RATS
Recreating A Terrifying Scene: using educational games to teach facts

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Abstract

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The concept of computer games in education is an expanding field. There is a strong need for appropriate pedagogical software to be used in education. This thesis is an exploratory study which involves the design of a computer game for primary school students in the ages 10 to 12 with a general focus on the subject of History and in particular, source criticism. Through an experiment involving the designed game and pre and post-test questionnaires, two school classes in Sweden were tested to see if the game could be used as an educational tool. Furthermore, if an implementation of certain aspects of elaborative rehearsal would have any further positive effects. The results indicated that the students were in fact able to learn through playing the game. However, the implementation of elaborative rehearsal did not yield any significant increase in learning outcomes.

Keywords: Educational game, elaborative rehearsal, history, source criticism, primary school, experiment, pre and post-test design.

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1. **Introduction**

Computer games have for some time been used in education. While this idea could sound arbitrary to some, this concept has been under steady development from 1970, expanding more from the early 2000s (Klopfer, Osterweil & Salen (2009, p. 20). Educational computer games come in many shapes and forms. Some are designed with a focus on educational purpose whilst others which are designed for an entertainment purpose initially, are used for teaching a range of different subjects. For instance, the Carmen Sandiego series, a popular educational game in the 1980s was designed to teach geography to school children (Turner, 2012). Another example concerns the most sold pc-game in the world, Minecraft (Sarkar, 2015). The game has been used in classrooms to teach a number of different subjects, all over the world and consequently a specific version focused on education will be released in 2016 (Minecraft Education Edition, 2016).

Developing an educational computer game is not a simple process. To design and create a game that supports learning in a fun and engaging environment requires an exploration into many fields of research.

This thesis involved the development of an educational computer game, with the pedagogical purpose of teaching source criticism within a historical context. This development was made possible through partnership with The Educational Technology Group (ETG), consisting of researchers from Lund and Linköping universities. The ETG designed an educational game that focused on teaching aspects of History to students aged 10-12. The work of this thesis is part of a project which has been carried out in collaboration with another Master Thesis student of Uppsala University, Jessica Brewster. As a prerequisite to the collaboration with Brewster, this project was to facilitate two research foci.

The project was an exploratory study that investigates if historical facts can be taught to students aged 10-12, through the medium of a historical game. A secondary focus regarded whether the implementation of certain aspects of the theory of elaborative rehearsal had any further positive effects in learning outcomes.

In addition to the research focus of elaborative rehearsal, Brewster’s theoretical background of constructivist teaching methods was also employed, alongside the focus of teaching source criticism. The game designed served as a research platform allowing the two foci to be included. Consequently the effects of these
were tested through an experiment involving pre and post-tests in two Swedish schools.

As schools have been under pressure to introduce more technological methods and equipment, complementing those found in modern society, there has been a great risk that schools are introducing pedagogical software without evaluating their power to teach. The demand for a more technological classroom can be noticed by the prominent influx of the use of laptops and tablets in schools. As schools equip their pupils with more advanced hardware, there is a strong need for appropriate software. In accordance with this, the background research for this thesis consisted of educational computer games, educational pedagogy, with a particular focus on History and source criticism. It also included aspects of elaborative rehearsal and a brief overview of constructivist teaching methods.

1.1. Defining the collaborative study

The collaborations with Brewster throughout the project concerned both practical and written work. As a result of this collaboration, two Master theses were produced and consequently, some sections in this paper have been written by both Särner and Brewster.

1.1.1. Method collaboration

The practical work involved the design process of the game and execution of the experiment, as described in chapter 4. Method.

1.1.2. Written collaboration

As this thesis was partly conducted in conjunction with Brewster, parts of it have been written in collaboration. The extent of this can be seen below. Any sections not mentioned can be presumed to be written individually, for the purpose of this thesis.

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2. **Purpose of this thesis**

The purpose of this thesis was to continue the research begun by the ETG in regards to HV and further develop the knowledge regarding the learning capabilities of history within educational games. In particular, the focus was to investigate whether a History game could be used to teach students aged 10-12 about a range of historical facts. An additional question asked whether aspects of elaborative rehearsal theory, could improve learning potential.

The main research question was as follows:

Can the educational game, *Historiens väktare* be effective in teaching students aged 10 to 12 about historical facts?

The secondary research question was:

Does an implementation of elaborative rehearsal have any further positive effect on learning historical facts in the game?

To be able to answer the research questions stated above, the work of this thesis includes (a) literature research of background material (b) design of the game/research tool and (c) evaluation and testing, utilising the research tool.

2.1. **Scope and Limitations**

This thesis facilitates conceptual and narrative design as well as the construction of dialogues for an extension of the educational computer game Historiens väktare (HV). The final version of the game designed for this thesis project was only utilised as a research tool and not for commercial use. The experiment was conducted in two primary school classes in Sweden. The limitations for this thesis involve the following:

- The game was to be an extension of a previously developed game (HV). Therefore, the overall design of the game was somewhat limited to a pre-existing concept and narrative.

- Graphical design and programming was outside the scope of this thesis. Graphics and illustrations were created by Carolina Ekström. Programming was done by Erik Anderberg.
The game was limited to the pedagogical purpose of teaching source criticism and facts in a historical context. It needed to be at an appropriate level of language and contain skills as guided by the History syllabus for Swedish public schools.

The game did not facilitate any auditory output. This limited the content to text and illustrations.

The language of the game was Swedish.

The testing was only administered to two classes of students in Southern Sweden. No other participants were utilised.
3. Background

3.1. Educational computer games

Computer games and education are two seemingly different concepts in regards to their initial purpose, entertainment contra learning. However, as computer technology has become such an important and unavoidable factor in our lives, the two concepts have for some time been combined to serve a mutual purpose.

According to Ke (as cited in McClarty et al., 2012), digital games do not have to be a distraction from learning just because they are fun to play. On the contrary, they can be effective tools for learning and intellectual development. The research of educational games is today a vast field concerning theories and frameworks that span over multiple scientific fields. It has also been argued that games have been effective in teaching a number of different skills necessary in today’s society (Squire, 2006).

Research and development in the field of games for educational purposes can be traced back to long before computers and video games became a popular means of entertainment. According to Jonas Linderoth (2012), there has been a relationship between education and games for over 200 years and presently this union serves as a foundation for another field of research and development. Others point towards the term “serious games” as a stepping stone for this relationship. In 1970, Abt (as cited in Ma, Oikonomou and Jain, 2011, p.26) used the term “serious games” to discuss a concept for games with an educational purpose as opposed to one purely for entertainment. Even though this concept primarily focused on board and card games at that time, Abt’s term has been applied to educational computer games today.

Fisch (2005, p. 56) states that multiple empirical studies have indicated evidence for children learning from educational computer games, regardless of the subject. From a study by the European Schoolnet including over 500 teachers, it was concluded that when computer games were incorporated into the educational process, students’ motivation was significantly greater (Wastiau et al., 2009).
3.2. Designing educational computer games

There are many factors one can consider in order to design an educational computer game. There are numerous game elements and mechanics one can implement as well as plenty of pedagogical aspects and learning methods that can be employed. One interesting analogy to describe the design process of an educational game is given by Klopfer, Osterweil & Salen (2009, p. 25):

“The process of designing and creating educational games can be thought of much like the process of baking. There are many attempts by a growing number of health conscious cooks to make things that are both yummy and healthy. It isn't easy to balance these two qualities. It is relatively easy to bake calorie-laden cakes filled with butter and trans fats that are quite tasty, or one could make piles of oat germ laden sawdust that could reduce your cholesterol if only you could actually eat it.”

To achieve a perfect balance; to create something that is a fun, engaging and “yummy”, as well as pedagogical, informative and “healthy” is not an easy task. There are different “recipes” for different projects, some will work while others will fail. Klopfer, Osterweil & Salen (2009, p. 25) continues by stating that it “depends quite a bit on the audience, context, content, goals, and facilitation” in regards to how to succeed with this conundrum. There are a considerable amount of ideas about designing educational games. To explore every corner of this vast research field would require immense time and effort. Even with that, it would still be difficult to ultimately identify and evaluate the most appropriate ideas to implement. Therefore, this thesis concerns itself with only a few aspects, utilising certain guidelines of Malone (1980).

Malone created a series of heuristics that were designed to assist in the creation of instructional games. These center around three core themes, including aspects of challenge, fantasy and curiosity (Malone 1980, p. 162).

Challenge within a game is usually something you can assume the presence of, in order to make it interesting. A game possessing no challenge could provide very little motivation to finish or to explore essential components in educational games. By introducing various levels of difficulty, a player is encouraged to strive further, learning more knowledge in the process. As children are now so adapt at playing computer games, the functionalities within the game have become less relevant.
Instead, the focus for introducing challenging agents needs to be completed within the narrative of the game (Malone 1980, p. 163).

Inciting one’s imagination is essential during a game, hence the inclusion of fantasy in Malone’s heuristics. Fantasy allows the potential for game immersion, situating the player within an environment they are unused to. This actually aids in the game-playing process as students can feel like they are truly in another world, being more comfortable with their actions as a consequence (Annetta 2010, p. 107). Barab, Arici, & Jackson (2005) also state that when a narrative story is present, students will be more engaged.

