showed that there was no statistical difference between the two mediums, which can be seen as both good and bad. The good is that a platformer could be used to convey information about a given topic and still allow the player to learn just as much as if they were reading the text in a book or compendium. The bad is that the time spent playing was longer than the time spent reading, navigating through the world can be seen as “stealing” valuable study time, but for a person that is learning the extended time could be seen as small breaks that allow a fresh mind to read each new text-segment rather than the possibility of fatigue if the person was reading a long text instead. In this study however the one participant that performed as well as the others told me that their participation was not serious, and I decided to keep the data to be able to show how the result can be skewed because of situations such as this one, if this is not considered.

There was some tweaking of the game, the compendium, and the questionnaire. All of which aimed to be as good as possible. The control group did not report any issues with the text after the pilot test, except that a few words were hard to pronounce and they didn’t understand them, such as the word sequence “subacute sclerosing panencephalitis” (SSPP). But when answering the questionnaire they remembered the sequence, this was probably because the participants thought it was a sequence of hard sequence of words.

The result in the study could have been different if the game genre was different, it would be interesting to make a comparison between different genres, to see if there is any difference between genres in how well the material is learned. I think this game could be a foundation to continue this research on with a bigger sample size, based on the results discussed in chapter 4.1 it is possible to make the assumption that this genre is a valid method to teach. In chapter 2.4 a number of reasons for this particular genre is mentioned. The results show that this genre have potential, and therefore is an answer to the question asked in chapter 2.3.2: “Can the results in this study shed any light on why this genre is underrepresented or will the results show that platform games can be useful tools for the player when learning about a particular topic?”. However, this study is short-term and no long-term effects on retention of what was learned or how it affected learning over time was explored.

A reason to use serious games in comparison to reading a text could also be that the person playing the game might have an easier time to take in the information in comparison to reading a long text. How we learn best varies for everyone and a text might not be the best or even a good way for everyone. Therefore, a good game that contain the essential or identical information could be a lot better despite the increased time to complete the game. This holds
true even if the result in this study only reflect short-term learning and not on how well the participant remember the information depending on medium.

5.2 Discussion

In this paper, I have explored how a serious platform computer game effects the learning experience in comparison to a compendium. Both game and text contained the exact same information. Early thoughts were to make a simulation program that would show the spread of a disease with various amount of people vaccinating. This however turned out to be a bit too big for a single individual. The idea to do something related to health and especially vaccines were still strong. After researching what usually was being done in this field and noticing that mainly point-and-click games were being used in this field, the decision to see if a platform game could be an effective way to teach. The result showed that the game and compendium were equally efficient. All participants scored below 10 points in the baseline (pre-questionnaire) test (see Appendix B - ) with an average of 6.30 points for the participants that read the compendium (the control group) and 5.00 points for the participants that played the game.

Another paper by Buchinger and da Silva Hounsell (2014), also discuss learning with a game. Their game is also quite unique, it is a 3D-game were the player moves around in a big open world in a third-person view. The players play in pairs and they collaborate and compete against other pairs. However, the paper does not compare how well the game conveyed the information compared to another medium, nor does it evaluate how well each participant learned the information presented.

The game in this study was designed with a single player in mind, and there was no competition between the players. Each individual had to learn the material inside the game to score better in a post test. They could not rely on a partner. It is important to see that each individual can learn something by themselves rather than relying on someone else. If I were to redo the experiment I would add a timer to the game to record the time spent reading the text. Since this could be a factor in how well material is remembered. As it is now, this is not a variable that is being recorded.

Boeker, et al. (2013) wrote in their study that E-learning is more effective than using a script-based approach. In their study they had 145 medical students, this may not represent the general public, and thus it can be hard to generalize the results. The study in this paper showed (in a smaller sample set) that there was no significant difference between using a serious game and a compendium, see chapter 4 for more details. A possible problem with the study done by Boeker, et al. (2013) is that the acquired knowledge is measured through self-assessment. Self-assessment is not an unbiased way to measure knowledge gain, the results could be less than reliable.

