A STUDY IN HISTORY TEACHING USING SERIOUS GAMES

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Abstract

The goal of this study is to observe if having more interactivity and media richness in teaching will lead to more meaningful learning and remembering information longer, compared to more traditional teaching such as books and slideshow presentations. It has been revealed that using multimedia tools such as video games, which use different cognitive load-reducing methods, can help the learner use less irrelevant cognitive process. This will lead to more cognitive load being assigned to more relevant materials. Two groups of participants were compared to each other, where one group was asked to play a video game containing historical information about the city of Skövde, while the second group was presented with a slideshow containing the historical information but only as simple text. The results from the experiment suggested that there is a significant difference between the two groups, meaning the participants who were asked to play the video game has less difficulty in recalling information after 7 days compared to the group who only read the slideshow presentation.

Keywords: Game-Based Learning, Cognitive Load, Meaningful Learning, Memory, Serious Games
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1 Introduction

In an article by Wainwright (2014) it is mentioned that video games have recently been recognized for their potential in teaching history in different ways. However, he also mentions that in these types of games, education takes a secondary priority. There are some studies according to Wainwright (2014) that demonstrate the immersion that video games creates while educating players about history. Here, Wainwright (2014) uses the game Civilization IV (2005) as an example of a game teaching history. In this game, the player takes the role of different rulers such as Catherine the Great for Russia who guides the player from Russia’s development in 4,000 B.C.E. to the twenty first century. Furthermore, Mortara et. al (2014) mention in their article, how virtual reality or worlds have been very useful in cultural heritage education by giving the player an immersive experience. An example of using virtual reality in cultural heritage is a virtual museum, which gives the user a first person experience which can also be beneficial in using different types of multimedia techniques in showing different content and information about the subjects in the museum. Although being very useful and efficient, Mortara et.al (2014) argue that this kind of application lacks the mechanism that allows more people participating in these activities. Therefore, games with educational purposes or Serious Games are becoming more and more popular, as it achieves teaching the player through a fun and immersive experience. In an article by McCall (2012), it is mentioned that not much research has been done in understanding the benefits of video games in history education. One of the areas that need more research is the use of multimedia instructional tools, which McCall (2012) suggests can be effective when used in a classroom environment. One of the good aspects of educational games is that is not exclusive to a particular genre of video games and it can be created by using different kinds of genres such as role-play and strategy games which can also be used as an active learning tool and help students learn more knowledge over time. According to McCall (2012), it is known that simulations are an effective tool for teaching the possibilities and consequences of different choices in a mathematical and physical world. An interesting aspect that simulation games introduce is the use of microworlds which represents “digital microcosms” which models the scientific and mathematical concepts for users, ranging from geometric properties to physical forces and chemical interactions” (McCall, 2012, p10). By the including rules in the microworlds, students can learn more efficiently by directly experiencing how the rules operates inside these worlds. It should also be mentioned that in some situations, it might be difficult for students and learners to pay attention and feel immersed to the materials presented in the classroom. This will lead to the information not being process and organized efficiently, which will make recalling it more difficult. This is why it is important to discover new and more efficient methods to present and teach information for learners.

As mentioned in the beginning, the goal of this study is to compare which type of teaching is more effective, traditional or game-based. The traditional teaching method is the use of media such as text and films in order to teach history. While advanced teaching, is using multimedia tools such as video games in order to teach history. Similar to every other experiment, one of the essential aspects that should be focused on at the beginning of each study is the target group. For this study it was established that the target group would be any person from the age of 19 to 40 with gaming experience. It is also important that if the participants have some level of gaming experience in order to avoid players having difficulties controlling the game. Hopefully, depending on the results of this study, researchers and educators can in the future use similar methods and theories to develop
video games as a teaching tool. For this study, it was decided to feature two test groups, the one which the information is presented to them by playing the game, while the second group receives the information through a slideshow presentation.
2 Background

2.1 Game Based Learning

Before going any further, it is important to explain what a serious game is and how it relates to these types of studies. Zyda (2005; reviewed in Rego, Moreira and Reis, 2010) explains serious games as:

“A mental contest, played with a computer in accordance with specific rules, which uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives.” (Zyda, 2005, p.26)

Michael and Chen (2006; reviewed in Rego, Moreira and Reis, 2010) state that while serious games should be entertaining, enjoyable and fun; it is not the main purpose. Also, according to Rego et al (2010), many types of platforms and technologies can be used for developing serious games. By using engagement and entertainment, serious games can motivate players in achieving specific goals such as improving a specific skill or better teaching. According to Zyda (2007; reviewed in Rego, Moreira and Reis, 2010) and Michael and Chen (2006; reviewed in Rego, Moreira and Reis, 2010), serious games can be applied to many different groups of domains such as healthcare, political, educational, government, religious games and art. One example is the military domain, where games like America’s Army (2012) are used in order to motivate people to join the army.

According to McCall (2012), students learn more efficiently if they are more actively involved in the learning environment (discovery learning) compared to when students are told the things they need to learn. However, there has not been enough research which suggests that using game environments as teaching tools are more effective than traditional methods. McCall (2012) writes that some studies, argue that discovery learning is not effective because of its short learning spans, and that it does not test for self-regulation and self-correction. McCall (2012) points out that recently, an important type of method has been proposed for discovery learning which is narrative computer games, the reason for this is that the players or learners are more likely to be more deeply engaged in the gameplay if a story line or narrative is included in the game compared to receiving the information and instruction via a multimedia presentation, such as a PowerPoint slide. However, McCall (2012) mentions in his article that it is important to have realistic context and guidance for discovery learning, in order to have an ideal learning condition. McCall (2012) further argues that in an exploratory condition, adventure based computer games have the potential for critical learning and to encourage activeness. One important aspect of the environments in adventure games is providing easy beginning stages, which provide the learners a generalization which is useful for more difficult stages. Also, another potential method for discovery learning are virtual environments which according to McCall (2012), re-creates real world environments which help the users feel more immersed.

In an article by Wong et al. (2007), it is mentioned that two of the essential technological aspects of entertainment in new media, are media richness and interactivity. Both of the aspects have a direct effect on learning by connecting attention to educational materials. Another way that both media richness and interactivity effect learning is indirectly, this is done by having higher enjoyment levels, which leads to higher motivation for more efficient
information processing. To summarize, by having purposeful selection of materials and by enhancing the enjoyment level, a more efficient learning process can be achieved.

Mitchell and Savill-Smith (2004) discuss in their review the benefits and barriers of computer game-based learning. These beneficial features of using video games as a learning tools include improving a number of cognitive skills and learning process such as working memory. Furthermore, in an article by Hubert-Wallander, Green, and Bavelier (2010) it is mentioned that amongst other things, training with video games for a few hours will increase the ability to assign cognitive resources among different locations and tasks more efficiently while searching for a target. Despite adapting the older generations to newer learning environments and exposing them to new technology has been difficult, according to Stewart et al. (2013), by benefiting from the content from the exposure to new technologies and training, the older generations can optimize their learning abilities. Also, according to Lai et al. (2013), students who receive information and knowledge through game based learning where they participate in game activities, increase and at the same time maintain the learning motivation of the students, compared to traditional education. However, Lai et al. (2013) mentions an article by Echeverria et al. (2011) which points out the difficulty of designing a system where educational content are combined with video game element. Here, a design method is proposed where in a fictional story; the interaction with the fictional characters inside the story should correspond to the appropriate course subject and information.

2.2 Long-term Memory

Considering that memory is part of Cognitive science, it is essential to explain this specific area in more detail. One of the main focuses of this study is how teaching history through video games affects the long-term memory. According to Hofgren (2009), memory revolves around information being encoded, stored and retrieved. Memory also consists of different processes, forms and neural mechanisms. There are two types of memories, short-term and long-term memory. Short-term memory, also known as working memory or immediate memory, has a limited capacity for storing information and ranges from seconds to around two minutes. Long-term memory however, is considered as a permanent storage where it receives the processed data from the working memory. Managing the processes that involves learning, comprehending and reasoning is also done by the working memory.

One of the two main types of long-term memory is “implicit” memory which relates to the procedural or unconscious part of the cognitive process. The second type is called “explicit” memory which focuses on the declarative and conscious part of the cognitive load. According Dew and Cabeza (2011), explicit memory revolves around the retrieval of past experiences or information which is measured with free recall or recognition tasks. This means that tasks such as recalling events from the past or remembering the lyrics to a song, uses explicit memory. For this research, it was decided to study the explicit memory of the participants, considering that in order to complete the surveys, they require to access past information which they have received during the test sessions.