Curiosity is a heuristic that utilises aspects of challenge and fantasy. Ensuring curiosity within a game can be difficult, but is essential in ensuring that students explore the learning environment. Providing hints, along with elements of feedback would probably assist in increasing a player’s curiosity, as it poses questions that require exploration to solve (Malone 1980, p. 165-166).

3.3. Learning and memory

When discussing educational computer games, one will inevitably reach the topic of learning and how it is connected to the ability to encode information in the memory. There are multiple theories and methods with the purpose of fostering effective memory encoding. This thesis is orientated towards investigating positive effects from employing certain aspects of the theories behind Elaborative rehearsal (Craik and Lockhart, 1972). The term is part of a framework called the Level of processing, which discusses two concepts of depth of processing; shallow and deep processing. Elaborative rehearsal concerns the latter; it is a process of a deeper level of encoding memory.

According to the American Psychological Association (APA): “Learning and memory are closely related concepts. Learning is the acquisition of skill or knowledge, while memory is the expression of what you’ve acquired.” (Apa.org, 2016).

According to Benjamin and Bjork (2000) there is evidence that for learning to be successful it needs to create strong memories and therefore be easily available. Alternatively, learning which is not useful is unlikely to be remembered (Benjamin and Bjork, 2000, p. 638).
3.3.1. Level of processing

In 1972, Craik and Lockhart presented a theoretical framework which challenged the pre-existing memory model by Atkinson and Shiffrin from 1968. The latter argued that providing information is rehearsed in the short-term memory (STM), that information will be stored into the long-term memory (LTM) for future retrieval (Atkinson and Shiffrin, 1968). Opposing this idea, Craik and Lockhart (1972, p. 671-672) emphasised that it is rather how we process information that determines encoding in the memory. They introduced two levels of processing, shallow and deep processing. Shallow processing is performed by maintenance rehearsal and only allows for retention of information in the STM. The deep processing is achieved when performing an elaborative rehearsal (or encoding). Furthermore, they point out that it is the type of rehearsal which determines whether a memory will be effectively encoded or not, as improvement in memory will only occur through a deeper processing (Craik and Lockhart 1972, p. 681). Roberts et al. (2014, p. 453) agrees that a deeper processing creates a stronger memory, whereas shallow processing would not.

3.3.2. Elaborative rehearsal

Elaborative rehearsal is a term which involves several processes with the purpose of transferring information from the STM into the LTM. Essentially, the main goal is to create a more powerful semantic understanding of a piece of information, a word for instance. One way of achieving this is to connect pieces of information to memory already stored in the LTM. Its counterpart, maintenance rehearsal, employs methods that simply involve a repetition of information without any attempt to create a more powerful meaning (Craik and Lockhart 1972; Craik and Tulving 1975).

Goldstein (2011, p. 174) emphasises the positive effect of elaborative rehearsal:

“…memory is superior when a meaningful connection has been made between an item and something else. Thus, memory for words is better when the words are processed by relating them to other knowledge, such as how useful an object might be on an uninhabited island.”
Considering that memory and learning are strongly associated, employing effective methods of elaborative rehearsal would consequently improve the possibilities for learning. There is substantial research that has been performed with the purpose of evaluating the aspects of the framework devised by Craik and Lockhart (1972). Benjamin and Bjork (2000, p. 640) argue that even if both types of rehearsal (elaborative and maintenance) increases the chance for memory retrieval, there is evidence indicating that information processed through elaborative rehearsal would have a significant advantage in regards to its ability for long-term retention.

Within the framework of this thesis, elaborative rehearsal served as a basis for the design of the one of the two game versions (as described in section 4.1.9.). The theory as a whole encouraged the formulation of specific dialogues to include aspects that would increase the retention of the acquired knowledge. In particular, this focused on the creation of a more powerful semantic understanding of new information. Linking recently discovered information with an additional commentary serves to create a stronger memory encoding, increasing the chance of retaining knowledge.

3.4. **History pedagogy and didactics in Swedish primary schools**

The public school system in Sweden is governed by the National Agency for Education (Swedish: Statens skolverk, or Skolverket). They explain their main focus by:

“The Swedish National Agency for Education is tasked with ensuring that all children and students have access to the same high-quality standard of education and activities in secure environments. Our mission is to create the best conditions for the children’s development and learning and to help improve the students’ learning outcomes.” (Skolverket.se, 2016)

Among other responsibilities, one of their tasks is to provide public schools with a National Curriculum (Swedish: läroplan), consisting of knowledge requirements and guidelines about how teachers should evaluate students’ reasoning and learning progress. The curriculum also includes subject specific syllabi (Swedish: kursplaner). These syllabi serve as the foundation for subject content and they
consist of central aspects to be focused on, including the pedagogical purpose and goals.

1.1.3. **History syllabus, central aspects and source criticism**

According to Skolverket (2011, p. 163-164), the general purpose for teaching History is to stimulate the curiosity of the students in regards to the subject and provide students with the opportunity for developing knowledge regarding how historical sources can teach us about the past. The education should allow for students to develop their ability to interpret, value and critically examine sources as a basis for gaining historical knowledge. Furthermore, the teaching should provide the students with the ability to understand how historical sources can be used in everyday life in order to broaden their perspective in regards to their own and others identity, values and perceptions.

The central aspects of the subject of History for grades 4 to 6 are divided into four topics: (1) Ancient times and the Middle Ages, up to about 1500, (2) The Nordics and Sweden’s Baltic Sea region, about 1500–1700, (3) Increased trade and the transformation of agriculture, about 1700–1850 and (4) How history and historical concepts are used (Skolverket, 2011, p.165-167). Within these topics are a number of different aspects that teaching should be focused on. This thesis involved a game design project based on teaching History and source criticism; therefore, certain aspects were of higher interest, in particular those concerning how to work with sources. The concept of source criticism is first mentioned in the syllabus for grades 7 to 9, however, a few aspects of this concept are introduced in grades 4 to 6. These are:

- “What historical sources, such as letters and other documents, can tell us about similarities and differences in the living conditions of children, women and men compared with today.

- How historical persons and events, such as Queen Kristina, Karl XII and the trials of witches, have been presented in different ways through different interpretations and different time periods.

- What the following concepts mean – change, similarities and differences, chronology, cause and consequence, sources and interpretation, and how they are used in historical contexts” (Skolverket 2011, p. 165-167).
3.5. **The Educational Technology Group**

The Educational Technology Group (ETG) is a group of researchers, PhD students and master students from Lund and Linköping Universities. Their work involves the development of digital educational systems to work as platforms for research. The ETG is not commercially driven; their main objective is to inspire and challenge the development of digital educational tools and to share their knowledge about possibilities and risks in regards to these. Their motivation for developing educational software is: “(1) Exploiting them as research instruments to explore learning processes and (2) Coming up with pedagogical software with a real-world value as pedagogical tools.” (Lucs.lu.se, 2016).

3.6. **Historiens väktare**

Historiens väktare (HV, English: Guardian of History) is one piece of educational software that has been developed by the ETG. HV is a web-based game which serves as a research platform and exists in a number of versions to support different studies and evaluations, all with a focus on educational practices within the subject of History in Swedish schools. The target group is students in grades 4 to 5. One pedagogical principle of HV concerns ‘learning by teaching’, which is achieved by the use of a ‘Teachable Agent’ (Silvervarg et al., 2014). However, the new version created for this project was not focused on this aspect and will therefore not be discussed further. In addition to the team members of the ETG, experts in history didactics were also consulted during the development of HV.

The concept of HV is centred on discoveries and inventions from 1400 to 1780. The game involves the players being introduced to certain historical settings within the previously mentioned timeline. Within these settings, the players can interact with certain characters such as inventors and researchers, and historical artefacts such as inventions and books. The interactions consist of dialogues which are based on historical facts surrounding the character or object in question. The purpose of these dialogues is to provide the players with sufficient information regarding certain historical facts. HV involves several different historical settings and characters. Usually, one historical setting is paired with one character which comprises a so-called ‘mission’. HV includes a number of different missions, for instance: Galileo Galilei in Florence, Italy, 1634, Isaac Newton in Oxford, England, 1685 or Émilie du Châtelet in Cirey, France, 1740. The geographical
locations which serve as a basis for the missions within the game are as follows: England, France, Germany, Italy, Denmark and Poland.

At the final stage of a mission, the players will partake in a so-called *teaching activity* where they are tested on this newly gathered information. The teaching activity can be one of three types, namely: a concept map, a timeline or a sorting activity. The player would require a certain amount of correct answers in order to proceed with another mission.

- The concept map involves connecting specific concepts to the historical character in the mission. In order to connect a concept, the player must declare the nature of the connection. For instance, Galileo Galilei studied Natural philosophy. Thus, for a correct answer, the connection between Natural philosophy and Galileo Galilei would be declared as “studied”.
- The timeline requires the player to connect two items with each other. An item could be either a person or an object introduced throughout the mission. After connecting two items, the player needs to place them in the correct timeline, as they occurred in history.
- The sorting activity consists of a number of different statements presented to the player. Each statement needs to be sorted into different boxes where there is a relevant connection. These boxes represent a character from within the mission.