Another topic worth discussing, is how and in what way this research could affect our society. People prefer to learn in different ways. Schools usually stick with the old and tested method of a text-book, lectures and maybe a movie to convey the knowledge. They use tests and grades to evaluate if the student at that point in time has gained a predetermined minimum knowledge about a particular subject. As this paper have shown a video game can teach the participant just as much as a text document can. So institutes that focus on learning should start using these emerging tools to help pupils that have trouble with
learning from texts. Giving the pupil another tool to learn can improve their knowledge gain and thus should be explored further.

A problem with implementing this solution is that not every student have access to a computer either at school. For serious games to work in an environment such as this requires a teacher that is proficient in using computers and understanding of new technology. Furthermore, to understand a game could be more complex than understanding traditional media such as books. In regard to time restrictions in a school, a book could be seen as more efficient than a game due to the fact that some pupils have little to no gaming experience and that can hamper their understanding of how to play the game.

The initial plan was to have a one week posttest as well, where participants would come back after one week and do the same questionnaire again. This test would be used to see how well their new knowledge were retained. This had to be scrapped due to a very low turn up, only one person turned up for this test which made it impossible to draw any useful conclusions.

5.3 Future Work

As mentioned in chapter 3.4.1 the game is lacking in both graphics and sound and that it could affect the learning experience. A game with more esthetically pleasing atmosphere could motivate the player to engage with game and feel more immersed. So one possible direction to take this could be to create a second artefact that add better graphics, sound and music to see if it have a positive or negative effect on the learning experience.

Also mentioned in chapter 3.4.1 is the lack of a timer, could a timer affect the learning and if that is the case to that degree? It could be interesting to see what would happen if the player and reader only had a set amount of time to read each snippet of text. This would require that each group have the same amount of time to read. So in the game each signpost could vanish after X seconds and the text the control group read also vanish after the same amount of time. The timer in the game would have to be placed on the signposts rather than on the level since the text is not presented to the player all at once, there are pockets of time were no reading is done.

Another possible direction of this study would be to have four groups, two controls for the game were one group contain participants that aren’t first time parents and the second are first time parents that have not been parents for long. And the game group have two groups with the same criteria. This could show if there is a difference in the interest of health depending on if the participant is waiting a child or already have a child.

In this work the study only looked at the immediate results rather than over time. The main reason for this was the lack of responses on the 1-week later questionnaire, it could be something interesting to look at how a longer experiment could or would affect the results. If the outcome is a positive result, this could be used to justify looking into other fields and genres of games. It would also be interesting to see if the game have an impact on retentive learning. If the is positive, that would be an argument for using serious games.

This research shows that a serious platform game do have potential as a tool for learning in the whole field of serious game health. Since platform games are a popular genre as long as the content is tailored it clearly have potential in other medical fields other than vaccines. Fuchslocher, Niesenhaus, and Krämer (2010) game about diabetics is a good example on
another field where platform games works, even if the genre in serious games still have some issues that needs to be resolved. One such issue is how to make these games both fun and educational. My personal opinion is that serious games are still games, and thus the game should also be fun. Even if the goal of the game is to teach the player something. If the game is a mere fact-dump on the player, they will probably end up stop playing the game.

As mentioned previously serious platform games have potential in the field of serious game health, and this needs to be explored further. The more tools available, the broader the audience will become. Not all genres appeal to everyone, some players prefer fast paced action, others prefer to explore, some prefer games that are heavy on the story while others prefer less story. Some of them prefer puzzle games while others prefer strategy. In short, people prefer different types of games, and as this research has shown serious platform games can work as a tool for learning about any health related topic.

A serious platform game allows the player to keep alert for the entire play session. This is because this genre often require attention from the player to successfully navigate through the levels of the game. However, it is important to keep the levels interesting and at the right level of challenge, otherwise the game becomes boring. If the game also put focus on the learning by giving the player time to either listen to a narrator say something or read a piece of information the player can also learn from the game. This research has shown that it is possible to both focus on the game and take the time to read the text in the game, with the end result that the player learned something. Change the text in the game to any other field in health and I suspect that the player will show that knowledge has been gained.

In a broader perspective this work could be used to justify others to look into how serious games can affect learning in other fields of interest and not only health related fields. The small sample size in this paper however makes the result less reliable. However, this should not discourage researchers from exploring new fields. This work even though it was on a small scale showed that serious games was helpful in some groups when it comes to learning.