2.3 Cognitive Load Theory

A theory presented by John Sweller (1988) was developed while studying problem solving. In cognitive load theory, Sweller argues that cognitive load in learners can be reduced by
instructional design. The main purpose of the theory is to close the gap between human cognitive architecture and information structures which are shown in the instructional materials, in order so the working memory can be used more efficiently (Sweller, 1988; Huang and Johnson, 2009).

Huang and Johnson (2009) mention in their article that in cognitive load theory, there are three types of cognitive loads which when combined, the total cognitive load will be created, which will not surpass a person’s working memory capability while learning new materials. The first category of cognitive load is the intrinsic load, which is related to the element interactivity, which is part of the instructional material. This means, if information and instructional materials has high element interactivity, it requires more working memory in order to process the materials, which will increase the intrinsic cognitive load. The second type cognitive load is the extraneous or ineffective load, which focuses on the process of working memory searching for information. The amount of extraneous load depends on how much working memory is required to complete learning tasks, and the way the materials are presented to the learner. Therefore, if the instructional design is more efficient, the ineffective cognitive load (extraneous) will be reduced. The last cognitive load type is called the germane or the effective cognitive load, which represents the effort that a person puts in order to construct automation and schema with less difficulty. This means that higher consistent load leads to deeper learning. To summarize, the goal of cognitive load theory is to increase the effective cognitive load, such as useful cognitive load which helps deeper learning and decrease the ineffective cognitive load such as extraneous cognitive load (Huang and Johnson, 2009).

2.3.1 Four Components/Instructional Design Model

The Four Components/Instructional Design Model also known as 4C/ID model presented by Huang and Johnson (2009), is a systematic, nonlinear and integrated instructional design model with the goal of increasing useful cognitive load and reducing the extraneous and irrelevant cognitive load, while the learner is in a complex learning environment and the learning process is occurring. Additionally, the model gives the developers the ability to intentionally design a game that targets specific skills of the player. This is done by combining the model’s design components and forming a relationship between them, which creates specific and complex learning environments for the learner. The 4C/ID model consists of four nonlinear design components.

Learning tasks: The first component of the model consists of authentic experiences which helps learners with schema construction for rule automation. It is important that learning tasks are complex and have the integration of the constituent skills. The learning tasks are categorized from simple to complex in order to select and develop more efficient learning tasks.

Supportive Information: The second component is mostly to “supports the learning and performance of non-recurring aspects of intended tasks” (Huang and Johnson, 2009, pp 8). This means that learners can use models and theories as supportive information for problem solving.

Just In Time Information (JIT): This component helps the learners to generate automated responses more easily. In JIT component, principles and rules are implemented and use
instances and demonstrations in order to explain the principles for all learning tasks more efficiently.

Part-task practice: The last component for this model promotes “rule automation for selected recurrent aspects of the intended complex task” (Huang and Johnson, 2009, pp 8). This design focuses on steadily expanding the learner’s ability to “automate the performance of recurrent skills” (Huang and Johnson, 2009, pp 8) using task building blocks.

Basically, the goal of Huang and Johnson’s (2009) model is to decide which one of the model’s aspects should be implemented more in the gaming’s characteristics which are challenge, competition, rules, goals, fantasy and changed reality, representation or story, curiosity and engagement, role-playing, control, multimodal presentation and task. For example, the primary design component with a higher priority, which is needed for creating a learning environment in a video game based on challenge, should be “learning task”. The secondary design component with less priority is “supportive information”, which should be used carefully if the designers want to create an instructional game with challenging gameplay. Finally, the design components with the lowest priority in creating a challenging gameplay, is “JIT information” and “Part-task practice” components from the model.

Another example is the engagement and curiosity characteristic, where the design component with the highest priority, is the “JIT information”. The reason for this is so the player would feel interested and immersed in the game. Also, in order to make the learner more engaged and curious, the learning environment has to be relevant for the player’s past experience. Furthermore, the component with less priority that is used for keeping the player engaged is “learning task” and “supportive information”. By using these two components, players can be guided constantly so that their cognitive structure will improve. This will lead the player to discover new methods to process information. And finally, the design component with the least priority for the engagement and curiosity characteristic is the part task part-task practice component. A few examples from Huang and Johnson (2009) design models can be seen in the figures shown below.

![Figure 1-Design emphasis for challenge. After Huang and Johnson (2009)](image-url)
2.4 Cognitive Theory of Multimedia Learning

2.4.1 Meaningful learning
Before going any further, it is important to explain the definition of meaningful learning. According to Mayer and Moreno (2003), meaningful learning revolves around connections which are being built between the verbal and pictorial representations during cognitive processing. This will lead to the learner’s receiving and processing the material more efficiently. This includes paying attention to the more essential parts of the presented information, and organizing it into a rational cognitive structure which will integrate with already existing relevant information. Mayer and Moreno (2003) also state that meaningful learning is achieved when the learner has the ability to use previous known information and apply them to new situations, in order to solve problems more efficiently.

2.4.2 Multimedia principle
A theory also known as the “multimedia principle” which was presented by Mayer (2001), suggests that people are able to learn more efficiently from pictures and words than from using only words. Nevertheless, this does not mean that by only adding pictures to words will make learning more efficient. The theory proposes that when it comes to learning through multimedia, there are three assumptions. According to Mayer and Moreno (2003) the first assumption is the human information processing system which consists of two channels, the first channel is the verbal and auditory channel, which is used to process verbal representations and auditory input. The second channel is the pictorial and visual channel which is used in order to process pictorial representations and visual input. The second assumption mentioned by Mayer and Moreno (2003) is that each channel which was mentioned earlier, has limited capacity of cognitive processing can occur in the verbal and visual channel. The last assumption is about the amount of cognitive processing required in the visual and verbal channels in order to achieve meaningful learning. This includes a person paying attention to the materials which are presented, organizing the material mentally into a coherent structure and lastly, integrating existing knowledge with the material presented. To summarize, to achieve meaningful learning, one should “select relevant information, organize it into coherent representations, and integrate it with other knowledge” (Mayer & Moreno, 2002, p. 111).
The table presented by Mayer and Moreno (2003) shows the three assumptions about how the mind works in multimedia learning.

Table 1: Three Assumptions about how the mind works in multimedia. After Mayer and Moreno (2003)

<table>
<thead>
<tr>
<th>Assumption</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual channel</td>
<td>When humans have separate information processing channels for visual and verbal material</td>
</tr>
<tr>
<td>Limited capacity</td>
<td>Only a limited amount of processing capacity is available in the visual and verbal channels.</td>
</tr>
<tr>
<td>Active processing</td>
<td>Substantial cognitive processing in the visual and verbal channels is required for learning.</td>
</tr>
</tbody>
</table>

In his book, Mayer (2001) uses figure 3 in order to summarize and represent the cognitive theory of multimedia learning. The figure consists of five columns and two rows, where the rows represent the two auditory and verbal channels mentioned earlier. The five columns shows the types of knowledge representation (physical and sensory), shallow working, deep working and long term memory representation. Many have mentioned that the capacity for physically presenting knowledge and storing them in long term memory is unlimited. However the capacity for mentally store and process images and words in the working memory is limited.

Figure 3: Cognitive theory of multimedia learning. After Mayer and Moreno (2003)

Mayer and Moreno (2003) explains in the first section, where words are connected to the eyes means that written words are processed by the eyes, where the words to ears means spoken words are being processed by the ears. Almost the same thing can be said about the connection between pictures and the eyes represent pictures being processed by the eyes. Next, the arrow that is labeled “selecting words” stands for the person paying attention to part of the auditory information that is being gathered by the ears, while the arrow which is labeled “selecting images” stands for the person paying attention to part of the visual information which is being gathered by the eyes. In the working memory section, where the arrow is labeled with “organizing words” means the person is creating a coherent verbal representation from the words which are being gathered from the eyes and ears, while the arrow which is labeled with “organizing images”, stands for the person creating a coherent pictorial representation from the images which are gathered by the eyes. Lastly, the arrow
which is labeled with “integrating” shows the merging of the pictorial model, verbal model and appropriate prior knowledge in the long term memory section. Here Mayer and Moreno (2003) propose that organizing and selecting processes might be directed by the past knowledge from the long term memory which is activated by the person in the learning process. In general, the article explains that in multimedia learning, five cognitive processes is needed for active processing which are selecting images, selecting words, organizing images, organizing words and integrating where each of these processes requires an amount of cognitive capacity in the information processing system.