The general narrative of HV can be described as follows: The player is introduced to the Castle of Time and its inhabitants. The castle is run by the *Guardian of Time, Chronos*, whose role is to keep track of and guard history. The player is informed that Chronos will soon retire and pass his responsibilities onto one of the assisting *time elves*. The player meets a time elf who explains that it is a great honour to be chosen for this position but in order to become the new Guardian of Time one is required to learn about history as much as possible and complete missions assigned by Chronos. This is achieved by utilising the time machine within the castle. However, the player is informed that the time elf is unable to do so because of travel sickness. Consequently, the player is requested to assist in this matter. The player proceeds to the office and meets Chronos. There, the player is assigned a mission that requires the use of the time machine, through which the player can travel to different time periods. After the player feels that enough information has been gathered, the teaching activity can be performed in the ‘Skolsal’ room, this will hereafter be referred to as a *skolsal-test*.
The interactions within HV involve simple point and click actions which can be performed by any input device similar to a mouse or touchpad. By clicking on characters or certain artefacts in a mission the player will initiate a dialogue. The dialogues progress when the player clicks on the assigned response. The game does not facilitate any free-text input; therefore the available responses are pre-defined and appropriately devised for the context. In most cases, the responses only amount to one, whereas in very few cases there are multiple options. There is no audio output throughout the game; the content is only reflected through text. All text is in Swedish.

3.7. Constructivist teaching methods

Constructivist teaching methods have some parallels to the elaborative rehearsal theories mentioned earlier, especially in regards to experiencing knowledge and social discovery. It is also the theory of the study being conducted in conjunction with this one, by Jessica Brewster. Constructivist teaching methods encourage a student to explore their learning environment, creating their own knowledge and understanding of events through exploration. This idea, developed by Jean Piaget in 1930, is exemplified further by defining the role of teachers as facilitators in the learning process (p. 253). The themes of scaffolding, effective questioning and reflection are key techniques used in a constructivist classroom. These three aspects allow a student the freedom to explore topics, openly discussing ideas and reflecting on their decision making with the support of the teacher. This opposes more traditional teaching methods like structured lectures, where the focus is geared towards if a student has the right or wrong answer, rather than the skills learnt around a subject (McCall, 2011).
4. **Method**

This chapter consists of two parts. **4.1. Adaptations to Historiens väktare** involve the methodology concerning the design process of the new version of HV. **4.2. Evaluation of HV** concerns the methodology of the experiment conducted for this thesis.

4.1. **Adaptations to Historiens väktare**

As HV is an existing game, most of the work completed in regards to game design is more easily related to the adaptations that needed to be implemented for the purposes of this study (hence the title of this chapter).

The rest of this chapter outlines the steps and methods that were used in the development of the new missions within HV, that is, the adaptations made to the game. The results of these methods can be found in Chapter 5.1.

4.1.1. **Finding a historical event**

As the game needed to take place within a historical context, an appropriate historical event needed to be selected. To simplify this task, there were criteria provided by the ETG that needed to be followed. The event needed to take place:

- Between 1400-1780
- In a country HV had previously included: France, Germany, England, Italy, Poland and Denmark

As the missions concerned source criticism, the event also needed to have a number of sources, preferably from different viewpoints or about different theories. They also needed to be available for use within an educational context.

In order to find an appropriate event, a web-based search was conducted, finding options that fit within the criteria listed above. These were then assessed according to the sources available for each event, before a selection was made.

4.1.2. **Mind map of chosen historical event**

On the basis of the extensive research completed, a mind map was created. This was done in order to gain a generalised understanding of the facts of the event and identify possible sources to be utilised. This would provide the basis for the processes of:
• Creating the narrative and dialogues on which the game would be based upon

• Constructing the pre and post-test questions

• Deciding on which sources would be best suited to the game

4.1.3. Brainstorming how to include SC in a game

As we needed to teach the students about source criticism, we conducted a brainstorming session which enabled us to suggest a number of ways that would allow students to interact with historical sources. These ideas were all based on commonly accepted history pedagogy that encourages interpretation and historical thinking regarding an event and its sources.

4.1.4. Workshop

In order to make the most educated assessment and decide on the sources and methods which would be best suited to our aim, a workshop was conducted at Lund University. This workshop was attended by Agneta Gulz and Annika Silvervarg (our supervisors), Magnus Haake (ETG member) and Irene Andersson (History didactics expert), as well as Ivar Särner and Jess Brewster. Over the course of a day, we presented our initial ideas from the brainstorming sessions and discussed which ones would be best suited for the purpose of the study.

The topics discussed at this workshop included:

• Aspects of SC and facts to be included: This was in order to decide what aspects of source criticism should be included, as well as how best to incorporate the facts.

• How the skolsal-test should be designed: This was to determine which of the many possibilities could be used in the game.

• What is the general narrative: The artefacts and characters that the students interacted with needed to be carefully chosen so they would fit within one (or more) of three categories:
  o Helped answer the mission questions
  o Was an excerpt or the author of a specific source
Answered questions that were included in the pre and post-tests.

The narrative of the game was to follow the existing format of missions already existing within HV, therefore our chosen characters and artefacts needed to be placed within this context.

- What the difference between the two versions of the game would be: This was an important aspect that needed to be discussed, as both constructivist teaching methods and elaborative rehearsal needed to be taken into account.

4.1.5. Grouping of aspects from the Mind Map

This was done in order to classify the necessary content into different groups. These groups were based on different characters, theories, sources and any additional points we needed to include. From this, it was hoped that facts could easily be attributed to specific sources and a definitive list of the characters and sources was visually identifiable.

4.1.6. Sketching of scenes based on chosen sources and characters

Basic sketches using pen and paper methods were chosen as a simple way of communicating our ideas for each scene. This needed to be done in order to have both a visualisation for ourselves, and to send it to member of the ETG who would be assisting with the design and programming of the game.

4.1.7. Dialogue scripting in parallel with creation of Pre and Post-test questions to match scene content.

The questions for the testing were written alongside the game dialogues, so all necessary information could be included within the game. Whilst the questions needed to represent two theories, they were still written conjointly, as the content for each set of questions needed to be included seamlessly into the game.

4.1.8. Feedback and revision until final version

This was the next step completed, as all content needed to be approved in English and Swedish before it could be implemented. Multiple versions of all of the game content was created and evaluated by the authors and by members of the ETG.
4.1.9. Difference of the two game versions

In order to test the theories of elaborative rehearsal and constructivist teaching methods, two versions of the game were constructed. One of these needed to be a control version, whilst the other applied elements of each of the theories to serve as an experimental version. As both theories are quite broad, it would have been unrealistic to include all aspects of either one, nor would that be completely feasible in a game setting. Consequently, the background research completed about each theory was used to focus on those points that would assist in this game context. This occurred following extensive discussions and comparisons between both theories. Consideration was also given to the interactions found in the existing game, which constricted the choices we would be able to realistically implement. The choice also needed to fit within the narrative.

4.1.10. Implementation of graphics and coding

This was the last step taken before testing began and was undertaken by members of the ETG who built the game within the existing structure.

4.2. Evaluation of HV

The evaluation of the game was performed through an experiment with a pre and post-test design. This was conducted with two primary school classes in the city of Helsingborg, located in southern Sweden. The experiment involved two groups, one control, one experimental in order to evaluate the effects of any introduced changes between the two versions. Consequently, the control group was assigned the game without the any additions while the experimental group was assigned the experimental version.

4.2.1. Participants

The participants in this experiment consisted of 44 students in the ages 11 to 12. They were Swedish students from two classes in grade 5. One class consisted of 17 students with 1 teacher (Class 1). The other class consisted of 27 students and 2 teachers (Class 2).

All students were divided into two groups, i.e. 22 students in the control group and 22 students in the experimental group. In order to be able to answer both the main, and the secondary research question, a sub-group division within each group was introduced before assigning the pre-tests. Meaning, half of each group (control/experimental) were assigned test version 1 as pre-test and test version 2 as
post-test, vice versa for the other half. This sub-division was introduced to avoid

differences in the pre and post-tests becoming a confounding variable.

In class 1, 8 students were assigned to the control group and 9 students to the
experimental group. In class 2, 14 students were assigned to the control group and
13 students to the experimental group. Assigning of students to groups was done
through randomisation.

4.2.2. Experiment conditions and equipment

The environment in which the study was conducted involved a real classroom setup
with students following the lead of the teacher(s). Controls for threats to internal
validity were limited. These threats involved variables such as scheduling,
computer equipment, teachers and pre-existing groups of students.

Each student was equipped with their own laptop, a Google Chromebook,
previously distributed by the schools for educational purposes. The pre and post-
tests as well as the game were performed using the web-browser Google Chrome.
The schedule was done through planning with both teachers in order to fit the
schedule of each class.

4.2.3. Pre and post-test

Two versions of the test were constructed, version 1 and version 2. Each version
consisted of the same questions but was slightly rephrased between the two
versions.