Marklund (2014, p. 4) writes the following in his paper: “They allow the player to form an understanding of intricate subject matters based on participation and experimentation rather than mere observation, and thus they are often argued to have great potential as educational tools.” This justify looking into other fields in education to see if serious games are a suitable method for transferring knowledge from the educator to the student.

Any educational field will have a various types of people. Some of them will learn easier from for example hearing someone talk, reading books and/or text, or doing practical tasks. Playing a serious game could involve both reading and doing something practical. According to Shams and Seitz (2008) multisensory learning can be beneficial. They write “[t]he results presented here demonstrate that multisensory training can be more effective than similar unisensory-training paradigms.” but they also state that more research is needed in the field. Multisensory means using multiple sensor organs and unisensory means a single sensor organ. This helps to justify the usage of serious games in the educational realm as it often involves more than one sensory organ.
References


Appendix A - Diseases covered by the child immunization program in Sweden.

**Diphtheria** is an infection caused by a bacteria called Corynebacterium diphtheriae. This disease causes a thick covering in the back of the throat. This can lead to difficulty in breathing, heart failure, paralysis and in some cases even death (CDC, 2016a).

**Tetanus** (also called “lockjaw”) is caused by the Clostridium tetani bacteria. This bacteria will produce a toxin inside the body that causes painful muscle contractions. This infection often causes the neck and jaw muscle of the infected to lock, making it hard to open and swallow. It can also make it hard to breathe which in 1 to 2 cases out of 10 are fatal (CDC, 2017a; CDC, 2017b).

**Poliomyelitis** (Polio) is a crippling and in some cases even fatal infection. This virus spreads between individuals and can invade the infected person’s brain and spinal cord; which results in paralysis or partial paralysis. 72 out of 100 will have no visible symptoms, and about one out of four people will have flu-like symptoms that may include a sore throat, fever, tiredness, nausea, headache, and stomach pain. These flu-like symptoms usually last between two and five days and will go away on their own. A small proportion of infected individuals will develop more serious symptoms that affect the brain and spinal cord. These symptoms are the feeling of pins and needles in the legs (paresthesia), meningitis which is an infection that covers the spinal cord and/or the brain. This occurs in about one out of twenty-five people with a polio infection. About 1 out of 200 people with a polio infection will be paralyzed (can’t move part of the body), or cause weakness in the arms and/or legs. Paralysis is the most serious symptom of polio, as it can cause death by affecting the muscles that help the infected person to breathe. Polio can cause problems long after the individual think he or she has fully recovered, it can be as late as 15 to 40 years before post-polio-syndrome sets in (CDC, 2014a).

**Pertussis** is a highly contagious respiratory disease, it is caused by a bacteria called Bordetella pertussis. This disease causes violent and uncontrollable coughing that can make it hard to breathe, pertussis can be fatal for children that are under one year old (CDC, 2015a).

**Haemophilus influenza type b** (Hib) is a serious disease caused by bacteria. This disease usually affect children under the age of five but it can affect adults with certain medical conditions as well. This bacteria spreads between persons and an infected individual may be asymptomatic, so a healthy individual may be infected by someone that does not know he or she is a carrier of the bacteria. If the bacteria stay near the nose and throat of the child it will probably not get sick, but the bacteria sometime spread to the lungs or bloodstream. If this happens Hib can cause serious problems. Prior to the Hib vaccine, Hib was the leading cause of bacterial meningitis in children under the age of five in America. Hib can also cause pneumonia, severe swelling in the throat that makes it hard to breathe, infections in the blood, joints, bones, and covering the heart, it can also lead to death. Before the Hib vaccine was introduced in America, about 20 000 children under age of five got Hib every year, and between 3% and 6% of these children died (~600 – 1200). Since vaccination against Hib began the number of invasive Hib cases has decreased by more than 99% (CDC, 2015b).
Pneumococcal disease causes a wide variety of diseases and they exist in all places of the world. They are one of the mayor causes to pneumonia and fatalities among older people are common. They can also cause meningitis and sepsis. These diseases can happen at any age, even if they are more common in children under the age of two and adults over the age of 65. In 2009 Sweden added vaccination against pneumococci in the universal vaccination for infants, prior to this around 100 children under age of five got sick with a serious pneumococci disease every year and three to four children died (Folkhälsovmyndigheten, 2016).