Mayer’s (2001) theory can also be related to educational video games considering that video games can be regarded as multimedia and that it can teach the player new knowledge. However, as Mayer (2001) stated, in order achieve meaningful learning, the learner have to have a deep understanding of the material which includes mentally organizing the important aspects of the materials into a coherent cognitive structure, when later is integrated with relevant prior knowledge. This means that the materials should be presented in specific ways in order to learn the materials more efficiently. Even though video games are considered as multimedia, viewing video game only as such would only give us a general view of how video games affect the knowledge of the learner, thus not only do we need look at video games as multimedia, but as a separate media by itself.

### 2.4.3 Video Game and Working Memory

In a research done by Boot et al (2008) they examine the effects video games have on specific cognitive abilities such as memory, attention and executive control. At one point of their research, when asking the participants to play a real time strategy game which was Rise of Nations, they realized that playing the game would improve cognitive performance. Also, working memory played an essential role in playing the game and the reason for this was that the participants needed to maintain information and complex goal in their mind as they were playing the game. Given that the participants need to remember important locations, buildings and resources, working memory is essential for playing these kinds of video games. Furthermore, research done by Adams et al (2012) shows that activities and information which are not directly to the main goal, will distract the person from paying attention on the essential instructional information in the lesson. Here, Adams et al (2012) uses Mayer’s cognitive theory of multimedia learning to show to the reader that learners are only able to process a limited amount of information in the working memory. According to Adams et al (2012), insufficient processing capacity can be used to create a mental representation of essential instruction information, especially when there is too much processing for understanding the narrative of the story and learning the way the game is played. However, if very little guidance and information are presented to the learner, they may not know what they are supposed to do in the game. Here Adams et al (2012) explains that according to Mayer’s theory, playing in a video game environment may require the player to focus on processing information which is not relevant to the instructional objective. However at some point, if the player’s working memory is overwhelmed with irrelevant information, there will not be enough cognitive capacity for generative and essential processing and the player’s mind might find more efficient methods for meaningful learning. It should be noted that generative processing is when deeper processing is used in order to understand the materials, whereas essential processing is when essential materials are represented by cognitive processing. In Adams et al (2012) article it is also mentioned that game environments that include narrative may improve multimedia learning.
2.4.4 Cognitive Overload

Going back to Mayer and Moreno’s (2003) article, it presents different methods for reducing cognitive overload in specific scenarios:

**Type 1:**

The first type of Mayer and Moreno’s (2003) cognitive overload scenario is when essential processing demands overloads the visual channel. One method here for load reduction is moving some essential processing from visual channel to auditory channel. Meaning it is more efficient to have words being presented as narration instead of on screen text.

**Type 2:**

The second scenario is when essential processing demands overloads both visual and auditory channels. By allowing time between consecutive bite size segments cognitive load can be reduced. This means during a lesson, rather than a continuous unit, it is presented in a learner controlled segment.

**Type 3:**

The third scenario in cognitive overload is when one or both of the channels are overloaded by incidental and essential processing. Here, interesting but irrelevant materials should be eliminated in order to avoid cognitive overload. Also, providing signs and cues for how the materials should be processed will reduce the processing of irrelevant materials.

**Type 4:**

Similar to the third scenario, both of the channels are overloaded by incidental and essential processing. The difference being that the materials are presented in a confusing manner. By placing words close to the corresponding parts of graphics and avoiding the use of identical spoken and printed words, irrelevant cognitive load can be reduced.

**Type 5:**

The last scenario occurs when representational holding and essential processing overloads both channels. The load reducing method used here is synchronizing corresponding animation and narration in order to decrease the need to hold representations in the learner’s memory. Also it should be noted that well designed instructions are more beneficial for high spatial learners¹ compared to low spatial learners².

2.5 Education and Historical Simulations

As mentioned before, while computer games were not considered as a teaching method not too long ago, recently game developers and education groups have realized the potential and benefits of using video games for educational proposes. People like Will Wright (2006), the mind behind video games like SimCity (1989) and The Sims (2000) has acknowledged the

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¹ High-spatial ability revolves around using minimum of mental effort to control mental images (Mayer and Moreno, 2003).

² Low-spatial learners however, must assign more cognitive processing to hold mental images in order to control mental images (Mayer and Moreno, 2003).
increase of scientific thinking while playing video games. Likewise, other writers like Steven Johnson (2005) and James Paul Gee (2003) also mention the ability of video games to encourage and motivate complex thought patterns and how it is an efficient model for teaching. In Paul Gee’s (2003) book, he puts together a convincing case about the capability of video games in creating motivation for different kinds of discoveries and encouraging social sharing of information. He points out that video games not being easy, creates challenges which are needed to keep the player involved and immersed. Also, playing games in an environment which encourages critical thinking, can lead to more efficient learning. According to Gee (2003), many of the learning principles can also be found in well designed games. Principles such as: interactive approaches, risk-taking, identity development, active exploration, engaging in cross-functional teams and so on.

In McCall’s (2012) article, the popular video game Civilization III (2001) is mentioned being used in actual classrooms and although there are some drawbacks, using Civilization III in classrooms shows that if used with proper guidance and in a right way, such as presenting the historical knowledge while at the same time, keeping the player immersed, video games can be a valuable teaching tool in schools today.

However, like all methods, there are researchers that criticize this kind of approach which mostly revolves around technical problems, high cost, and difficulty in using complex games for teaching tools and so on. McCall (2012) argues that by giving the player the ability to make meaningful choices in a simulation games, they can be efficient learning tools. Before going any further, it should be explained for the reader what problem space actually is which according to McCall:

“Problem space is a useful concept inspired by video game theory and problem solving theory that effectively encapsulates both game realms and historical scenarios. Historical simulation games present the player with problem spaces. These are visual, spatial, and aural worlds with challenges that the player must overcome.” (McCall, 2012, p.11)

By using Problem spaces of the past in simulation game, it can encapsulate both historical scenarios and game realms. Many aspects of the past can be used in the form of challenges and can be considered a problem space, where the player is able to overcome come different obstacles. However, it should be noted that historical agent usually do not offer clear goals, but by using aspects of historical events in a problem space and implementing rules of interaction in a right way, an environment about cause and effect in past and present societies can be created for the player. According to McCall (2012), by implementing the problem solving aspect of history in a video game, where the player is faced with different decision making challenges, it can help the player obtain a sense of the past and its possibilities, improve strategic problem solving skills and being able to identify and analyze the limitations which shaped human actions in the past. Considering that simulation games are system themselves, it can be a very powerful tool in teaching historical system and considering that most of the students and history teacher lose sight of the environments and systems which the people of the past lived in, using simulation games in order to teach historical information in an historical environment can improve the history learning for the students. McCall (2012) explains the teaching principle in his article by writing:
“If the goal is to teach and learn about a system, use a representation of the system that is as analogous as possible” (McCall, 2012, p.13)

One of the important abilities of video games is that by manipulation of elements inside the system, they allow us to virtually experience aspects of history which are not possible in traditional media such as text, aspects like battles, family life and agriculture.

According to an article by Mortara et al (2014), there are three different kinds of serious games that focus on history which are: cultural awareness, historical reconstruction and heritage awareness. For this study, the historical reconstruction was chosen as the main category considering that in these kinds of games, the main educational goal is creating a faithful reconstruction of a specific historical event and period or aspects such as art, politics, sociology and archaeology as much as possible. As there are no physical evidences or remains from many historical events such as battles, there are only descriptions of those events. Therefore, using games in order to create environment that closely represents the source material can help us better understand the knowledge of the past in a more efficient way. Many types of historical events have been reconstructed by using these methods, events such as The Battle of Thermopylae and The Siege of Syracuse. Considering nowadays most of video games are created in a 3D environment, it is possible to reconstruct the historical environment with rich detail which adds more to the player’s immersion. As mentioned before, historical accuracy and representing any historical and cultural artifacts faithfully, is crucial in any historical reconstruction, it is also quite difficult to achieve, especially if the remains and information of the event is incomplete. Therefore, it is essential that both historians and game designers collaborate closely in order to reconstruct history as accurate as possible.

2.6 Related work

In order to use the most suitable method in a study, it is always necessary to observe and analyse other researches for motivation. For this section, all of the related works are educational games with the goal of teaching different subjects. However, except the projects Crystal Island, Historical Inquiry Tutorial and Metalloman, none of the works mentioned in this section has been part of a scientific study and it is unclear if the methods used in these works are scientifically accurate.