The tests were constructed on the basis of the two research foci. Therefore, the test
consisted of two parts of questions, (1) questions regarding historical facts found
throughout the game and (2) questions regarding source criticism.

In regards to the historical facts, there were 14 multiple-choice questions; each
question had 6 possible answers out of which 1 were correct. Consequently, the
score could then be a number from 0 to 14. In regards to source criticism, there
were 10 multiple-choice questions; each question had 5 possible answers out of
which 2 were correct. For each correct answer, the student received 1 point.
Consequently, the score could then be a number from 0 to 20.

In total, each test consisted of 24 questions. In addition to the questions, each
student was required to give their name. No other variable was collected. All
questions were ordered randomly.
The tests were constructed in the web application Google Forms and were distributed to the respective teachers via e-mail. Consequently, the teachers distributed the tests to the respective student. The data was immediately transferred to a Google account when a student had finished the last question of each test.

4.2.4. Procedure

The experiment was split into three time slots on three days during one week (Monday-Friday). Each time slot was about 1 hour long. The schedule was set up as following:

Day 1: class to perform the pre-test.
Day 2: class to play the game.
Day 3: class to perform the post-test.

The teachers were informed prior to the experiment to only intervene if a student was having problems with matters regarding comprehension of unfamiliar words.

Since the students were of the young age between 11 and 12 and that they needed to answer 24 questions, loss of attention and engagement needed to be considered. A certain balance had to be made in order to gather sufficient data for statistical analysis, as well as assuring that the data would be of high quality. Therefore, the pre and post-tests were divided into two parts; the students were required to answer 12 questions first, followed by a short break, after which the remaining 12 questions were answered. On day 1, the short break consisted of the students playing another version of HV for a short while. This version did not involve any information related to the game designed for this thesis or the questions and were therefore deemed appropriate. On day 3, the students were prompted to play Othello during the short break.

4.2.5. Observations and other feedback

In addition to the data gathered from the pre and post-tests, observations were conducted during all of the time slots. Observational notes were taken by Jessica Brewster and later checked and reviewed by Ivar Särner. After the post-tests were completed, each class was encouraged to give any kind of feedback about the game in general.
5. Results

The results of the methods outlined in Chapter 4 have below been split into two parts, those regarding the game design that was used and the data collected from the experiment.

5.1. Adaptations to Historiens väktare

5.1.1. Finding a historical event

Amongst the many potential historical events that met the criteria outlined in section 4.1.1, The Great Plague of London in 1665 was ultimately selected as the event for the game. Extensive background research into The Great Plague of London revealed a great number of different sources that were publicly available, such as diaries, medical journals, city rules and laws (Museum of London, 2016). Many of these discussed the living conditions and how the disease impacted London. An interesting aspect about these sources was that they discussed numerous ideas and theories about what really caused the plague and what kinds of remedies would be effective. This was ideal for the game, as it offered a wide range of viewpoints and theories that could be utilised.

The initial research was completed through Wikipedia, searching for any historical event that fit the criteria. After the Great Plague of London had been selected, many more resources were utilised. In particular, the sources for the Great Plague came from a variety of locations. The main sources that were used within the game are:

- *The Diary of Samuel Pepys*: Concerns diary entries about the everyday life of the author Samuel Pepys, written from 1660 to 1669. He wrote many things about his life in London, his home, his friends, family and what happened around him. Amongst other historically important events, Pepys diary includes substantial information about The Great Plague of London. As the author was an eyewitness account to these travesties, this source has provided a great deal to historians investigating this event (Pepys, 1665).

- *Loimologia*: A treatise published in 1672 by physician Nathaniel Hodges, who also was an eyewitness account to the Great Plague of London. While most of the physicians fled London during the time, Hodges remained and recorded the event from a medical point of view. His work is considered to be one of the most important
sources about the work of physicians and how theories of medicine and remedies were utilised against the plague (Holland, 2000, p. 322-324).

- **Plague Orders**: Written by the City of London and published during the plague. The Plague orders were specific rules and regulations concerning the plague. They were enforced upon the residents of London at that time as a method of reducing the spread of the disease (Roberts, 1721).

- **Bills of Mortality**: A registry in which the total amount of deaths were recorded each year in every parish of London. The cause of death was also recorded and particularly how many had died from the plague (Museum of London, 2015).

- **The Causes and Cure of the Pestilence**: A treatise written by Reverend Thomas Rosewell in 1665. Written from a more theological standpoint, Rosewell’s work concerns a spiritual justification for the plague as well as methods for atonement to God (Rosewell, 1665).

- **Yersinia pestis discovery**: The bacteria that was the cause of the disease bubonic plague. Discovered by Alexander Yersin in 1894 (Moote, 2006).

Any information discovered from these sources, and others, were stored in a mind map (mentioned in more detail below).

### 5.1.2. Mind map of Great Plague of London

The mind map contained information from a variety of sources and was a mixture of factual information and anecdotal comments from sources. The information included: general facts about the disease, how it spread and its symptoms, how many were killed by it, how the people at that time believed it spread and what kind of remedies were prescribed by the physicians. At a more detailed level, there was also a variety of important sources, characters and locations.

### 5.1.3. Brainstorming how to include SC in a game

During this session, there were many ideas that had the potential to teach students about source criticism. These included: travelling to an archiving facility, a university or having a more in-depth conversation with Chronos specifically about source criticism. This was in addition to the idea we ultimately selected, integrating
sources within a historical context. These ideas were all based on commonly accepted history pedagogy that encourages interpretation and historical thinking regarding an event and its sources.

The options for the skolsal-test were also numerous, consisting of: sorting sources into groups, rearranging book pages, using source clues to progress in the game and timeline activities.

5.1.4. Workshop

The workshop conducted at Lund University was ultimately invaluable as it was where almost all aspects of the game were decided. The discussions that took place in the workshop resulted in the findings below.

Aspects of SC and facts to be included

During the workshop, based on the advice of Irene Andersson and in deference to the points in the syllabus that reference source criticism, it was decided to include two main concepts of source criticism, identification and analysis. Within source identification, the challenge is to establish: the author (or creator), the purpose, the intended audience and when the source was created. In regards to the analysis of sources, the task was to focus on ensuring the students would be able to infer the answer to questions, based on quotes given by a variety of answers.

In regards to the facts being included, it was decided that those used would be ones that could be easily found from either primary sources or characters who had lived during the epidemic. The facts chosen also needed to be included in the pre and post-tests that were to be designed alongside the dialogue.

How the skolsal-test should be designed

As there were already a number of existing formats for the skolsal-testing designed by the ETG, it was decided that it would be best to utilise one of these designs. The motivations for this were partly that it would involve less work and testing on behalf of the ETG, but predominantly because one of their existing formats matched our preliminary designs. As the test had been successful before, it was also a more reliable format. The test chosen was a type of concept map, which required students to draw links from different theories to different sources. A preliminary design of these can be found in Figure 1, and a more detailed version can be seen in Figures 11 and 12.
Prior to the workshop, the decision had been made to choose the Great Plague of London as the topic the game would be based upon. Consequently, discussion about the Plague within the game context was focused mainly on the types of questions that we could pose to the students. As there had already been a substantial amount of research completed about the event, we focused on those questions that could draw a variety of answers from the sources available. It was decided that two questions would be posed for the second mission, how many people died from the plague and what caused it. Both of these questions seem quite simple to answer, however at the time of the plague, the truth for both questions would go unanswered. This meant that the sources utilised reflected a variety of opinions and contained different facts about the two questions.

What the difference between the two versions of the game would be

In discussing the implementation of the theories, which would provide the change between the two versions, a magical walkie-talkie was eventually chosen. This was the idea that appealed most to the ETG and the authors, for its potential to subtly influence the players and due to the ease in including it. It also offered the most potential in which to frame and present both theories within the game. Examples were presented to the ETG members that illustrated the type of dialogue that might be included, including a questioning aspect that highlighted aspects of elaborative
rehearsal and constructivism. This was discussed and found to be a popular idea amongst the group.

5.1.5. Grouping of aspects from the Mind Map
After a decision had been made on the types of sources, characters and questions that the students would interact with in the game and in the pre and post-tests, a further amendment to the mind map was performed. This was done in order to classify the necessary content into different groups. These groups were based on different characters, theories, sources and any additional points we needed to include. From this, facts could easily be attributed to specific sources and a definitive list of the characters and sources was visually identifiable. The sources chosen to be the basis of the game include:

- The Diary of Samuel Pepys, written by Samuel Pepys
- Loimologia, written by Nathanial Hodges
- Plague Orders, released by the City of London
- Bills of Mortality, released by the City of London
- The Causes and Cure of the Pestilence: A Treatise, written by the Reverend Thomas Rosewell

5.1.6. Sketching of scenes based on chosen sources and characters
Due to the work mentioned above, when it came to sketching, this was a matter of including all the necessary aspects in a scene that could be an example of the visuals we wanted within the game. This was done using the traditional pen and paper method, chosen as it was quick to execute and made revisions simple. At the end of this step, we had created five scenes that each contained one character and, at times, multiple artefacts.