Measles (Rubeola) is often called a “childhood disease” and many assume it is a disease that cannot cause any serious problems. The disease start with fever, runny nose, cough, red eyes and a sore throat. The infected individual will also develop a rash that spreads over the body. The disease is very contagious and spreads through the air when an infected individual sneezes or cough. Some of the more common complications of measles includes inflammation of the laryngitis (the voice box), pneumonia, bronchitis, croup, and it remains a leading cause of vaccine-preventable infant mortality (CDC, 2015c). In about 1 in 1000 the measles can cause acute inflammation of the brain, in very rare cases (~5-10 per 1 million) a late complication can occur called subacute sclerosing panencephalitis (SSPP), and this occurs on average 7-10 years after the measles disease. In high income countries the fatality rate of measles is 1/1000-5000 cases (Folkhälsomyndigheten, 2017a).

Mumps is another “childhood disease” that many associate with a disease that is not dangerous, it is highly contagious and the virus spreads by coughing and sneezing. However mumps can lead to some serious complications, these includes encephalitis (inflammation of the brain), meningitis, mastitis (inflammation of the breast tissue), oophoritis (inflammation of the ovaries), and deafness. Mumps can in very rare cases be fatal. In males it can lead to orchitis (inflammation of the testicles) that can cause fertility problems (CDC, 2014b). In Sweden this disease must be reported by law by the doctor that treats the patient.

Rubella is a disease that spreads by a virus and it only cause problems in humans. It spreads through droplets that infect new individual through the mucous membranes in the nose. A pregnant woman could pass it on to her developing baby. If this happens a developing baby could develop serious birth defects such as heart problems, loss of hearing and eyesight, intellectual disability, and liver or spleen damage. Among people infected between 25% and 50% will not show any symptoms. One to five days prior to the rash showing up a few other symptoms could manifest themselves. These includes a low-grade fever, headache, mild pink eye, swollen and enlarged lymph nodes, cough, and runny nose. A sore throat can be a symptoms in adults (CDC, 2016b; Folkhälsovmyndigheten, 2013).
Appendix B - The questionnaire

These are the questions asked in the questionnaire. Correct answers will be bolded. There are a total of 52 answers in 9 questions. There are a total of 29 correct answers and 23 wrong answers.

- Name or alias (only used to pair results together, you will remain anonymous)
- Gender
  - Man
  - Woman
  - Other
  - Prefer not to disclose
- Age
  - 20-24
  - 25-29
  - 30-34
  - 35-40
  - 41+
- Do you have an education in medicine?
  - Yes.
  - Yes, but limited.
  - No.
- Did you play the Game or read the Compendium?
  - Game
  - Compendium
- Which of these statements about tetanus (lockjaw) are true?
  - Causes painful muscle contractions.
  - Causes blistering in the throat.
  - Can be fatal.
  - Can make it hard to breathe.
  - Is caused by a virus.
  - Is caused by a bacteria.
  - I don’t know.
- Diphtheria is an infection that can lead to difficulty in breathing, heart failure, paralysis and in some cases even death.
  - True, excluding death.
  - True, including death.
  - False, diphtheria is a harmless disease.
  - False, with a proper diet you will not diphtheria.
  - I don’t know.
- What is true about polio?
  - About 70 out of 100 will not show any symptoms of the disease (they will be asymptomatic).
  - Polio is not a possibly deadly disease.
  - Polio can affect the brain and spinal cord.
  - Polio is harmless if you eat properly and are in overall good health.
  - Polio can cause meningitis.
- About 1 in 200 will be paralyzed or have weakness in arms and/or legs.
- Polio can cause problems later in life even if it looks like the individual has fully recovered.
- Polio is caused by a virus.
- **Polio is caused by a bacteria.**
- I don’t know
- **What is true about pertussis?**
  - Pertussis is a highly contagious disease that affects the brain.
  - Pertussis is harmless to children and adult alike.
  - **Pertussis causes violent and uncontrollable coughing that makes it hard to breathe.**
  - Pertussis is caused by a virus.
  - **Pertussis is caused by a bacteria.**
  - I don’t know.
- **What is true about haemophilus influenza type b (Hib)**
  - Hib usually affect adult, but not children.
  - **Hib can be spread from person to person.**
  - **Hib was prior to the Hib vaccine a leading cause for bacterial meningitis in children under the age of five in America.**
  - Hib cannot be fatal.
  - **Hib can cause pneumonia, severe swelling in the throat, and infections in the blood, joints and bones.**
  - **Hib can cover the heart.**
  - **Hib is caused by a bacteria.**
  - Hib is caused by a virus.
  - I don’t know.
- **What is true about pneumococcal disease?**
  - **Can cause a wide variety of diseases and can be found all over the world.**
  - Can be fatal among older people, but not to children.
  - It cannot cause meningitis or sepsis.
  - **The disease can happen at any age.**
  - It can cause haemorrhaging from all orifices.
  - I don’t know.
- **What is true about the measles?**
  - Measles is a harmless childhood disease.
  - **Measles can cause subacute sclerosing panencephalitis.**
  - Measles is not contagious.
  - **Measles can be fatal in high income nations.**
  - I don’t know.
- **What is true about the mumps?**
  - **Can be fatal.**
  - Is a harmless childhood disease.
  - **Can cause fertility problems in males.**
  - Is not contagious.
  - **Is caused by a virus.**
  - Is caused by a bacteria.
o I don’t know.