2.6.1 Crystal Island

Crystal Island is a narrative discovery learning computer game created by Adams et al (2012) in which the players learns information about pathogens. The game was part of an experiment where one group of participants plays the narrative based game while the second group is presented with information about pathogens through matched slideshow presentation. In the game crystal island, the player is tasked to determine the cause of an outbreak on an island. This goal is achieved by learning different facts about pathogens and how they work. The player is placed in a 3D environment from a first person perspective where they can interact with in game computers, talk to the in game characters, read posters on the wall and pick up objects. Also the game will ask the player to complete three quizzes (through in game characters) by using the information they have learned from the game. Unfortunately the results from the experiment provided no evidence which suggest that computer based narrative games are more efficient in academic learning compared to traditional education such as classrooms or text books.
2.6.2 Historical Inquiry Tutorial
A research done by Lusk et al. (2008) focuses on working memory capacity (WMC). Working memory capacity represents the person’s ability to process a main task in the working memory and maintain significant information while processing a main task in the working memory. Lastly, WMC represents the ability to access and recover information which is relevant to the main task being processed in long term memory. In this experiment, students are randomly assigned to two versions of a multimedia tutorial about historical inquiry. One being non-segmented instruction and the other being segmented instruction. The segmented instruction included narrated instructional multimedia and was designed using Adobe’s Flash. The tutorial consisted of 14 narrated multimedia segments where each of them lasted approximately 45 seconds. In general, the instruction included 1120 words and lasts for 11 minutes. By the end, Lusk et al. (2008) discovered that students with high working memory capacity (WMC) had much higher recall level and produced more applicable historical interpretations than students with low WMC. Therefore, working memory capacity had a positive effect on the students’ application and recall scores.

2.6.3 Metalloman
This game was developed and used in a study done by Wong et al. (2007), where the main goal was to compare the effects of media richness and interactivity on learning in different types of media such as video games, replay, hypertext and normal text. Basically the study aims to discover if learners are able to learn more efficiently if they can interact more with the materials and if so, what amount of interactivity or media richness is enough for achieving the most efficient result in interactive teaching. In Metalloman, the player is able to identify biological structure and connect them with different functions for creating a physiological process. Also in the game, the player has the ability to access different scales of the human body, from the entire body to groups or individual organs and even to molecular part of the human body. The player is able to achieve the goal by completing activities such as identifying sample structure in order to unlock wormholes, collection substance items and using substance items in order to reactivate processes. In the end, Wong’s et al. (2007) study suggests that new media can be more effective in teaching educational material compared to traditional methods.

2.6.4 History Game Canada
Developed using the game engine for the popular strategy game “Civilization”, the goal of history game Canada is to give the player the ability to control early Canadian civilizations such as the English, French, Ojibwe and Huron. The players which are 12 -18 years old will learn about historical events which occurred in Canada from different perspectives. One interesting feature about this game is that the player has the ability to envision a different reality in history and find out what might have been if specific events turned out differently (HASTAC, 2009).

2.6.5 The Cat and the Coup
In the documentary game “The Cat and the Coup” which was created by Kurosh ValaNejad and Peter Brinson, the players plays as the cat of the first Prime Minister of Iran, Dr Mohammad Mossadegh, where they have to set different events in the game in motion, such as knocking down objects from shelves. The main goal of the game is presenting the player with information from different parts of Mossadegh’s history, from the prime minister’s downfall, to nationalizing the oil industry in Iran. The interesting aspect of this game is its
unusual approach to the game’s genre and using clever methods to explain the rise and fall of Mossadegh to the player, the environment inside the game consists of dreamlike atmospheres and symbols that represents different countries such as Iran. (PLAY, 2011; Steam, 2011)

2.6.6 Building Detroit
This web based educational game focuses on improving different skills such as geography, mathematics, history and economics. However the main focus of the game is to teach the player about Detroit’s history from the 1750s to 1890s. In the beginning of the game, the player can decide which kind of career they will have and which person to marry. The game will then present historical facts based on those decisions. Later, the game will ask the player to finish specific objectives like farming and doing trading business with others. After finishing each of the objectives, the game will show the player an important historical event that occurred during that time period. The player can also choose to view the in depth timeline of the city’s history without any gameplay, this is when user is not interested in the game and is mainly interested in the history of the city (Schaller, 2012).
3 Problem

3.1 Aim

As said at the beginning, the main aim of this study is to compare two teaching methods. The first method is learning history through the use of multimedia tools such as video games, while the second method is considered a more traditional technique of learning such as books and PowerPoint presentations. The reason for this comparison is to study the effect of media richness and interactivity on meaningful learning, and if the player is able to remember the materials presented to them through the application more efficiently after the passage of time. For this application, it was decided to use the history of the city "Skövde" as a learning subject, which was designed in a way to simulate a learning environment for students inside a classroom. Also as mentioned earlier, media richness and interactivity are the most important aspects of new media entertainment. Therefore, the two main questions for this study are: By presenting information through media richness and interactivity inside a media such as video games:

1. What kind of effects will it have on the persons long term memory (specifically explicit memory) compared to more traditional methods e.g., books and presentations?

2. Will it lead to meaningful learning, if yes, how?

3.2 Hypothesis

The hypothesis for this study is that the participants would remember the history of the city more efficiently after the passage of time when it is presented to them through a video game compared to traditional teaching such as history books, films and presentations. Also the way that the materials and information are presented and interacted with (media richness), has a direct effect on the amount of meaningful learning and long-term memory (explicit memory).

3.3 Method

3.3.1 Design

While designing the prototype, many of the inspirations came from the research done by Adams et al (2012) where they use a “computer-based narrative discovery learning game” for students in order to learn information about pathogens. As motioned in previous sections, the results presented in their research, shows no evidence that would suggest computer based narrative games are more efficient in academic learning compared to traditional education such as text books or classrooms. In this research, it was decided to use past knowledge and experience from studies done by Adams et al (2012), and apply cognitive theory in order to achieve meaningful learning and make the prototype more efficient. This means that the materials inside the game should be presented to the player in a way which the amount of cognitive processing will be assigned to both verbal and visual channels effectively, which will lead to the decrease in irrelevant cognitive process. This is done by having both spoken and printed words inside the game and in some occasions, images that are related to the current narrative in the game which is presented to the player. It should also be mentioned that all of the historical information were taken from the book “Skövde
under 600 år” by Göran (2000) while the materials related to the railway, were obtained from an article by Berger and Enflo (2013).

The learning environment of the video game group consisted of a computer game designed by the Unity 3D, while the learning environment for the traditional group consist of multiple slideshows created by Canva, which is an online graphic design platform. The presentation contains information about history of the city which was also presented in the video game. Many aspects of the game are designed using the load reduction methods such as Cognitive Overload which was presented by Mayer and Moreno (2003), the method can be read in the background section. For example, by avoiding the use of identical and irrelevant words, cognitive load can be spent on more important and relevant information. The game is divided into two time periods, the first half revolves around events in the 18th century, while the seconds half is set in the 19th century. During the course of the game, the player plays as a fictional character in the city of Skövde where they need to complete specific tasks and interact with other characters in order to progress in the game. These tasks vary from moving objects such as barrels to specific locations, to gathering information about the Western Main Railway. At the beginning of each level, the player is presented with a short introduction about the history and narrative inside the game. For these sections, in order for the player to achieve meaningful learning and recall the materials presented in the game, one method which was used in an experiment done by Kim and Gilman (2008) was applied to the prototype. In their research, it is suggested that by adding graphics (images) and spoken narration to the texts, it will help learners perform more efficiently. To add spoken narration to texts inside the game, the “text to speech” feature in iOS was used, where different types of speech and accent could be used for different characters in the game. This method was also used in certain parts of the game, where the player could interact with specific objects and the game would present a back-story or additional information about that object. For example, at the second part of the prototype, the player can walk towards the Billingen hotel in Skövde and gather more information about the building. Here, while the text about the hotel is being read to the player by the game’s narration, two images from the hotel are shown to the player. One is an old photo taken from the 19th century, while the other was taken recently.
Also, in order to avoid cognitive overload in many parts inside the game, some of the reducing methods presented by Mayer and Moreno (2003) was implemented in the prototype. One of the load-reducing methods is moving essential cognitive processing to auditory channel which is done by adding spoken narration to the text. The second method used to reduce unimportant cognitive load, is eliminating irrelevant materials and provide the player with signs and cues. This is mostly visible in the dialog buttons where instead of showing the entire text, only relevant word which represented the entire text is presented to the player. Is should be noted that this aspect of the game was mostly inspired by the game *Mass Effect* (2007).