5.1.7. Dialogue scripting in parallel with creation of Pre and Post-test questions to match scene content.
In creating the dialogue, each scene was allocated separate facts and sources that were dependant on what the focus for the scene was. This allowed us to link the dialogue and questions to each character/artefact and ensured we would not miss any necessary piece of information. Some of the sources utilised in the game were written in a very old style of English and were consequently simplified in order to meet the level of literacy of the players. All content was written in English.
5.1.8. Feedback and revision until final version

The first drafts of the dialogue and questions were sent to the ETG and Mats Lind for their input and suggestions. We also requested that Irene Andersson be sent a copy, due to her extensive knowledge of history didactics, as well as the target age group. Overall, the first round of feedback was positive, suggesting that we had established the correct level of language, however some suggestions were proposed. For the questions, there was a lot of discussion on the amount of questions that should be included (discussed below) and some comments about the difficulty of the source criticism questions, which were addressed. Once feedback from all parties had been received and included, the dialogue and questions were translated into Swedish by Ivar Särner. These were again sent out to the ETG, Andersson and Lind, and after further amendments, mainly in regards to simplifying the Swedish used, both documents were finalised.

5.1.9. Difference of the two game versions

As there was a need to include two theories within this study, it was essential that those chosen complemented and supported both. Särner’s chosen theory of elaborative rehearsal focused on creating a stronger semantic meaning for effective memory encoding. Within Brewster’s chosen theory of constructivism, only the aspects of effective questioning, reflection and scaffolding were (albeit briefly) included. As the game has an existing framework that emphasised the use of dialogues and did not contain sound, the most realistic way of framing these theories was through new text. This was also the most effective way of including two theories that were based on reflection and a better understanding of a concept.

The final combination of constructivism and elaborative rehearsal elements, led to a small change, the implementation of a magical walkie-talkie that could travel through time with the player (see Figure 13). This gave the students a direct link with Chronos based at the time castle. This text was carefully written to incorporate both theories, usually in the form of reflective questioning that encouraged students to think about the questions and reiterate the facts mentioned. For example, ‘68,596 people have died from this plague! But Samuel thinks the “true” number is much higher. Why would the official amount not be correct?’ The way this quote is formulated encourages students to think more about the number being posed and how it relates to Pepys’s opinions about the death counts conducted by the city. This aids in promoting the elaborative rehearsal theory of Särner by encouraging a
deeper encoding, as the number is linked with a greater concept. It also guides them into reflecting on the excerpts that accompany this comment, in which Pepys mentions that the poor were often not included in the official death counts. By highlighting words like ‘true’ and asking open-ended questions, the constructivist guide of Chronos scaffolds the educational experience.

5.1.10. Implementation of graphics and coding

The overall implementation of the game was completed by members of the ETG. Carolina Ekström created all the required graphic designs for the game, designing all scenes, artefacts and characters based on our descriptions or provided links illustrating examples, for e.g. a portrait of Samuel Pepys. Erik Anderberg then utilised these and completed all coding, implementation and testing.

5.1.11. Final design

The outline of each mission could be described as an information gathering activity followed by a knowledge test. Mission 1 was to serve as the introduction to the historical context in general and in particular to a key aspect of source criticism, namely the identification of a source. This took place in the house of Samuel Pepys, a diarist from 1665 who recorded in detail, his experiences that year. The knowledge test takes place within the Castle of Time, in dialogue with the time elf. Key points involve:

- Identification of a source
- Source: Diary of Samuel Pepys
- Time travel to Pepys residence in 1665
- Dialogue about the diary and its contents
- Questions regarding identification of Pepys’ diary

The following (Figure 2) is a basic concept map of mission 1:

```
Castle of Time -------- Time machine -------- Samuel Pepys' house -------- Diary of Samuel Pepys
Interactions Chronos Time elf
Choose destination      Interactions Samuel Pepys Diary

Figure 2. Basic concept map for mission 1.
```
Mission 2 is far more complex than the previous, encouraging students to visit a number of scenes and interact with a range of characters and artefacts. This mission introduces more source criticism and analysis methods, and is set on the streets of London in 1666, once the plague has abated. The students are tasked with discovering the answers to two questions, and must complete two tests in the skolsal to complete the mission.

Key points involve:

- Analysis of multiple sources
- Sources: Diary of Samuel Pepys, Bill of Mortality, Plague orders, Loimologia and Priest’s announcements
- Time travel to Streets of London in 1666
- Dialogues and text about each source
- Skolsal-test regarding how the sources are connected to the mission objectives

The following (Figure 3) is a basic concept map of mission 2:
Following is a walkthrough of the two missions.

**Mission 1: Source identification - The Diary of Samuel Pepys**

The mission is given by Chronos in his office and the players’ screen is updated with the new mission information and objectives, displayed in the top right corner. The mission information contains explanations of what a source can be and how important the ‘identification of a source’ is in regards to the process of source criticism. Additionally, the player is informed of how sources can be classified as primary or secondary.
The objectives of the mission and the basic outline are as follows: The players use the time machine to travel to London and meet with Samuel Pepys. Whilst there, the player should try to learn as much as possible about his diary. This is done utilising dialogues and by reading excerpts from the diary. When the player feels ready, he or she can return to the Castle of Time and answer questions from the time elf. Moreover, the player is informed that a terrible disease is spreading in London.

After receiving the mission from Chronos, the player can leave the office and proceed to the room with the time machine, where the option to travel to the destination London in 1665 is available. The time machine takes the player to the house of Samuel Pepys where he is standing by a table, on which his diary is placed (see Figure 4). Clicking on him initiates the first dialogue. Here Pepys explains when he started writing the diary, and for what purpose. Lastly he informs the player that they can read the diary. Clicking on the diary opens up a new window (see Figure 5) showing a foreword and an entry from April 30, 1665. The preceding dialogue, with Pepys, along with the foreword contains information required to answer questions given on the player’s return to the Castle of Time.

The other diary entry introduces aspects of the Great Plague of London and contains important information the players need to know in order to give a correct answer to certain questions in the pre and post-test. Back in the Castle of Time the player can initiate a dialogue with the time elf. Here the time elf poses questions in regards to identification of the Diary of Samuel Pepys (see Figure 6). After completing all questions, mission 1 is complete and the player can go back to Chronos in order to begin mission 2.
Figure 4. Mission 1, Source Criticism Identification task in Historiens väktare. Pepys and his diary.

Förord:

Denna dagbok tillhör Samuel Pepys
Jag skriver denna för mig själv så att jag kan se tillbaka och minnas mitt spännande liv.

April 30, 1665

Hittills har det registrerats att 4 dödsfall är orsakade av pesten. Alla fruktar att sjukdomen kommit hit igen.
Man har också börjat med de där stora brasorna igen för att försöka döda smittan i luften.

Figure 5. Diary of Samuel Pepys, Foreword and Entry.
Mission 2: Analysis of multiple sources - Plague ridden streets of London

After meeting with Chronos in the office, the new mission information and objectives are received. The mission information continues the focus on source criticism and explains the importance of analysing multiple sources. Sources are all important and by analysing multiple ones we can discover different views, opinions and determine their purpose. Thus the usefulness of them is dependent on what is discovered. Moreover, the players are informed that in addition to the diary of Samuel Pepys, there were many other primary sources that discussed the plague with different points of view. Consequently, the mission objectives are explained as follows: The player is to travel back to London, one year later, to try and discover the cause of the plague and how many died from it.

The new destination, Streets of London, 1666 is now available in the time machine. The player will arrive at the scene called Crossing.

Crossing

The player is again introduced to Samuel Pepys. This time he is standing on the street at a crossing in London (see Figure 7). Next to him is his diary and a billboard on which two documents are pinned. The streets are seemingly filthy as there are multiple piles of garbage, surrounded by rats. There are two signposts
pointing left and right respectively, which are placed on each side of the billboard. Clicking on any one of these signs will bring the player to a new scene. The one pointing left directs to the Church, the one pointing right directs to the Square. There is also a sewer grate, clicking it will bring the player to the scene Rat Lair. Logically there are no signpost directing the player to the Rat Lair, therefore, a few clues are included to catch the attention of the player. These clues consisted of: a small mention of them by Pepys, rats surrounding the sewer grate and pairs of small yellow dots, appearing and disappearing, to resemble eyes of rats. The scenes can be accessed in any order.

Clicking on Pepys will initiate a dialogue. He continues to talk about his diary and that he came out into the streets to inspect the Bills of Mortality, in which the total number of dead from last year is recorded. Pepys draws the attention to his diary for the player to read. In addition to the entry from mission 1, it now includes three more diary entries which contain important information the player needs to remember. After reading the diary, the player can click on the billboard which opens up a new window showing two documents in full size; Plague Orders and the Bills of Mortality. Each contains important information relating to theories about the cause of the plague, as well as the amount of dead.

![Figure 7. Crossing scene with Samuel Pepys and diary and billboard in Mission 2.](image)
Church

In this scene the player meets a priest standing outside a church (see Figure 8). Through a dialogue the priest is explaining that it is the sins of the people that have unleashed the wrath of God upon London and the public.