- What is true about rubella?
  o A pregnant woman cannot transmit rubella to her developing baby.
  o **Between 25% and 50% shows no symptoms.**
  o It is spread through direct touch.
  o **It is caused by a virus.**
  o It is caused by a bacteria.
  o I don’t know.
Appendix C - In-depth data from the pre-questionnaire.

These tables represent data from the pre-questionnaire. Meaning this was the questionnaire the participant answered prior to playing the game or reading the compendium, depending on which group they were in.

In Table 1 we can see some information for each participant. In the column “Gender” it could either be ‘M’ or ‘W’ where ‘M’ stands for man, and ‘W’ stands for woman. The “Group” column tells the reader if the participant was in the game group or text group, the text group is the control group. The column “Age” shows which age group the participant is a part of. The last column “Do you have any education in medicine?” tells the reader if the participant had any previous education in the field of medicine in general.

Table 1 Information about each participant.

<table>
<thead>
<tr>
<th>ID</th>
<th>Gender</th>
<th>Group</th>
<th>Age</th>
<th>Do you have any education in medicine?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>Game</td>
<td>25-29</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>M</td>
<td>Game</td>
<td>25-29</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>M</td>
<td>Game</td>
<td>25-29</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>W</td>
<td>Game</td>
<td>20-24</td>
<td>No</td>
</tr>
<tr>
<td>5</td>
<td>W</td>
<td>Game</td>
<td>20-24</td>
<td>No</td>
</tr>
<tr>
<td>6</td>
<td>M</td>
<td>Game</td>
<td>20-24</td>
<td>No</td>
</tr>
<tr>
<td>7</td>
<td>M</td>
<td>Text</td>
<td>25-29</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>Text</td>
<td>20-24</td>
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</tr>
<tr>
<td>9</td>
<td>W</td>
<td>Text</td>
<td>20-24</td>
<td>No</td>
</tr>
<tr>
<td>10</td>
<td>M</td>
<td>Text</td>
<td>30-34</td>
<td>Yes, but limited</td>
</tr>
<tr>
<td>11</td>
<td>W</td>
<td>Text</td>
<td>20-24</td>
<td>No</td>
</tr>
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<td>Text</td>
<td>20-24</td>
<td>No</td>
</tr>
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<td>13</td>
<td>W</td>
<td>Text</td>
<td>20-24</td>
<td>No</td>
</tr>
<tr>
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<td>W</td>
<td>Game</td>
<td>20-24</td>
<td>No</td>
</tr>
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<td>Text</td>
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</tr>
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<td>W</td>
<td>Game</td>
<td>20-24</td>
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<tr>
<td>18</td>
<td>W</td>
<td>Game</td>
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<tr>
<td>20</td>
<td>M</td>
<td>Text</td>
<td>20-24</td>
<td>No</td>
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</table>
In Table 2 we can see the number of correct and wrong answers given for the first four questions of the questionnaire. There was no analysis on the number of wrong answers the participant checked.