![Figure 5-The dialogue system inside the game](image)

The last load-reducing method used, is placing words close to the corresponding parts graphics and avoiding the use of repeated spoken and printed words. This is done by making sure the texts presented in the game are relevant to the narrative of the story and does not include identical words so often. Also most scenarios in the game where additional text and information is presented, images related to the text also appear in order for the player to become immersed and understand the story with less difficulty.
While designing the game, Huang and Johnson’s (2009) four components/Instructional Design Model are also used in order to make the game more immersive and achieve more meaningful learning. For this study, the game design guidelines from the Story and Representation, and Engagement and Curiosity characteristic were applied to the gameplay. For the story and representation aspect of the game, the focus was on the two main components, learning task and supportive information. The learning task part of design emphasizes on the connection between individual tasks and completing these tasks in order to finish the story. This is can be seen the final part of the game where the player is asked questions about the railway. In order to answer them correctly, the learners need to gather information about the railway in the previous level, thus progressing to the next level and completing the story. The supportive information component helps the game provide relevant background information for the players to view the main story line. This is done by presenting information at the beginning of each level, where the narrative of the game or the main character explains the back story or the main situation of that time period and level. For the engagement and curiosity characteristics of the game, the JIT information, learning task and supportive information components were used in designing this aspect of the gameplay. As mentioned earlier, JIT or Just In Time information is the component that helps the player have automatic responses faster. By implementing this component into the game, players can maintain their interests in the story and are more motivated in continuing playing the game. This is done in different ways inside the game, for example, at the beginning of the game, the player is shown the tutorial section of the game where the main goal and instructions are presented. This way, the player will be familiar with the gameplay which reduces irrelevant cognitive process linked to the player responds when a task is given to them. Also during the game, the main character will mention what the main task is and what the player needs to do. The goal for this is to motivate the player in completing the task and at the same time, using cognitive load in how to complete the task more efficiently.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Primary Design Component</th>
<th>Secondary Design Component</th>
<th>Tertiary Design Component</th>
<th>Game Design Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenge</td>
<td>Learning task</td>
<td>Supportive information</td>
<td>JIT information</td>
<td>Using learning task for creating a</td>
</tr>
<tr>
<td></td>
<td>Learning task</td>
<td>Supportive information &amp; JIT information</td>
<td>Part-task practice &amp; JIT information</td>
<td>Supporting the layer from multiple directions</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------</td>
<td>------------------------------------------</td>
<td>--------------------------------------</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td><strong>Competition</strong></td>
<td>part-task practices</td>
<td>Learning tasks</td>
<td>Giving immediate feedback to facilitate game competition.</td>
<td></td>
</tr>
<tr>
<td><strong>Rules</strong></td>
<td>JIT information</td>
<td>Learning task</td>
<td>Formulate appropriate decision making to compete successfully</td>
<td></td>
</tr>
<tr>
<td><strong>Goals</strong></td>
<td>Learning task</td>
<td>Supportive information &amp; JIT information</td>
<td>Part-task practice</td>
<td>To make the learning tasks and goals parallel to avoid diminishing the learning tasks</td>
</tr>
<tr>
<td><strong>Fantasy, Changed Reality, and Role Playing</strong></td>
<td>Learning task</td>
<td>Supportive information</td>
<td>Part-task practice &amp; JIT information</td>
<td>Making the set-up believable so supportive information and tasks are aligned with the game environmental.</td>
</tr>
<tr>
<td><strong>Story and Representation</strong></td>
<td>Learning task</td>
<td>Supportive information</td>
<td>Part-task practice &amp; JIT information</td>
<td>Aligning the learning task with the game design</td>
</tr>
<tr>
<td><strong>Engagement and Curiosity</strong></td>
<td>JIT information</td>
<td>learning task &amp; supportive information</td>
<td>Part-task practice</td>
<td>To facilitate the player’s personal interest and curiosity.</td>
</tr>
<tr>
<td><strong>Control</strong></td>
<td>Supportive information &amp; JIT information</td>
<td>Learning task</td>
<td>Part-task practice</td>
<td>Help players better control the gameplay</td>
</tr>
<tr>
<td><strong>Multimodal Presentation</strong></td>
<td>All</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Task</strong></td>
<td>Learning task, Supportive information &amp; JIT information</td>
<td>Part-task practice</td>
<td>Make players simultaneously engage in learning during the gameplay</td>
<td></td>
</tr>
</tbody>
</table>
3.3.2 Participants
The participants for the research consisted of students from the University of Skövde or people with some amount of gaming experience with a mean age of 26.7. Fourteen of the participants were part of the multimedia (video game) group, while fourteen of the participants were part of the group which was presented with the slideshow. In the multimedia group, 8 of the testers were males and 6 of the them females while in the traditional group, 7 of the participants were males and 7 of the them females. It should be noted that in the multimedia group, 6 of the players had more gaming experience compared to the others. Also, while choosing the participants, it was essential that they have not been living in Skövde for a long period of time and did not have prior knowledge of the city's history. Fortunately, all of the participants were either international students or lived in another city.

3.3.3 Procedure
Taking inspiration from the work done by Wong et al. (2007), it was decided that in each of the test sessions, the participants from each group were asked to perform the test in an environment where they felt the most comfortable. Also if possible, the test sessions were done individually. For the video game group, the participant were asked to play the strategy video game for around 15 minutes or until they have finished the game before that time. The actions of the players during the playthrough were observed and documented. For the traditional group, each participant was shown a collation of slides containing the information of the city’s history. After the test session, the participants from the video game group were presented with a questionnaire focusing on how much gaming experience they have. After 7 days, the participants from both groups were asked to complete a questionnaire, which consists of 23 questions (visit Appendix B), and revolved around important historical facts about Skövde, which was presented inside the game and slides.

Figure 7- A slide containing information about Skövde's big fire

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THE BIG FIRE OF SKÖVDE
THE PROBABLE CAUSE OF THE FIRE
• Closely spaced wooden interiors
• Open fireplace in most of the houses.
• Started from one of the townfolk's house called "Sorbons"
3.3.4 Ethical Considerations

In the area of ethics in experimenting and research, Fouka and Mantzorou (2011) suggest that: "Research ethics involve requirements on daily work, the protection of dignity of subjects and the publication of the information in the research." (Fouka and Mantzorou 2011, p. 3).

According to Fouka and Mantzorou (2011), one of the major issues in ethics and informed consent, is preventing any attacks on the participant’s personal liberty and integrity, and protection of the autonomy for the patient. Another major concern mentioned by Treece and Treece (1982; reviewed in Fouka and Mantzorou, 2011), is when a study is done on a group of people without getting their consent, or when personal details such as sex, age, hobbies are not kept confidential.

For this study, UNESCO’s code of conduct social science research were followed in order to maintain a high standard of responsibility, accountability and integrity for this research which relates to all aspect of the study such as recording, collection, citing of the scientific material. For example, according to UNESCO’s code of conduct, participants should be fully aware of their right to refuse to be a part of the study. For this research, before each test sessions, it was explained to the testers that they can withdraw at any time during the experiment. As mentioned earlier, all information and results related to the participants were kept confidential which they were informed of.

3.3.5 Limitations

The original plan was to work alongside a company called Paradox Interactive on a similar project that included history. The company would provide different kinds of resources like participants for testing, information about game design in strategy games and other game related information. Unfortunately due to certain circumstances, the collaboration was discarded.

Also it as mentioned earlier, the Unity3d game engine used for designing and developing the prototype. However, due to not having any experience in using the game engine, a large amount of time was spent in learning how to operate with Unity3d, which led to many trials and errors at the beginning. The reason of choosing this particular game engine was that, in order to create a more believable learning environment where the player can feel more immersed, a more powerful engine was needed compare to other game engines such as Game Maker. Also considering that Unity3d is free to use and has better support and documentation, it was clear that this engine was the better choice.

Also, due to time constraints, it was decided not to create an exact virtual replica of the city Skövde which would have taken a large amount of time and manpower. Instead, in order for the player to relate to the city, a similar and smaller version of the city was created with only a few buildings and landmarks being almost similar to the ones in real life, such as the park and St. Helena Church. Furthermore, in order to save some time in the game’s development, asset which were available in the Unity store where used in the game.

Considering that both groups had to wait 7 days in order to receive the questionnaire, it became difficult to contact the participant in person in some occasions. To tackle this problem, one of the questionnaires was created using the website called Survey Monkey. This questionnaire was only presented to the video game group right after they participated in the experiment and included question regarding the player’s gaming experience. The second questionnaire which was send to both groups after 7 days, was created using Google
Forms. This way, if a participant could not be available in person after one week, the questionnaire could easily be sent to them where their responses and answers would be saved automatically in the form.
4 Tests and Analysis

4.1 Pilot Test
Before doing the main experiment, a pilot test needed to be conducted in order to find any kind of bugs or inconsistency in the gameplay. The test featured 10 participants which most of them were students from the university of Skövde. Each person played the game individually for almost 15 minutes. Before starting the game, the main goal of the study was explained to the participant and assured that their personal information would be kept confidential. While playing the game, the player’s actions were observed and documented in order to be certain that the participant is comfortable with controls and nothing is out of the ordinary.