![Figure 8. Church scene with Priest.](image)

Square

In this scene, the player is introduced to the physician, Nathaniel Hodges. Around him are a number of different houses and piles of garbage, accompanied by rats (see Figure 9). On a door on one of the houses a red cross is painted. Clicking on Hodges initiates a dialogue in which he explains his work with his medical treatise *Loimologia.*
Rat Lair

In the center of the lair on a big pile of garbage, the Rat Lord is sitting, as seen in Figure 10. He is surrounded by numerous other rats, on which fleas are crawling. Clicking on him, the player initiates a monologue. Through this monologue the player is informed about the role of the rats during the Great Plague of London.
After visiting all scenes the player is prompted to travel back to the Caste of Time and complete the skolsal-test.

**Skolsal-test**

These tests were designed to test the students’ knowledge about the sources they had read during the game. Some of the responses could only be answered if they had read one specific source. For each task (see Figure 11 and 12), the student needed to drag an arrow from a source to one of the theories. A source could provide the answer to multiple theories and vice versa. Once a student had answered at least 75% of the test correctly, they were considered to have passed. Feedback given to the student included green arrows for a correct response and red arrows for an incorrect one (as seen in Figure 12).
Walkie-talkie design

When the students clicked on an artefact or character, the walkie-talkie became animated, flashing its lights and moving slightly. This attracted the attention of the
students and ensured they were aware of some new information. A text-based pop-up appeared with this information whenever the walkie-talkie was clicked on by the player, as demonstrated in Figure 13 below.

Figure 13. Chronos text through walkie-talkie, seen in top left corner.
5.2. Evaluation of HV

Prior to the experiment, the number of participants amounted to 44. However, when the study was completed the number had dropped down to 40.

5.2.1. Pre and post-test

First, the two tests were compared to see if there were any significant differences between the two test versions using a t-test for between groups testing. The pre-test scores were used for this since they are unaffected by the experimental conditions. There were no significant differences between the tests (t= -0.6737, df=38, p= 0.5046). The mean values were also very close for the two test versions (3.4 versus 3.75).

The effect of the walkie-talkie implementation as well as the general effect of playing the game was then tested by means of an ANOVA. A two-way mixed ANOVA was performed using pre-post as a within subject factor and walkie-talkie, no walkie-talkie as a between subject factor. There was only one significant main effect. That was the factor pre-post (F(1,38)=17.2397; p=0.000179). The mean value of the pre-game scores was 3.565 questions correct and the mean value of the post-game scores was 5.088. The interaction between the walkie-talkie factor and the pre-post factor was not significant (F(1,38)=0.0178; p=0.894678) which can be interpreted as the two game versions having the same effect.

5.2.2. Observations

Following each session, the observations and comments recorded were checked for their accuracy based on what both observers (Särner and Brewster) had seen and heard. Sometime changes were made if an error in Swedish had been made. Overall, an assortment of comments and behaviours by students was collected. Though not applicable for testing the study’s treatment, these observations are useful in analysing student’s behaviours and opinions of the game, which could have some impact on future studies.

Observations: Pre and post-tests

In regards to the pre and post testing, the observations of the students were the same. In both classes, the students appeared to be highly concentrated and focused on the task, both rooms extremely quiet whilst the students were completing the tests. A minimal amount of students asked for assistance as they had previously been informed that they should complete the work on their own. The teachers in both classes, particularly Class 1, commented that the students were far more
concentrated than usual. The teacher of Class 1 also noted that the students who would usually give up if they didn’t know something, continued to concentrate despite their difficulties. During the post-testing however, some students did appear to be quite bored at having to take a test again.

Observations: Playing Historiens väktare

Once again, both classes were noted to be extremely quiet when they first began playing the game and most were concentrated on reading the text in the game. In both classes though, some students appeared to be clicking through all the scenes to the final skolsal-test quite quickly. One student finished everything in 15 minutes, whilst others took closer to 30 minutes. Observations of both classes indicated the same levels of frustration with it came to the final skolsal-tests. Students became quickly disappointed when they could not finish it on the first go, though they continued to try until they had passed it. Some children even got out pieces of paper to record their correct answers.

Feedback

Comments from Class 1 after they had finished the game were all about two points. The game was fun, until the skolsal-test. Then the game was very hard.

Class 2 had similar comments, also agreeing that the game was good, but that the skolsal-test was too hard. They also mentioned that they enjoyed playing the game as they got to explore London and could meet different characters, something they would have like more of. They also wanted to be able to have a more interactive dialogue with the characters and reply to the dialogue themselves. Also, there were some who pointed out that it was confusing that you did not control any character, and it felt weird to just be “floating in the air” as in the beginning they thought that the player was the time elf.

Another comment from the teacher of Class 1, was that the students in other classes were extremely jealous that they were not playing the game as well.
6. Discussion

This thesis aimed to answer whether the new version of the educational game Historiens väktare could be utilised as an educational tool in regards to teaching historical facts to children aged 10 to 12 in general (main research question) and in particular, if an implementation of elaborative rehearsal would have any further positive effect on learning outcomes (secondary research question).

The data analysed did show significant results indicating that the computer game could be utilised as an educational tool to teach historical facts. In regards to the second question, the data analysed showed no indications that the implementation of elaborative rehearsal had any further positive effect on learning within the game designed for this thesis. Essentially, the two versions of the game had the same effect. According to the results of the T-test performed, to see whether there was a difference in the two versions of the pre-test, there was no difference and therefore it was not considered to be a confounding variable when testing the effect of the two game versions.

As to why the implementation of facts within the game was effective in teaching students, it is probable that the main reasons lie within the design and inclusion of engaging characters within a historical context. Including contemporary sources and characters and situating them within their world may have encouraged the students to pay more attention to what they were saying. It may also have allowed them to link the facts with the context. The students also had some previous knowledge regarding the plague from the 1300’s (The Black Death), which indicates the possibility that they retained that information and could apply it better to the knowledge they discovered during the game’s interactions. Another reason why the students were able to learn from the game might have been that the questions about the Great Plague of London in the pre-test activated their attention to this topic. Regardless of pre-existing knowledge, the questions introduced them to the topic and together with the answers, the pre-test painted a picture in their minds. Combined with playing the game afterwards, this enabled them to explore this topic further in a meaningful context and it might have been easier for them to grasp this new information.

The results did not lend any support for the implementation of the elaborative rehearsal theory; the implementation was not sufficient enough to affect a result on the outcomes of the game designed. There are a number of factors as to why this occurred.
The theory of elaborative rehearsal might not have been implemented thoroughly enough, indicating that the effort to enable the players to create a more powerful semantic meaning about the facts was perhaps not sufficient. The treatment provided possibilities to connect certain facts together. This was spread throughout the game in order to fit into the context of each scene and would only incorporate small sets of facts each time. Hypothetically, by increasing the amount of facts to be connected, with the purpose of broadening the concept of the historical event, it might result in a stronger overall effect. The amount of facts included was limited during the design process to avoid the content being too overwhelming for the young players to comprehend. Moreover, there were no controls ensuring that the players actually read the information conveyed through the walkie-talkie; the animations were enough to catch their attention, but the treatment could have been overlooked if the player was merely clicking through the dialogues and text in order to reach the skolsal-test as quickly as possible.

Another factor which could have been influencing the effect of the walkie-talkie is that the game was required to be based on two theories. This had an impact as the narrative and dialogues had to include aspects of source criticism as well as the historical facts needed for testing within this study. The amount of text at some points in the game was therefore quite substantial. Having long sections of text could have been negative in two aspects. (1) The amount of information would take longer, and could have been more difficult to process and (2) being introduced to big chunks of text could have been intimidating for some students, which could have led them to avoid reading and just clicking through the dialogues to try complete the mission. The negative impact of both aspects could also have been more significant for students who had problems with reading and comprehension in general.

Moreover, as the pre and post-test were constructed on the basis of the two studies, the tests were required to consist of a number of questions in order to consider both theories. This meant that instead of having only 14 questions there were instead 24 (10 source criticism questions) that needed to be answered. Considering the young age of the target group, the length of the tests could have had a negative impact when considering the potential loss of attention or fatigue. In addition to this, the source criticism questions could be considered to be much more difficult than the ones about historical facts. The source criticism questions were more complex in regards to their formulation. Also, the answers to each question required more time and effort as they involved critical thinking and sometimes an analysis of source
quotations. Considering this aspect, the pre and post-tests could have been less mentally tiring if the source criticism questions were excluded. Potentially this could have increased the performance in regards to the historical facts questions.

To create an educational computer game focused on the subject of History, it is imperative to include sources within the game, as they are the basis for historical knowledge. However, trying to concentrate on source criticism and the teaching of specific facts at the same time is a complicated balance to achieve. Although the results indicated that the game could teach historical facts, no such results existed for source criticism, as concluded in the collaborated thesis of Brewster (2016). This could be an indication that the students focus during the game could have been fixated towards the facts, rather than the source criticism aspects. As a general remark it can be said that trying to apply two research foci is difficult within the context of one game, particularly if pre and post-testing is required.

In addition to the data analysed, the observations taken revealed some interesting aspects about the game. Many of the students said that they enjoyed the game in general; they found it interesting and fun to explore history within this context. There was also a general consensus that the game was hard, especially the skolsal-test in Mission 2. However, this was not seen by all as something negative as some saw it as incentive to work harder. Students also found the more interactive parts of the game to be engaging. For example, they commented on the dialogue within the game, wishing that they could have had even more of a discussion with the characters, like the Rat Lord. This interest is perhaps what increased the retention of knowledge, as the inventive ways used to display the information were something they could relate to and were interested in, as opposed to traditional methods like textbooks.
References


Rosewell, T. (1665). *The causes & cure of the pestilence, or, A brief collection of those provoking sins recorded in the Holy Scriptures, for which the Lord hath usually sent the sore destroying pestilence or plague among a people: together with some special receipts and preservatvies [sic] against the further encrease of this pestilential disease, and may serve as a seasonable call from the Lord to invite all sorts of people to a speedy return unto the Lord, and a forsaking of those sins, which otherwise will cause the wrath of the Lord to break out among us, so that there will be no remedy.* London: [s.n.], printed in the year MDCLXV [1665], Harvard University Library, http://nrs.harvard.edu/urn-3:DIV.LIB:1145550 [Accessed 26 May 2016].


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# Appendix A. Pre and post-test questions

Historical facts questions (correct answer in bold text):

V1 = Version 1  
V2 = Version 2

<table>
<thead>
<tr>
<th>Q</th>
<th>English</th>
<th>Swedish</th>
</tr>
</thead>
</table>
| 1 | V1: When did the Great Plague break out in London?  
  V2: In what year did the Great Plague of London officially begin?  
  - 1662  
  - 1663  
  - 1664  
  - 1665  
  - 1666  
  - 1667 | V1: När bröt den *Stora Pesten i London* ut?  
  V2: Vilket år kom den *Stora Pesten* till London?  
  - 1662  
  - 1663  
  - 1664  
  - 1665  
  - 1666  
  - 1667 |
| 2 | V1: What was the cause of the Great plague of London?  
  V2: The Great Plague of London was caused by:  
  - Infected fleas and rats  
  - Punishment from God  
  - Poor health of Londoners  
  - Poisonous air  
  - The food ran out  
  - The food was too unhealthy | V1: Vad var orsaken till den *Stora Pesten* i London?  
  V2: Den *Stora Pesten* i London orsakades av:  
  - Smittade löss och råttor  
  - Guds bestraffning  
  - Befolkningens dåliga hälsa  
  - Förgiftad luft  
  - Maten tog slut  
  - Maten var för onyttig |
| 3 | V1: The disease spread very quickly, why?  
  V2: Why were the disease able to spread so quickly as it did?  
  - Bad doctors  
  - Civil war  
  - The medicine ran out too quickly  
  - Bad hygiene  
  - There were too few hospitals  
  - The medicine was too expensive | V1: Sjukdomen spreds väldigt fort. Hur kom det sig?  
  V2: Hur kom det sig att sjukdomen lyckades spridas så fort som den gjorde?  
  - Dåliga läkare  
  - Inbördeskrig  
  - Medicinen tog slut för fort  
  - Dålig hygien  
  - Det fanns för få sjukhus  
  - Medicinen var för dyr |
| 4 | V1: After a while, the disease got worse, why?  
  V2: Why did the disease get worse?  
  - The summer was very hot  
  - England was at war with the Netherlands | V1: Efter ett tag blev sjukdomen värre, varför?  
  V2: Vad var det som gjorde att sjukdomen blev värre med tiden?  
  - Sommaren var väldigt varm  
  - England var i krig med |
| 5 | V1: Who was allowed to leave the city during the plague? | V1: Vem hade tillåtelse att fly från London? |
|   | V2: Many wanted to leave the city, who was allowed to? | V2: Många ville fly undan pesten. Vilka fick göra det? |
|   |   |   |
|   |   | - De som hade ett skriftligt godkännande från borgmästaren |
|   |   | - Alla som var sjuka |
|   |   | - Alla som var fattiga |
|   |   | - Alla köpmän |
|   |   | - Bara de rika |
|   |   | - Ingen |

| 6 | V1: Where did the first people die of plague? | V1: Var dog den första människan av sjukdomen? |
|   | V2: Many people died from the disease, where did the first one die? | V2: Många människor dog av sjukdomen, var dog den första? |
|   |   |   |
|   |   | - På gatan Baker street |
|   |   | - I området runt Tower of London |
|   |   | - På Westminster-torget |
|   |   | - I området ‘St-Giles-in-the-Fields’ |
|   |   | - I kungens slott |
|   |   | - På landsbygden utanför London |

| 7 | V1: What stopped the Great Plague? | V1: Vad gjorde att sjukdomen försvann? |
|   | V2: What was the reason for the Great Plague to end? | V2: Vad var orsaken till att pesten slutade? |
|   |   |   |
|   |   | - En stor brand |
|   |   | - Ny medicin |
|   |   | - Bättre utbildade läkare |
|   |   | - Den kalla vintern |
|   |   | - Fler och fler gömde sig inomhus |
|   |   | - Människorna började äta mer nyttig mat |

| 8 | V1: What did the King do when the | V1: Vad gjorde den engelska kungen när |
|   |   |   |

- People stopped visiting each other
- There was no healthy food left in London
- The medicine was too bad
- All the doctors died

- Nederländerna
- Människorna slutade träffa varandra
- Det fanns inte längre någon nyttig mat kvar i London
- Medicinen var för dålig
- Alla läkare dog

- Everyone who was sick
- Everyone who was poor
- All the merchants
- Only the rich
- Nobody

- V1: Who was allowed to leave the city during the plague?
- V2: Many wanted to leave the city, who was allowed to?

- V1: Where did the first people die of plague?
- V2: Many people died from the disease, where did the first one die?

- V1: What stopped the Great Plague?
- V2: What was the reason for the Great Plague to end?
<table>
<thead>
<tr>
<th>Page</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>Plague came?</td>
<td>V2: The King did something when the plague broke out. What?</td>
</tr>
<tr>
<td></td>
<td>s)</td>
<td>- Left London</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Asked his doctors to help the sick</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- He made sure that more hospitals were built</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Died of the plague</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- He gave money to the poor</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- He trained to be a doctor</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Page</th>
<th>Question</th>
<th>Answer</th>
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<tbody>
<tr>
<td>52</td>
<td>V1: Some animals were exterminated as a way of stopping the disease. Which ones?</td>
<td>V2: Which animals were exterminated to stop the plague from spreading?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Cats &amp; dogs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Rats</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Pigeons</td>
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<tr>
<td></td>
<td></td>
<td>- Cows</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Pigs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Sheep</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Page</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>V1: How many plague deaths were officially recorded during the outbreak?</td>
<td>V2: What was the official number of people killed during the Great Plague?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 68 595</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 223 666</td>
</tr>
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<td></td>
<td>- 99 989</td>
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<td></td>
<td></td>
<td>- 44 233</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- 10 000</td>
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<td></td>
<td></td>
<td>- 158 146</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Page</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>52</td>
<td>V1: What did the authorities do when the plague officially broke out?</td>
<td>V2: The authorities did something special when the plague came. What?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Released special plague orders</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Advise people to leave the city</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Skrev speciella pest-regler</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Bad folket att lämna staden</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Brände ner stora delar av staden</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Eldade upp mat som de trodde var smittad</td>
</tr>
<tr>
<td></td>
<td>Burned parts of the city</td>
<td>Burned food they thought was infected</td>
</tr>
<tr>
<td>---</td>
<td>--------------------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Confiscated unhealthy food</td>
<td>Built more houses for the homeless</td>
</tr>
<tr>
<td></td>
<td><strong>Beslagtog onyttig mat</strong></td>
<td><strong>Byggde fler hus till de hemlösa</strong></td>
</tr>
</tbody>
</table>

| 12 | **V1:** What identified a house as being infected by the plague? |
|    | **V2:** How could you tell if a house had a plague victim? |
|    | - A red cross painted on the door |
|    | - Flowers hanging on the door |
|    | - List of victims on the door |
|    | - A black skull painted on the door |
|    | - The entire house was painted black |
|    | - The people who lived there had moved |

| 13 | **V1:** What was the name of the document that kept track of the causes of death? |
|    | **V2:** In London during that time, the amount of people who died was recorded. Where was this recorded? |
|    | - Bill of Mortality |
|    | - Book of Plague |
|    | - Record of Deaths |
|    | - The Bible |
|    | - Doomsday book |
|    | - The Plague records |

| 14 | **V1:** Where did the people bury the ones who dead of the plague? |
|    | **V2:** The people who died from the plague needed someplace to be buried. Where? |
|    | - In the cemetery |
|    | - In plague pits outside the city |
|    | - In the river Thames |
|    | - In the English Channel |
|    | - In the sewers of London |
|    | - In the parks |

|   | **V1:** Vad var ett kännetäcken på att någon i huset hade blivit smittad? |
|   | **V2:** Hur markerades hus för att visa att någon smittats där? |
|   | - Ett rött kors målat på dörren |
|   | - Blommor hängandes på dörren |
|   | - En lista på de människor som dött, uppspikat på dörren |
|   | - En svart dödskalle målat på dörren |
|   | - Hela huset var målat svart |
|   | - Människorna som bodde där hade flyttat |

|   | **V1:** Vad kallades det dokument som användes för att skriva ner antalet döda under denna period i London? |
|   | **V2:** I London under den tiden skrev man ner hur många som dog. Vad kallades detta dokument |
|   | - Registret över döda |
|   | - Pestens bok |
|   | - Dödslistan |
|   | - Det skrevs ner i Bibeln |
|   | - Domedagsboken |
|   | - Pestregistret |

|   | **V1:** Var begravdes de som dog av pesten? |
|   | **V2:** Människor som dog av pesten behövde någonstans att begravas. Var? |
|   | - På kyrkogården |
|   | - I pestgräpar utanför staden |
|   | - I floden Themsen |
|   | - I Engelska kanalen |
|   | - I Londons kloaker |
|   | - I parkerna |
Source criticism questions (correct answer in bold text):

V1 = Version 1  
V2 = Version 2

<table>
<thead>
<tr>
<th>Q</th>
<th>English</th>
<th>Swedish</th>
</tr>
</thead>
</table>
| 1 | V1: Which are two important tasks to complete when you’re identifying a source?  
V2: What do you have to do when you’re identifying a source? Choose 2 from those listed below.  
- Finding out who the author is  
- Discovering when it was created  
- Seeing how long it is  
- Working out how much it would have cost  
- Reading it to find hidden codes | V1: Vad är viktigt att göra när man ska identifiera en källa? Välj två alternativ  
V2: Välj två alternativ som är viktiga när man ska identifiera en källa.  
- Att ta reda på vem som skapade källan  
- Att ta reda på när källan skapades  
- Att ta reda på hur många sidor den har  
- Att ta reda på hur mycket den hade kostat  
- Att läsa den för att hitta gömda koder |
| 2 | V1: What two points can classify a source as being a ‘primary’ source?  
V2: Choose two points which help define what a ‘primary source’ is.  
- They were written at the time an event took place  
- They were written by an eyewitness to an event  
- They are the first source published after an event  
- They are the most important source about an event  
- They are the only source about an event | V1: Källor till en historisk händelse kan kategoriseras som antingen ’primär’ eller ’sekundär’. Vilka två alternativ kan kategorisera en källa som ’primär’?  
V2: Källor till en historisk händelse kan kategoriseras som antingen ’primär’ eller ’sekundär’.  
Välj två alternativ dom du tror bäst förklarar en ’primär’ källa.  
- Källan skapades under samma tid som när den historiska händelsen ägde rum  
- Källan skapades av någon som personligen var närvarande  
- Det är den första källan som skapades om den historiska händelsen  
- Det är den viktigaste källan som skapades om den historiska händelsen  
- Det är den enda källan som finns om den historiska händelsen |
| 3 | V1: Which two options below indicate a source is a ‘secondary’ one?  
V2: A secondary source can be easily | V1: Källor till en historisk händelse kan kategoriseras som antingen ’primär’ eller ’sekundär’.  
Vilka två alternativ kan kategorisera en
identified if they meet two of these conditions.

- It was produced after an event had taken place by someone who didn’t witness it
- It’s an analysis of an earlier historical event
- It is the second source produced about an event
- It is an important source, but not the most important
- It features only half the information of a primary source

källa som ‘sekundär’?

V2: Källor till en historisk händelse kan kategoriseras som antingen ‘primär’ eller ‘sekundär’.

Välj två alternativ dom du tror bäst förklarar en ‘sekundär’ källa.

- Källan skapades efter att den historiska händelsen ägde rum och av någon som inte var med när det hände
- Det är en analys av en tidigare historisk händelse
- Det är den andra källan som skapades om den historiska händelsen
- Det är en viktig källa - men inte den viktigaste
- Källan innehåller bara hälften av informationen från en primär källa

4 V1: What two options best describe why sources are so important to historians?

V2: Why are sources so important to historians? Two of the answers below are correct.

- They can provide information about events and issues
- They can tell us how people lived in the past
- Historians have to read every source before they can publish their ideas
- They are always easy to understand
- They clearly answer all questions historians have

V1: Vilka två alternativ bäst beskriver varför källor är viktiga för historiker?

V2: Varför är källor viktiga för historiker? Välj två alternativ.

- De ger information om historiska händelser
- De ger information om hur människor levde förr i tiden
- Historiker måste gå igenom alla källor innan de kan publicera sina egna idéer
- Källor är alltid lätt att förstå
- Källor svarar klart och tydligt på alla frågor som historiker har

5 V1: Which of the following 2 statements do you think is correct?

V2: There are many reasons why sources are useful. Which two do you think are right?

- All sources can be useful, it just depends on how you use them.
- Having multiple sources is useful as we can discover

V1: Vilka två påståenden tror du är korrekt?

V2: Det finns många anledningar till varför källor är användbara. Välj de två som du tror är rätt.

- Alla källor kan vara användbara, det beror bara på vad man vill veta
- Att ha flera källor är användbart eftersom de ger oss olika information
### many views about an event
- Sources are only useful if they were written by someone important
- Sources are only useful for establishing if an event really happened.
- Sources can prove anything.

### V1: What are 2 things you should consider if there are multiple sources and views about an event?
V2: If there are multiple opinions and sources covering an event, what do you need to remember?
- You can compare them and see if similar facts emerge that reveal the real events
- Even if they have different opinions, they can still give us useful information
- Only one source is going to give you useful information
- It’s best to pick the source that sounds correct
- To only use the source that is official

### V1: Vad är viktigt att tänka på när det finns flera källor med olika information om samma historiska händelse? Välj två alternativ.
V2: Ibland kan det finnas flera olika källor till en och samma historiska händelse. Vad är det viktigt att tänka på då? Välj två alternativ.
- Att jämföra de olika källorna och se om det finns liknande fakta
- Även om källorna ger olika information kan de vara användbara
- Endast en källa kan ge oss användbar information
- Att endast använda den källan som känns mest rätt
- Att endast använda den källan som är officiell

### V1: Official records are useful sources, but aren’t always correct. Which 2 reasons explain why?
V2: Sometimes even official sources like church records or law books are inaccurate. Choose 2 options below that could explain why this is true.
- Some of the population may not be included, for e.g. women, the poor
- They may have been created based on false information
- They only contain useless information
- They are most often created by the King or Queen
- They are only created for important persons

V2: Ibland är officiella dokument t.ex. lagar och kyrkböcker inte korrekta. Välj två alternativ som du tror kan svara på varför de kan vara fel?
- Det saknas ofta information om vissa grupper av människor. Till exempel kvinnor eller fattiga
- Det finns risk för att de grundar sig på felaktig information.
- De innehåller bara onödig information
- De är oftast skapade av kungen eller drottningen
- De är endast skapade för viktiga personer
8 V1: Which 2 statements below are true, based on this excerpt?

V2: Read the quote below and pick the two statements which you think are correct.

_It got up and put on my coloured silk suit, with my new wig which I bought a while ago, but will not wear, because the plague was in Westminster when I bought it._

- He won’t wear the wig as it might be infected with the plague
- He bought the wig in Westminster
- He only wants to wear the suit in Westminster
- Colourful suits are not appropriate during a Plague year
- All wigs might have the plague

“Jag vaknade och klädde på mig min färgglada kostym, som jag köpte tillsammans med min nya peruk. Peruken kommer jag däremot inte ta på mig för att pesten härjade i Westminster när jag köpte den.”

- Författaren ville inte ta på sig peruen för den kan vara smittad med pesten
- Författaren köpte peruken i Westminster
- Författaren vill bara bära peruken i Westminster
- Färgglada kostymer är inte passande att ha på sig när pesten härjar
- Alla peruker är smittade med pesten

9 V1: Which 2 sentences below are true, based on the following quote?

V2: What two facts can be found by reading this diary excerpt?

_It was sad to hear the bells ringing so often for deaths today. I think I heard it ring 5 or 6 times today._

- Bells are rung when someone has died
- 5 or 6 people had died that day.
- Bells are rung at weddings
- The bells are very loud
- 5 or 6 bells are rung for every death

“Det var tråkigt att höra klockan ringa så ofta för dödsfall idag. Jag tror jag hörde den ringa 5 eller 6 gånger idag.”

- Klockan ringde när någon hade dött
- 5 eller 6 personer hade dött den dagen
- Klockan ringde när någon hade gift sig
- Klockan måste ha varit väldigt högljudd
- 5 eller 6 klockor ringde för varje dödsfall

10 V1: If you’re researching the day-to-day lives of the common people, which of these primary sources would be the most useful?

V2: From the options below, which two sources do you think would be the most useful to find out about day-to-day life?

_It was sad to hear the bells ringing so often for deaths today. I think I heard it ring 5 or 6 times today._

- _En personlig dagbok_
| A personal diary | Brev till familjen |
| Letters to family | Bibeln |
| The Bible | En vetenskaplig tidsskrift |
| A scientific journal | Lagboken |
| The Law Books | |

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