**Table 2** Answers for four out of nine diseases in the pre-questionnaire.

<table>
<thead>
<tr>
<th>ID</th>
<th>(4) Tetanus</th>
<th>(1) Diphtheria</th>
<th>(6) Polio</th>
<th>(2) Pertussis</th>
</tr>
</thead>
<tbody>
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<td>0</td>
<td>5</td>
<td>0</td>
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<td>0</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
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<td>1</td>
</tr>
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<td>1</td>
<td>3</td>
<td>0</td>
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<td>0</td>
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<td>0</td>
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<td>0</td>
<td>1</td>
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<td>0</td>
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<td>0</td>
<td>2</td>
<td>0</td>
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<td>0</td>
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<td>2</td>
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</table>
The number of correct/wrong answers given to the last five questions are displayed below in Table 3.

**Table 3** Answers for five out of nine diseases in the pre-questionnaire.

<table>
<thead>
<tr>
<th>ID</th>
<th>(8) Haemophilus influenza type b</th>
<th>(3) Pneumococcal disease</th>
<th>(3) Measles</th>
<th>(4) Mumps</th>
<th>(2) Rubella</th>
</tr>
</thead>
<tbody>
<tr>
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<td>0</td>
<td>0</td>
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<td>1</td>
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</tbody>
</table>
Table 4 below show the total number of correct/wrong answers each participant had in the pre-questionnaire. Participant 1 had zero correct, and zero wrong answers. This means that the participant choose the answer “I don’t know” on all questions.

**Table 4** The total amount of points over all questions for each participant in the pre-questionnaire.

<table>
<thead>
<tr>
<th>ID</th>
<th>Correct answers selected</th>
<th>Wrong answers selected</th>
</tr>
</thead>
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</table>
Appendix D - In-depth data from the post-questionnaire.

The tables in this appendix represent data from the post-questionnaire. Meaning this was the questionnaire the participant answered after to playing the game or reading the compendium, depending on which group they were in.

In Table 1 we can see some information for each participant. In the column “Gender” it could either be ‘M’ or ‘W’ where ‘M’ stands for man, and ‘W’ stands for woman. The “Group” column tells the reader if the participant was in the game group or text group, the text group is the control group. The column “Age” shows which age group the participant is a part of. The last column “Do you have any education in medicine?” tells the reader if the participant had any previous education in the field of medicine in general.

<table>
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<tr>
<th>ID</th>
<th>Gender</th>
<th>Group</th>
<th>Age</th>
<th>Do you have any education in medicine?</th>
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</thead>
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<td>No</td>
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<td>Game</td>
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<td>No</td>
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<td>Text</td>
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<td>No</td>
</tr>
<tr>
<td>8</td>
<td>M</td>
<td>Text</td>
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<tr>
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<td>Text</td>
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</tr>
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<td>M</td>
<td>Text</td>
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<td>Yes, but limited</td>
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<tr>
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<td>Text</td>
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</table>
In Table 2 we can see the number of correct and wrong answers given for the first four questions of the questionnaire. There was no analysis on the number of wrong answers the participant checked.

### Table 2
Detailed results for the first four out of nine questions in the questionnaire.

<table>
<thead>
<tr>
<th>ID</th>
<th>(4) Tetanus</th>
<th>(1) Diphtheria</th>
<th>(8) Polio</th>
<th>(2) Pertussis</th>
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</table>
The number of correct/wrong answers given to the last five questions are displayed below in Table 3.

**Table 3** Detailed results for the last five questions in the questionnaire.

<table>
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<th>ID</th>
<th>(8) Haemophilus influenza type b (Hib)</th>
<th>(3) Pneumococcal disease</th>
<th>(3) Measles</th>
<th>(4) Mumps</th>
<th>(2) Rubella</th>
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</tbody>
</table>
Table 4 shows the total number of correct/wrong answers each participant had in the post-questionnaire.

**Table 4** The total amount of points over all questions for each participant in the post-questionnaire.

<table>
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