After the test the participants were asked specific questions which were:

- How long do you usually enjoy a game before moving on to another in hours?
- Were the game’s instructions easy to understand? 5 being the highest and 1 being the lowest.
- Were the controls easy to handle?
- Did the game’s narrative felt related to gameplay?

After the questions the participants were asked if they had any additional comments about the game.

After viewing the answers and comments for all participants, it was clear that almost all of the players felt they understood the game’s instructions and that the controls were easy to handle. Also, more importantly, all testers felt that the game’s narrative felt related to the gameplay and that learning the story and history of the city was enjoyable. Most of the additional comments revolved around the camera speed in the game, and that is was hard recognizing which of the characters in the game is the main character which the player controls.

After the pilot test, all of the bugs found during the experiment were fixed and some changes were made to the gameplay in order to make the game easier to play for the testers, most notably the camera. Other changes included altering the user interface in the games to avoid cognitive overload. For example, the font size and colour of the texts were changed so the player could read more easily. Also, a marker was place above the main character so that the player could spot him faster. It should be noted that none of the participants that did the pilot test, participated in the final test.

4.2 Main Test
For the second and final test session, two types of groups were included. In the first group which tested the game, each participant was asked to play the game individually, each experiment took about 15 minutes to complete. Before playing the game, similar to the pilot test, the main goal of the study was explained to the tester and that their personal information would be kept confidential. Next, each player was asked to go through the instruction of the game and get familiar with the game’s task and controls. While playing the prototype, specific actions from the player were observed and documented which were:
- How many times did the player have to replay some levels
- How many mistakes they made during each level
- Were any difficulties the player encountered in the games
- If they were immersed in the game

After the test was complete, the participants were asked to complete a questionnaire (visit Appendix A). After completing the survey, the testers were asked to complete a second questionnaire after 7 days. The second survey included questions related to Skövde's history and the main purpose of this was to see how much the participants remember after a week. Also, for both groups, after each question, the tester is asked to rank from 1 to 5 how confident they were about their answer. This way, it can be easier to indicate if each question was answered only by chance or not. If for any reason, the participant was not able to do the survey in person, a copy of the survey was sent to them via internet. Table 3 shows the age and sex of the participants and if they had any gaming experience. The gaming experience is ranked in three categories: low, medium and high.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Sex</th>
<th>Gaming experience</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>28</td>
<td>Male</td>
<td>High</td>
</tr>
<tr>
<td>P2</td>
<td>27</td>
<td>Male</td>
<td>Low</td>
</tr>
<tr>
<td>P3</td>
<td>25</td>
<td>Male</td>
<td>Low</td>
</tr>
<tr>
<td>P4</td>
<td>25</td>
<td>Female</td>
<td>Low</td>
</tr>
<tr>
<td>P5</td>
<td>24</td>
<td>Male</td>
<td>High</td>
</tr>
<tr>
<td>P6</td>
<td>29</td>
<td>Female</td>
<td>Low</td>
</tr>
<tr>
<td>P7</td>
<td>31</td>
<td>Male</td>
<td>Medium</td>
</tr>
<tr>
<td>P8</td>
<td>19</td>
<td>Female</td>
<td>High</td>
</tr>
<tr>
<td>P9</td>
<td>25</td>
<td>Male</td>
<td>Medium</td>
</tr>
<tr>
<td>P10</td>
<td>24</td>
<td>Female</td>
<td>Low</td>
</tr>
<tr>
<td>P11</td>
<td>24</td>
<td>Female</td>
<td>Low</td>
</tr>
<tr>
<td>P12</td>
<td>24</td>
<td>Female</td>
<td>High</td>
</tr>
<tr>
<td>P13</td>
<td>28</td>
<td>Male</td>
<td>Medium</td>
</tr>
<tr>
<td>P14</td>
<td>22</td>
<td>Male</td>
<td>High</td>
</tr>
</tbody>
</table>

In the second group however, the participants were presented with slides which included information about Skövde which was present in the game. Each participant was asked to go through the slides without any time constraints or limitations. Similar to the first group,
after the session was over, the learners were asked to complete a questionnaire which included questions about the history of Skövde which was presented in the slides. Also, for some participants who were not physically available, a link generated from Canva was sent, so the person could view the presentation. However, after conforming that the learner has viewed and read the slides, the presentation was deleted in order to avoid cheating during the survey. Table 4 shows the age and sex of the participants who were presented with the presentation.

Table 4- Participants from the traditional group

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Sex</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>24</td>
<td>Female</td>
</tr>
<tr>
<td>P2</td>
<td>28</td>
<td>Female</td>
</tr>
<tr>
<td>P3</td>
<td>27</td>
<td>Male</td>
</tr>
<tr>
<td>P4</td>
<td>31</td>
<td>Male</td>
</tr>
<tr>
<td>P5</td>
<td>25</td>
<td>Female</td>
</tr>
<tr>
<td>P6</td>
<td>25</td>
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<td>P7</td>
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<td>P10</td>
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</tr>
<tr>
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<tr>
<td>P12</td>
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<tr>
<td>P13</td>
<td>37</td>
<td>Male</td>
</tr>
<tr>
<td>P14</td>
<td>24</td>
<td>Male</td>
</tr>
</tbody>
</table>

4.2.1 Observation

While observing the participants during the test session, it was discovered that participants who had more gaming experience were more immersed in the game and could complete the tasks faster. In a few occasions, players with lower gaming experience seemed to forget what the current task of the game was and needed aid in order to finish the level. Fortunately, in none of the test sessions, did the participants become exhausted or bored, and all of them finished the game.

Another discovery was that most of the player did not use the zoom function in the game which occasionally led to the player having difficulties finding the objects which they needed to interact with inside the game. Also, during the last level, where the player needed to
answer questions using information gathered from the previous level, players with higher gaming experience seemed to complete the level with fewer attempts, some completing it in their first attempt. One pattern which was noticeable was when a text was shown and read to the player. Here, most of the participants skipped the texts when they finished reading the text, instead of waiting for the audio to read the entire text. At the end, only one complaint from some of the testers was that the voices did not sound realistic and would prefer real human voice. Other than that, almost all of the participants thought the experience was very interesting and enjoyed not only learning about the city's history, but the concept of the game as a learning tool itself.

4.2.2 Questionnaire Results

After going through all of the surveys done by all of the participants in both groups, the amount of correct answers in each questionnaire was written down and from that, the mean correct answers were calculated. After putting all the means from both groups next to each other, a paired t test was taken which the results can be seen in the table below.

<table>
<thead>
<tr>
<th>Groups</th>
<th>Traditional Group</th>
<th>Game Group</th>
<th>t</th>
<th>df</th>
<th>Standard error of difference</th>
<th>P (T&lt;=t) two-tail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.53671</td>
<td>0.66414</td>
<td>2.5351</td>
<td>13</td>
<td>0.05</td>
<td>0.0249</td>
</tr>
<tr>
<td>SD</td>
<td>0.17202</td>
<td>0.11489</td>
<td></td>
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Judging by the results, the P-value of the test is 0.0249 which is less than 0.05. By conventional criteria, this difference is considered to be statistically significant. This means that there is a significant difference between the two groups. Therefore, the hypothesis of people remembering information longer through video games is correct.
Figure 8 displays the results regarding the mean of correct answers given by both the traditional group and the video game group. The total mean of each group was achieved by first sum up the correct answers given by all of the participants. Next, the sum of all correct answers is divided by the total number of testers. This is done for both groups. As seen in the chart, it is obvious that the mean of the correct answers for the video game group is higher than the traditional group. This shows that participants, who played the video game, remembered the information about Skövde’s history longer compared to the group which was presented with the slides.

Figure 9 shows the results regarding the mean of the confidence level from both groups. As seen in the chart, there is not any significant difference between the two groups. However, the confidence level in the traditional group is slightly higher compared to the video game group.
group. This could have different interpretations, one most likely is because most of the participants particularly students, are accustomed to receiving information thorough traditional means such as books and presentations. Therefore, they might feel more confident in receiving and remembering the materials inside the slides. On the other hand, the exact opposite can be said about the testers who played the game, where learning and remembering information through video games is usually not the norm. Thus, the player may not feel as confident as the other group that they will recall information more efficiency. But as said earlier, these are only assumptions and more testing and participants are needed in order to see any significant difference.

Also is should be mentioned that after each test session for the video game group, the participants were asked from 0 to 5, “do you feel video games are a better tool for learning than traditional methods e.g. Books or Classroom?” Almost all answered 4 or 5, which means that most of the players believe if done right, video games can be more efficient as a learning tool compared to other methods. Furthermore, many additional comments given by learners after playing the game, were about how they found the experiment very interesting and enjoying, and wish to see learning based gaming more prominent. Although, while most believe video games cannot replace traditional methods of learning completely, they still believe it can complement traditional learning in an efficient way.
5 Conclusions

The main purpose of this study was to compare two teaching methods, and conclude which of the two is more efficient in presenting information, specifically about history, to the learners so they would remember it longer. The first method was using multimedia tools as a teaching tool which in this case, video game is the chosen multimedia. The second teaching method used in this study, was presenting a collection of slides which includes materials about the city of Skövde’s history that was also presented in the video game. The reason for choosing a video game was to discover if media richness and more interactivity has a positive effect on meaningful learning. The prototype was developed using the Unity3d game engine. Inside the game, the player is presented by back-stories regarding the city’s history. Also, the player is required to complete specific tasks related to the story in order to progress in the game. The gameplay was also designed using different guidelines and cognitive load-reducing methods (visit background section) thus, the player will not be overwhelmed by irrelevant information and will remember the materials longer.

The experiment was conducted on 28 participants in total. 14 of the participants were shown a presentation which was created using Canva. The other 14 participants were asked to play the video game which took around 15 minutes to complete. During each playthrough, the player’s actions were monitored. At the end of the test, the players were asked to complete a questionnaire regarding the history of Skövde in 7 days.

5.1 Summary of results

As mentioned earlier, the main two questions of this study were: by presenting information through media richness and interactivity inside a media such as video games, what kind of effects will it have on the persons long term memory (specifically explicit memory) compared to more traditional methods e.g., books and presentations? And will it lead to meaningful learning, if yes, how? Judging by the results, the media richness and cognitive load-reducing features used in the prototypes were effective. For example, almost all of the participants who played the prototype were able to answer the questions, which were related to the tasks inside the game. However, for some players, it was slightly difficult to recall information that was presented to them only through spoken and printed text and images, information such as back-stories. Also, questions about years and numbers were somewhat difficult to remember. This might be because for some people, remembering numbers can be more confusing then remembering simple texts. But overall, comparing the results from the two groups showed that the participants, who tested the game, performed better than the group who read the presentation. Another interesting discovery that was made from the experiment was the level of confidence each group had. According to the result data, the traditional or presentation group had slightly more confidence than the video game group. As mentioned before, this might be due to participants being more familiar and accustomed to reading information through slide shows, compared to other forms of media, such as video games. While observing the players during the test session, it was clear that they were immersed in the game and were motivated to complete the story. After reading additional comments which were giving after each test session, almost all of the participants found the game very enjoyable and believed video games if used right, can be more efficient as a learning tool compared to other methods. It should be pointed out that the testers with lower gaming experience had some difficulties with the game’s control which at some occasions
took them out from the immersion of the game. For example, during most of the game some participants forgot that they are able to zoom in or out inside the game, which led to them having problems in finding the next objective. In the end, the only criticism some of the players had with the prototype was that voices did not sound realistic, which made it somewhat difficult to feel completely immersed.

5.2 Discussion

For this study, the main plan which was to work and receive resources from Paradox Interactive had to be changed after considering the circumstances. Afterwards, it was decided to use Unity3d to create the prototype, which led to some obstacles due to the lack of experience with the game engine. Going through the results, it can be understood that one obstacle for these types of learning tools is people who do not have any experience with video games and are most likely to have difficulties in receiving information. The reason for this is when someone is not familiar with video games and the controls; their cognitive process for irrelevant information will increase and will lead to cognitive overload. Therefore, it was important to find participant with gaming experience to be part of the experiment. Fortunately, there were not any difficulties in finding people who were familiar with video games, considering that most of them were students who played video game quite often or had played in some point in their life. Having this in mind, one of the more interesting findings in this study was that players with higher gaming experience completed the game faster than the others, but at the same time, their results did not differ significantly compared to the others who had lower experience with games. This might indicate that if a game is designed correctly and if the controls are easy to understand, relevant information can be transferred and processed by the player without wasting any cognitive load on irrelevant materials. However, this does not mean that all people can experience meaningful learning by playing video games. For example, elderly people are more likely to have less knowledge of modern technology and will experience stress while operating any modern machinery. Therefore, while playing a serious game, most of the cognitive process is spent on understanding how the technology and controls work. So in conclusion, designing video games with teaching purposes can be more efficient for people with experience with video games or even with modern technology.

The outcome of the experiment can be related to applying cognitive load suggested by Sweller (1988) and Mayer and Moreno’s (2003) load-reduction methods, which helped reduce many of the irrelevant cognitive loads for both auditory and visual channels from Mayer and Moreno’s (2003) Cognitive theory of multimedia learning. Also, by using Huang and Johnson’s (2009) Instructional Design Model which is based on cognitive load theory, it was possible to realize which of the components in the game should be more focused on in order to make the player more interested in story and be more curious. By examining the results, it is clear that the methods and theories above had a positive effect on the outcome of the experiment, and that the participants from the video game group, recalled the materials more efficiently, which means they achieved a higher level of meaningful learning.

Nevertheless, as mentioned earlier in the result section, many in the video game group had difficulty recalling information from the sections inside the game which was presented with spoken and printed text, and images (back-story). This might be due to the additional cognitive load the player need in order to process the information. It should be mentioned that the decision for using spoken text and images alongside printed text was based on
Mayer’s (2001) “multimedia principle” which suggested that people are able to learn more efficiently from pictures and words than from using only words. However, Mayer clarifies that only by adding pictures to texts may not always lead to a more efficient learning method. This problem can be addressed by better writing where only relevant materials is presented and irrelevant information is reduced to a minimum if possible.

While conducting the experiment for this study, only the level of gaming experience for the video game group was documented. The reason for this was that considering the traditional group did not play the game and were only presented with a slide show presentation, their gaming experience level would not be relevant to the results. However, during the analysis of the results, it was clear that not including this specific information was a mistake. By knowing this data, we could see if different levels of gaming experience for both groups have an effect on recalling information more efficiently.

At the beginning of the study, it was decided to ask the participants to do a post-survey right after they have finished playing the game. After 7 days, the same questionnaire was given to the testers once more. This idea was later changed for the reason that a test right after receiving information might affect the long term memory. However, the last level in the game revolved around the main character trying to convincing the townsfolk to vote for the building of the railway. This is done by answering specific questions using information which was obtained through interacting with NPCs in the previous level. The objective of this level was to have the player do a semi test at the end of the game, which was hidden inside the gameplay and narrative of the game. Looking at the results, it is clear that most of the participants had a higher success rate with the questions which was related to the last level of the game. Having this in mind, it can be argued that materials and information which are hidden inside the gameplay and achieved by completing, can lead to a more efficient explicit memory.

Also, seeing that the video game group recalled information more efficiently than the traditional group, it can be said the first group’s explicit memory improved more compared to the second group. However, by not knowing the state of the participant’s explicit memory before the test session, it is unclear if a learner has a more efficient long-term memory compared to the others, and if it affects the results in anyway. This means that one participant might have a much more efficient explicit memory and can recall information more easily, whether the information is present through video games or slideshows.

As stated in the “aim” section of the thesis, the test sessions and experiment was designed to simulate an environment similar to learning in a classroom, as much as possible. The reason for this was that at the beginning of the study, it was decided that the main focus group would be tourists that are interested in the city they are visiting. However, learning new information might have different results and outcome, depending on the situation. For example, a student might be more motivated to learn, if they know that they have to take a test in the future about the materials from the video game, compared to the tourist that does not need to take a test afterwards.

5.3 Future work
In future studies, it would be interesting in improving different aspects of the current research. One is having more applicants and a more controlled group. Considering that the participants from the traditional group, which was presented with the slideshow, were either
in their home or in an environment which was not very suitable for doing test sessions. It would be more efficient if in the future, the test was done in a classroom or another learning environment. And as for the survey, the participants from both groups would be asked to answer the questionnaire in a more formal setting where they can concentrate more, and will not get distracted by irrelevant cognitive load.

Another aspect that should defiantly be improved is the looks and the environments inside the game. By using better 3D models such as characters or buildings that represents each period of time more accurately. This way, the player would feel more immersed in the game world and its narrative, which would help them receive and process information more fluently. Finally, by having better writing for the story, which includes less irrelevant information, and by having actual voice actors for reading the texts, would help making the world inside the game more believable.
6 References


[Accessed 15 March 2015].

[Accessed 14 March 2015].


Wong, W. L. et al., 2007. Serious Video Game Effectiveness. ACE’07.


Appendix A - Questionnaire

Thank you for participating in our survey. Your feedback is important.

Before answering the following questions, keep in mind that there are no risks involved with your participation in this research study nor are there any personal benefits.

The data collected in this experiment will be anonymous. Reports of this experiment will not include individual data in a form by which you could be identified. The data will be securely stored.

Your participation in this study is entirely voluntary and your decision to participate is confidential. You can stop at any time.

If you have any questions, concerns, problems about your rights as a research participant or would like to offer input, please contact a12imafa@his.se.

You must be 18 years of age or older to take part in this research study.

I voluntarily consent to participate in this study. In signing this form, I certify that I am 18 years of age or older.

Click 'Agree' if you decide to proceed and agree with the information above.

1. Do you agree to the above terms? By clicking Yes, you consent that you are willing to answer the questions in this survey.

☐ Agree

2. Are you Male/Female?

☐ Male

☐ Female

3. What age are you?
4. How long do you usually enjoy a game before moving on to another in hours?

☐ 18-20

☐ 20-23

☐ 23-25

☐ 25+

5. What Genres do you play?

☐ First Person Shooter

☐ Sports

☐ Action/Adventure

☐ Simulation

☐ Third Person Shooter

☐ Educational

☐ Survival Horror

☐ Puzzle
6. Which do you prefer out of the following? 5 being the highest and 1 being the lowest.

- Graphics
- Gameplay
- User Interface
- Sound
- A.I

7. Was the game's instructions and controls easy to understand? 5 being the highest and 1 being the lowest.

1 2 3 4 5

8. Was the game's narrative felt related to gameplay?

1 2 3 4 5

9. Do you feel video games are a better tool for learning than traditional methods e.g. Books or Classroom? (1 for strongly disagree and 5 for strongly agree)

1 2 3 4 5

9. Do you have any other comments?
Appendix B - Second Questionnaire

Survey-Part2

* Required

1. At the beginning of the 18th century, how many inhabitants did Skövde have approximately? *
   a. Around 150 inhabitants
   b. Around 200 inhabitants
   c. Around 350 inhabitants
   d. Around 500 inhabitants

2. In the city, the military was represented by... *
   a. Captain
   b. Lieutenant
   c. Soldiers
   d. All above

3. In the city, the Justice system was represented by *
   a. Mayor and Aldermen
   b. Mayor and Judge
   c. Judge and Aldermen
   d. Aldermen and The People

4. At the beginning of the 18th century, two of the townsfolk were required to stand guard in order to prevent________. *
   a. Theft
   b. Invasion
   c. People selling tobacco and alcohol
   d. Fire

5. The two chosen townsfolk had to stand guard from________. *
   a. 4 A.M. to 10 P.M.
   b. 10 P.M. to 4 A.M.
   c. 4 P.M. to 10 A.M.
   d. 10 A.M. to 4 P.M.

6. In order to prevent any fires in the future, what was the city obligated to place in specific locations in the city? *
   a. Barrels of water
   b. Axes
   c. Sandbags
   d. None

7. What were the people not allowed to sell to the guards? *
   a. Alcohol
   b. Opium
   c. Tobacco
   d. 1 & 2
   e. 1 & 3
8. In which year did the great fire in Skövde occur? *
   a. 1736
   b. 1756
   c. 1719
   d. 1750

9. In total, how many of the farms, burned down during the fire? *
   a. 55
   b. 80
   c. 26
   d. 10

10. What was the cause of the fire? *
    a. Natural causes
    b. An accident
    c. Someone started the fire
    d. They way the houses were built at that time.

11. From which house did the fire start? *
    a. Sorbons’ house
    b. The Mayor’s house
    c. Emil’s house
    d. Robert’s house

12. Currently, in which park are the houses that survived the fire located? *
    a. Boulogner Park
    b. Käpplunda Park
    c. Heléns park
    d. Ångsö Park

13. At the beginning of the 19th century, how many inhabitants did Skövde have approximately? *
    a. 740
    b. 900
    c. 1060
    d. 850

14. At the mid of the 19th century, to which country did the people from Skövde immigrate to? *
    a. America
    b. Canada
    c. Germany
    d. Spain

15. The first plans and designs of the original St. Helena Church were found in excavations carried by ______. *
    a. Ivar Johnsson
    b. Axel Forssén.
    c. Lars Kellman
    d. Axel Kumlien
16. In what year was Hotel Billingen built? *
   a. 1888  
   b. 1777  
   c. 1890  
   d. 1920

17. What is the name of the sculpture found in Hertig Johans Square? *
   a. God father  
   b. Man and Pegasus  
   c. Funtain of life  
   d. Europa and the Bull

18. What was located in the upper floor of the old town hall? *
   a. The Mayor's house  
   b. The City's school  
   c. The City’s museum  
   d. The Theater house

19. By building a railroad, what effects did it have on Skövde? *
   a. Obtaining raw materials and other inputs got easier  
   b. Cheaper to travel between cities  
   c. Connection between the cities  
   d. None

20. By having access to the railroad network what other benefits did Skövde get? *
   a. Increase in the information flow  
   b. Faster delivery by the post office  
   c. Faster mode of transportation  
   d. Economy growth

21. How did the railway effect Skövde's economy? *
   a. Many people got wealthy  
   b. The railway helped attract more investors to the city  
   c. Timely updates on market movements for the merchants  
   d. Cheap travel equals more money spent on building the city

22. What was the long term effect in having a railway network for Skövde? *
   a. It help the city expand much faster  
   b. Population growth which led industrialization of the city  
   c. Better communication with other cities  
   d. None

23. In what year did Skövde’s railway open? *
   a. 1910  
   b. 1800  
   c. 1759  
   d. 1859
Appendix C - Slideshow presentation

1. A Brief History of Skövde

2. Start of the 18th Century
   - One of the Smallest cities
   - 154 inhabitants
   - 381 inhabitants 50 years after its foundation

3. Start of the 18th Century
   - Professions:
     - Blacksmith
     - Potters
     - Coppersmiths
     - Miller
     - Glaziers
     - Tailors
     - ...

4. Start of the 18th Century
   - Military:
     - Captain
     - Lieutenant
     - Number of soldiers and sailors
   - Justice System:
     - Mayor
     - Aldermen

5. 18th Century

6. 1719
   - Fires were occurring around the land
   - New fire regulations in order to prevent fires in the city.
1719

FIRE REGULATIONS:
• Two of the townsfolk had to stand guard
• From 10 P.M. to 4 A.M.
• Barrels of water in specific locations in the city for easy access
• Forbidden to sell tobacco and alcohol to the guards

1756

THE BIG FIRE OF SKOVDE

PROPERTIES DESTROYED IN THE FIRE:
• 55 of the biggest farms
• The Church
• The town hall
• ...
19TH CENTURY

SOCIAL LIFE
- Revolved around luxury festival theaters
- 856 inhabitants by the mid 19th century
- Between 1855 and 1891, around 580 people immigrated to America

SAINT HELENA CHURCH
- First plans and designs were found in excavations
- In 1927
- Carried out by Axel Forssén

SAINT HELENA CHURCH
- Rebuilding and expansion in the 1200s and 1400s
- Considered a pilgrimage church
- Attracted large crowds
- Considered among the richest in the district

SAINT HELENA CHURCH
- Underwent extensive reconstruction from 1888-1889
- Using the designs and drawings of Carl Moller

THE OLD TOWN HALL
- Located on Hertig Johans Square in central Skövde
- Built in 1776 (after the big fire)
- Renovated in 1853
THE OLD TOWN HALL
- The city's school was located in the upper floor in 1776.
- Skövde's city museum was also located in the Old Town Hall until 2005.

HERTIG JOHANS SQUARE
- Central Square in Skövde
- Named after Duke Johan
- The sculpture, "Fountain of life" can be found at the square
- The sculpture was created by Ivar Johnsson.

IMPORTANT BUILDINGS LOCATED AT THE SQUARE:
- The shopping center Commerce
- Saint Helena church

HOTEL BILLINGEN
- One of the oldest hotels in Skövde
- Located at Tradgards street
- Built in 1888
- Designed by architects Axel and Hjalmar Kumlien
- Collaborated, with Skövde's architect Lars Kellman.

SKÖVDE'S RAILWAY
- Route between Falköping and Töreboda
- Built in 25th of July 1859
SKÖVDE’S RAILWAY

ADVANTAGES:
• Obtaining raw materials and other inputs became easier
• Which made the city grow faster

SKÖVDE’S RAILWAY

ADVANTAGES:
• More distribution of information
• Increase in information flow

SKÖVDE’S RAILWAY

ADVANTAGES:
• Timely updates on market movements for merchants
• Which led to economic expansion

SKÖVDE’S RAILWAY

ADVANTAGES:
• Population growth
• More labor force and employment
• Led to the city becoming more industrialized

Additional Comments: