LEARNING FROM SPATIOTEMPORAL STORIES WITH STORIX - ONE SIZE FITS ALL?

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ABSTRACT

Storytelling is a primary vehicle for structuring and presenting knowledge, experiences and attitudes. As such, it is a fundamental tool in education. The digital era has provided us with novel tools for compiling and disseminating stories. Stories are often firmly embedded in a spatiotemporal context, where time and place play essential roles. As a consequence, we have developed a concept, termed Storix, where we add new dimensions to stories by timestamping and geo-referencing individual story elements. In addition to the traditional narrative, sequential organization of a digital story, we provide a map and a timeline. Thus, the user is free to to explore the events from a variety of dimensions. We present indications of educational potential of the concept by reporting and discussing results from applying Storix as a learning tool in a 7th grade local history lecture. We found that the system supports differing learning styles. Moreover, the learning outcome for students favoring concrete experiences rather than abstract conceptualization, was higher than expected.

KEYWORDS

Storytelling, spatiotemporal content, learning styles, hypermedia, timeline, map.

1 Introduction

Stories, made and told, are an essential part of the fabric of any culture. It is the primary vehicle for structuring, disseminating, and exploring knowledge, experiences, and attitudes. As such, it is obviously a fundamental tool in education.

The need and search for alternative media for supporting stories yielded cave paintings and symbols carved in clay. Gutenberg made a quantum leap and facilitated mass production and dissemination of written and illustrated stories, reaching the less wealthy parts of society.

In the middle of the nineteenth century, Lumiere and contemporaries captured the light, and soon moving images told stories. Later, soundtracks were added, dramatically enhancing the experience. As in case of the printing press, but at a grander scale, radio and television broadcasted stories to huge audiences in the most remote parts of society, both literally and metaphorically speaking.

Then came computers, followed by Internet, and with that, hyperlinked multimedia content. New opportunities appeared; content became easy to produce, by anyone, at a low cost, both in terms of money and effort. Moreover, multimedia content may easily be cut in pieces, mixed and applied to new contexts, yielding different and surprising stories, sometimes offering novel insights.

Two concepts, both originating from the music industry, cover this type of digital content creation; *mashups* and *remixes*. A remix is using the original material, but alters for instance pitch, dynamics, or tempo of parts of the tune, in order to produce a different version. The mashup, however, is a more radical mix, typically blending fragments from various tunes of wildly differing style and origin, never intended by their creators to meet in a single track.

As we write, the mashup term has become central when trying to describe, in various contexts, and not necessarily in a consistent manner, what is referred to as Web 2.0. The phenomenon has naturally received due attention from learning communities, see for instance [15] and [10].

In mid 2005, just months after Google amazed the web community with their Google Maps, housingmaps.com were launched. The site combined the popular Craigs List (classified ads) with Google Maps, and suddenly people were able to find homes for sale in their neighborhood, pinned down on a map with stunning, street-level details. The first in a remarkable series, still growing each day, of Map Mashups was born.

Consequently, the digital era has provided us with novel tools for producing and consuming stories; the World Wide Web has become nothing but a huge, loosely linked repository of stories, available as fragments or as complete works. People can create their private, transient stories by surfing hyperlinks in more or less intentional manners. On the other hand, they can create new and permanent stories by utilizing easily available mashup tools.

The educational consequences are overwhelming, complex, and not entirely obvious. In this paper, we will present a tool, the *Storix* browser, which augments basic storytelling principles with remix/mashup ingredients from the current Web 2.0 scene.

Stories are often firmly embedded in a spatiotemporal context; in addition to describe *what* is happening, and *who* is involved, the *where* and *when* aspects surface frequently. This is the main rationale for Storix.

Simply put, we have designed Storix as a temporally augmented map mashup designed to support construction and presentation of digital stories embedded in time and space. More specifically, we define a digital story to be a set of *events*, that are composed by any combination of text or digitally represented multimedia, such as images, graphics, audio, and video. In addition, each event is required to have a title, a time stamp, a reference to a geographic location, and a unique ID making it possible to put the events in a narrative order. Consequently, Storix enables the users to freely explore the story events in any sequence, accessed from any of the available navigation dimensions: the narrative table of contents, the map, or the timeline.

In a prior study, reported in [7], we demonstrated the value of Storix as a collaborative documentation tool in primary schools. In this paper, we focus on validation of Storix as a proof-of-concept tool in exploring spatiotemporal stories in an educational setting. More precisely, we address three research questions, all applying to spatiotemporal stories in general, but investigated specifically with the Storix tool:

1. Will spatiotemporal story browsing, with a rich and potentially confusing interface, work in a realistic educational setting in primary school? More specifically: a) Will they manage to operate the tool? and b) Will the tool provide satisfactory learning outcomes?

2. Will the pupils take full advantage of the map and the timeline, or will they stick to the more familiar left-hand side table of contents?

3. Will spatiotemporal stories favor particular learning styles?

In the following section, we discuss some related technologies and research, and introduce Storix in more detail in Section 3. In Section 4 we present and discuss findings from an experiment where we apply the Storix concept in a regular class situation in a seventh grade lecture on local history. We close the paper with some concluding remarks.

2 Related Work

Before presenting Storix in more detail in Section 3, we briefly point to sources that have been of influence in our work.

First of all, inspiration regarding functionality and user interaction has come from the growing number of geospatial applications, many of them web based. One of the most prominent, and definitely pioneering, is Google Earth, which obviously has an educational potential [14]. Another interesting service from Google is their Book project, where they are scanning library books in huge numbers, and generate searchable and online versions. A not well known feature of the Google Books project, is that selected books has their geographic locations (towns, addresses etc) referenced on an accompanying map. When clicking on the marked places, you are presented with the section of the book where this location is mentioned[1].

Recent advances on web based tools and services[2] have made it increasingly easier to implement advanced spatiotemporal applications. As an example, MyLifeBits uses time and location for retrieval and presentation on maps and timelines, and provides the user with an authoring tool to compile stories [6]. GeoTime is a more sophisticated (and correspondingly expensive) tool for advanced analysis of spatiotemporal data, primarily targeting the intelligence communities. It started out as a visualization tool [8], but was later augmented with functionality for leveraging story-telling concepts to enhance the exploration processes [4].

Storytelling, both oral and textual, relies on structural support. A stream of words is hard to comprehend without pauses, voice modulations, and other means for capturing and maintaining the attention of the audience. Books without sections, chapters, headers, pagination, and tables of contents would be of limited interest. The field of *narratology* provides a diverse ground for strategies and models, see [11] for an overview. In our work, we have developed a simplistic story structure based on the *fabula* concept of Mieke Bal [1], see Section 3 for further details.

Regarding our experiment, focusing on learning aspects of a spatiotemporal story browser, we have drawn on experiences reported from research on multimedia and hypermedia in education, see for instance [13]. Parts of our work relate to *learning styles* applied to digital media [12, 13]. Works from the field of *digital story-telling*, which applies to digital works that students compile for reflection and insight, have also been of inspiration [12].

In the research presented in this paper, the primary focus is on educational aspects of exploring spatiotemporal stories. As indicated above, there are a number of candidate systems available. However, easy-to-use and low cost solutions offered limited functionality and flexibility. Other, more capable systems, fell out of scope due to prohibitive pricing policies and/or complicated user interfaces. Hence, we decided to implement our own browser, named Storix, based on free and open-source components.

3 Storix: A Spatiotemporal Story Browser

3.1 Conceptual model

Storix can be thought of as a book, where each section, i.e., a piece of content (text and/or multimedia elements) with a header, is referenced in the table of contents, on a map, and on a timeline. The *turn the page* functionality is implemented as *previous/next* buttons. How to navigate through the book is entirely up to the reader; sequentially,

[1] See for instance the Jules Verne's "Around the World in Eighty Days": `http://books.google.com/books?id=2_OflXjThdIC`

[2] A good example is the "Exhibit" toolkit from the SIMILE group at MIT: `http://simile.mit.edu/exhibit`

by "turning pages", or randomly by selecting sections on the map, on the timeline, or in the table of contents.

The content model in Storix reflects this metaphor. Content is distributed in sections, where each section contains any combination of text and digital multimedia such as images, video, and audio. In a recursive fashion, sections may contain subsections, complying to the section definition. However, we use the term *event* instead of section, in order to comply to common narratologigal models, such as Bal's *fabula* model [1].

An event occurs somewhere and sometime. Thus, we associate location and time to each event. This facilitates remixing of content; as an addition to the narrative, sequential organization of a book, summarized in the table of contents, the events can be laid out on a map or on a time line. With this additional freedom, the users might access and experience the content in novel ways, hence, constructing personal, transient stories defined by the sequence of accessing the events. Obviously, such freedom may heavily influence the perception of the content.

3.2 Design

The Storix front-end, the interface to the user, is essentially a collection of synchronized *content views*, representing different aspects of the selected event.

The main component is the *event view*, displaying event content, that is, text and/or multimedia elements. The event window is updated whenever the user performs one of the following actions: 1) Clicks on an event marker in the map, 2) Clicks on an event label in the timeline, 3) Clicks on an entry in the table of contents, or 4) Cliks on the "previous" or "next" button, situated close to the header in the event window (see Figure 1). The current event is highlighted in the secondary, or *navigational*, views (map, timeline, table of contents).

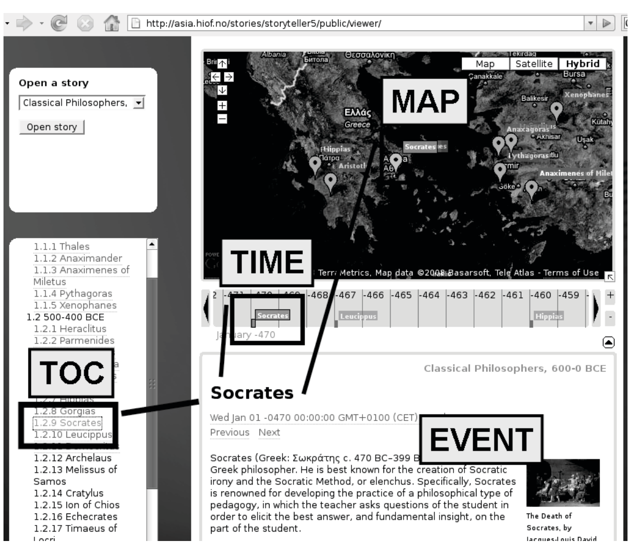


Figure 1: Synchronized Storix components

The *table of contents* (TOC) is a standard hierarchical layout of the events, represented by clickable headers.

The *map* organizes the events according to their spatial relations. For each event, a marker, accompanied by a label with the header, is placed on the correct geographic location.

The *timeline* may be dragged or zoomed, corresponding to the map navigation means. The marked events are clickable and labeled with headers.

3.3 Implementation

Storix is a web based application implemented with off-the-shelf, free, and open source software components, and relies heavily on open standards. Server side, the *Ruby on Rails* web application framework has been used together with the open source PostgreSQL database. For data exchange between client and server, XML is served upon request with AJAX technology, facilitating partial updates of the web page.

Starting at the back-end, the story content is represented as a tree structure in the database. Each event is a node in the tree. This allows for reuse of whole, or parts of, stories in new stories. As an example, a story on the German occupation of Norway in April 1940 could be incorporated in a mashup covering World War II in general.

Out of convenience, we chose Google Maps as the map providing service. The Google Maps API allows for rapid development of customized mashup prototypes. For example, it was quite straight forward to modify the markers to display text labels which improves searchability of events.

The timeline component was developed especially for Storix, as a reusable JavaScript component. In order to be a supplement to the map component, it supports scrolling and zooming, and has a resolution ranging from milliseconds to centuries. Just like on the map, each event is equipped with a clickable label to facilitate searchability and provide consistency with the map view.

The table of contents view is a plain vanilla left-hand side hierarchical site navigation tool, found in the majority of content oriented web sites.

The main view is the event container, displaying content, that is, any combination of text, images, audio, and video. This component is implemented following a standard web page metaphor.

As this is a proof-of-concept prototype, there are many limitations in the implementation. In particular, geographic *tracks* and *areas*, and temporal *intervals* are not supported. However, these limitations are of less importance for the research presented in this paper.

4 Experiment

In our experiment, we engaged a grade seven class with sixteen pupils, of age between eleven and twelve, along with their teacher. The main idea was to study the use of Storix in a regular class room setting[3].

Our three research questions were answered on a basis of observations, interview with the teacher, and empirical data on browsing behavior.

To answer the main question, "Doest it work?", we used observations and interviews, in order to shed light on the *usability* of the tool. Our main indicator regarding *learning outcome* was an analysis of the committed tasks and the expected score, as predicted by the teacher.

The clicking behavior were illustrated by automatically recorded data, correlated to the nature of the tasks and the individual assignment submissions.

The learning style aspects were treated by correlating scores, click data, and a foregoing categorization of the pupils preferred learning style.

4.1 Learning styles

The concept of learning styles is based on the idea that learners have different preferences towards learning. There are several theoretical approaches to learning styles, all with different perspectives on this complex concept [3, 5]. In this project, we based our analysis on the widely used work of Kolb [9].

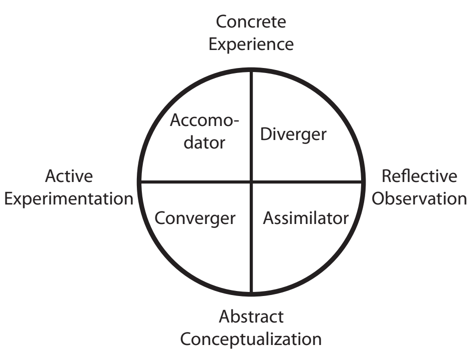


Figure 2: Kolb's four types of learners

Kolb states that "it is the combination of how people perceive and how people process that forms the uniqueness of 'learning style' - the most comfortable way to learn". According to Kolb, effective learning is a four-stage cyclic process that includes concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), and active experimentation (AE). He argues further that people have different strengths and weaknesses regarding the stages in the learning circle, and he ends up with four types of learners (see also Figure 2):

Accommodator The activist who favors AE and CE
Diverger The reflector who favors CE and RO
Assimilator The theorizer who favors RO and AC
Converger The pragmatist who favors AC and CE

[3]However, due to lack of computers in their classroom, the test was carried out on a visit to our campus.

The children's teacher was asked to characterize the pupils according to Kolb's learning styles. Based on his knowledge of how the pupils were performing in a regular educational context, he ended up with two main categories: Divergers and Convergers. The result may reflect the class room practice where neither theoretical conceptualization nor pure practical tasks are emphasized. In our context, we define Divergers (D) as pupils who prefer concrete experiences and who solve problems using a nonlinear and unpredictable approach. Normally they are not among the best performers at school. Further, Convergers (C) are pupils that perform well in school and approach problem solving relying on linear and predictable approaches.

The teacher identified four groups as Divergers, and the other four as Convergers. Considering that we are dealing with groups of two, and not individuals, this non-trivial categorization might be questionable. Still, we think this is an interesting point of departure in our initial investigations.

To further complicate the matter, there are several objections against using learning styles as a planning tool for education, for instance those raised in [2]. The main criticism has focused on lack of empirical evidence, and the value of matching teaching and learning styles. Nevertheless, we find the concept of learning styles, as described by Kolb, to be a useful instrument for researching the value of an educational tool. In a best case scenario, learning styles could be a means to design educational tools that are open and flexible, accommodating a variety of learning profiles, independent of formal definitions.

4.2 Design

Our target group, a grade seven class, consisted of sixteen pupils, of age between eleven and twelve. The setting was to use Storix in a regular lecture on local history. Their teacher had previously, together with a colleague, compiled a story on Fredriksten Fortress as a project in an ICT course for teachers. They focused on the history of the individual buildings; when they were built, their usage, and their historical significance. The story consisted of 25 events in the fortress area, spanning 111 years in time (1659 - 1770).

The lecture started with a short presentation of Storix, where after the pupils browsed another story to familiarize themselves with the tool. The pupils worked in teams of two, each sharing one computer (Figure 3).

The pupils were then given an assignment, consisting of 23 tasks presented as a crossword (eleven tasks), as a number of sentences where words were missing (eight), and as questions (four). They were asked to use Storix to carry out as many tasks they could manage in the next 30 minutes.

The assignment was designed so that the pupils would have to use both the map and the timeline, in addition to the text, to solve the tasks. There were four time related tasks; two which required reading the text of the event, the other two could be accomplished by inspecting the timeline

Figure 3: Pupils exploring Storix

and reading the event labels. Out of the eleven map related tasks, four required text examination, while the remaining could be solved by inspecting the map. Six tasks were most easily solved by using the table of contents. Two of these tasks required reading the full text of two events, and one required reading four events. Finally, two questions provided no hints at all, thus forcing the pupils, in the worst case, to click through all events to find answers.

During the lecture, the three authors passively observed the pupils and took notes. After the lecture, three of the groups were interviewed, as well as the teacher. The assignments were collected and analyzed.

In addition, data on the usage of the tool was collected automatically by the software itself. For each click leading to an event, a database entry were recorded. The entries consisted of a time stamp, the ID of the event, the type of click (map, timeline, table of contents, or next/previous buttons), and the group ID.

4.3 Findings

4.3.1 Observations

During the initial presentation of Storix, most of the pupils stated that they where rather comfortable with computers, which they used for gaming, surfing, and chatting. All of them had access to computers at home, in addition to the school equipment. Only a few were familiar with map based web sites or applications. However, they almost instantly grasped the main idea with Storix: they easily panned and zoomed the map, and dragged the timeline through the centuries. They were quite enthusiastic, and seemed to enjoy the challenge. They approached the assignment with a serious attitude, working hard and focused during the session.

4.3.2 Browsing behavior

A total of 775 clicks were recorded during the lecture. The main purpose of collecting this information was to illustrate the *browsing patterns* of the groups, rather than helping us to *explain* their behavior. Equally important data, like dragging or zooming the map or the timeline, were not recorded. Hence, we found it out of the present scope to treat the data with rigorous statistical methods, but relied on visual inspection of plots of the data.

We start with a birds eye view of the session by inspecting the distribution of click categories for each event, as shown in Figure 4.

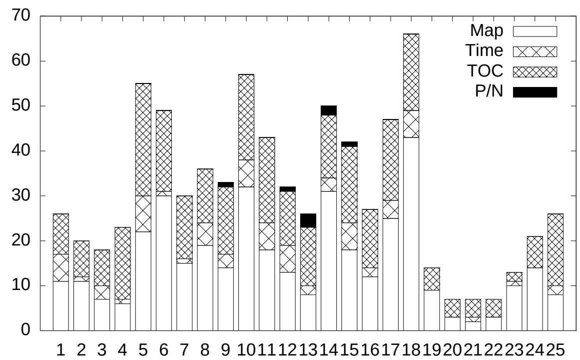


Figure 4: Number of clicks (y-axis) distributed over event numbers (x-axis) and click origin

A first finding is that the clicks are unevenly distributed among the events. Recall that some events did not require clicking, but rather an inspection of the headers. Other events needed a full examination of the text, and moreover, some of these events were required in several tasks. A more detailed analysis revealed, for each event, a good correlation between the number of received clicks and the clicks required to solve the tasks.

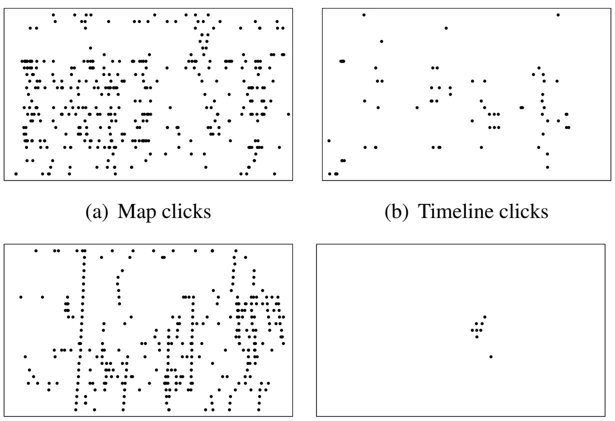
There is also a large variation in event click origin. The previous/next buttons received only 1% of the clicks, which demonstrates either 1) that these buttons where not as dominating as the other event interfaces, or 2) that sequential clicking through events were not needed, or 3) that the table of contents afforded a more attractive way of linear navigation.

The dominating click category is the map, with 49.5%, followed by the table of contents with 40%, and finally the timeline with 9,5% of the clicks. Intuitively, we would expect a correlation of click origin and the number of clicks required, of each type. This is however not the case, since the number of required clicks are distributed as follows: Map - four clicks, TOC - six clicks, and Time - three clicks. However, keep in mind that not all groups managed to get through all tasks, and, moreover, the map related tasks dominated the first half of the tasks, while the last part were dominated by time and table of content related tasks.

To further illustrate the connection between number of clicks, their types, and the tasks, let us consider events 18 and 5. Event 18 has received the highest click score, and has the highest number of map clicks. The explanation might be that two tasks required visiting this event, one spatially oriented task (no. 6), and one task preferably accessed via the table of contents (task 15).

Further, the third most accessed event, no. 5, exhibits the highest number of visits both from the timeline and the table of contents. This event is addressed in a time related task (10), and in a table of content type task (13).

The temporal distribution of clicks is plotted in Figure 5, where we find all clicks from all groups distributed over time, events, and click types. The x-axis represents the time, and the y-values correspond to the event numbers. We find a fairly even click distribution over time and events, with the exception of the less accessed events (see the comments of Figure 4).



(a) Map clicks (b) Timeline clicks

(c) TOC clicks (d) Previous/next clicks

Figure 5: All clicks distributed over time and events (x-axis: time, y-axis: event number)

We can also see a a slight domination of map based clicks during the first part of the session, while the table of contents clicks are in majority in the last part. This could possibly be explained by the lack of correlation between the distribution of click types and task types discussed in connection with Figure 4.

In Figure 6 we have plotted three key parameters for each group, sorted on descending score values. In addition to the score (percentage of completed tasks), we find the click frequency (percent of the maximum number of clicks by all groups), and a measure of the *clicking ef ciency*. We estimated the minimal number of required clicks for each task. For some we used the *worst case* number of needed clicks, typically where the pupils needed to click "blindly" through the events, without any hints on where to find the answer. For each group we then computed the total number of required clicks corresponding to their set of completed tasks. The click efficiency was then computed as a scaled ratio between the required clicks and the performed clicks. No superfluous clicks yield 100% efficiency, and a high number of clicks "missing" the target will lower the efficiency. Thus, the clicking efficiency can be viewed as a *normalized* click measure, taking into account the score of the groups and the specific number of events needed to complete the accomplished task.

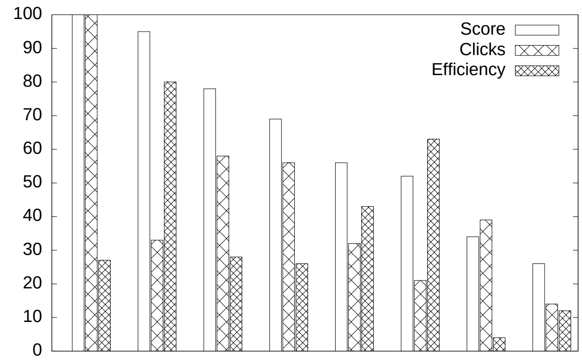
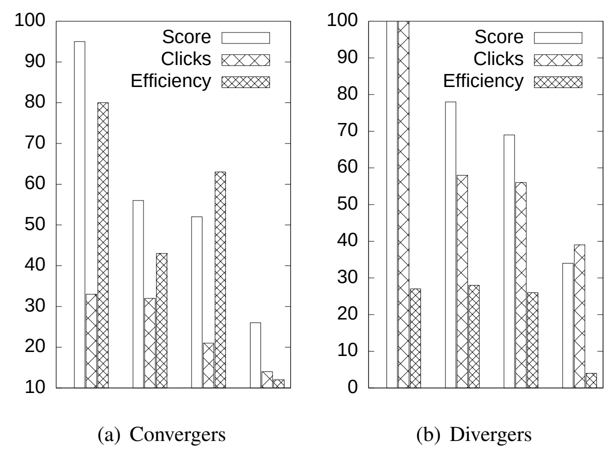


Figure 6: Scores, click rates and clicking efficiency (percentage, y-axis) grouped per team (x-axis)

By examining Figure 6, we first notice a large variation in number of clicks (from 32 to 217), and in score (from 26% to 100%). Further, it is clear that there are no correlations between the three parameters. The two groups with highest scores exhibit radically different clicking behavior. One group has carried out a "click-them-all" strategy, resulting in many clicks and a relatively low level of efficiency. The other group has been more restrictive and selective in their clicking, still obtaining nearly a full score, and also the highest efficiency score. In contrast, the group with the second best efficiency scored below average.

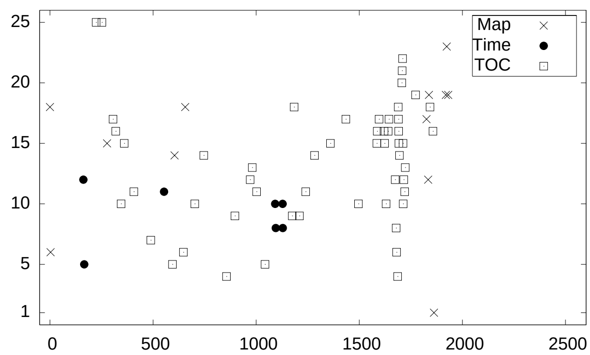


(a) Convergers (b) Divergers

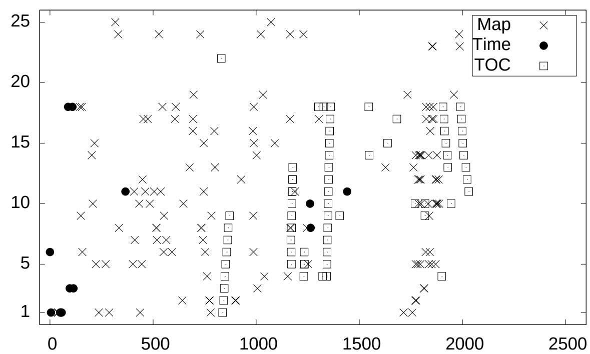
Figure 7: Learning styles: Clicks, scores, and efficiencies

However, by organizing the groups according to their learning styles, a pattern emerges, as seen in Figure 7. Within the same category, we observe a correlation between click frequency and outcome. Moreover, the average score is higher among the Divergers, 70.7% against 57.6%. As expected, the efficiency is higher in the Convergers category. Interestingly, three best groups among the Divergers have obtained approximately identical efficiency score, just below 30%.

The fundamentally different browsing patterns of the two groups with highest scores are illustrated in Figure 8.



(a) Convergers



(b) Divergers

Figure 8: Browsing pattern in teams with highest score

The click pattern in Figure 8(b) reveals five sessions of rapid, sequential clicking through parts of the table of contents (blue "columns"). For some reason, parts of these click-throughs are repeated after a short time, as if they had failed to find the answer to the task, thus repeating the search procedure. It serves as an example of a "brute force" strategy, however, with a successful result.

4.4 Discussion

Our experiment demonstrates that pupils at this age have no problems in using an advanced and rather complex browsing tool like Storix. They are the new generation of highly computer literate children. "These children have grown up with computers at home...The computer is an integral part of their daily life", their teacher explained. In particular, they navigated the map with ease, even though few of the pupils had prior experience with map applications. However, from another study, we learned that all pupils in a grade three class were users of Pokemon games on the Nintendo DS or Gameboy platforms. All these games make extensive use of maps of the their virtual worlds.

In addition to finding answers in the event texts, the pupils were able to deduce secondary information from the map and the timeline, thus finding "hidden" answers and synthesizing new knowledge.

An interesting finding was the differences in browser patterns between Divergers and Convergers. Figure 8 shows the browsing pattern of the best group of each learning style (they also were the two best groups in total). Although the two groups were both successful in solving their tasks, they revealed two different browsing strategies. While the group of Convergers had an analytical approach where they carefully browsed through Storix with few clicks, the Divergers seemed to explore every part of the system less structured and more holistically. The Convergers seemed to favor the structured table of content, while the Divergers spent more time using the map and the timeline for navigation.

These two different browsing styles were not only typical for these two groups, but were also found to be representative for the other groups of Divergers and Convergers. Every group chose a browsing strategy that matched their learning style.

The teacher had suggested that the Convergers would perform best on solving the tasks, as they were considered to be more analytic and structured in their schoolwork. Surprisingly the Divergers performed much better than their teacher had suggested and in general also better than the Convergers. In particular, in retrospect, the teacher was slightly surprised that the best performing group managed the technology so well. The teacher suggested that the possibilities of exploring the material from different angles might be one reason for the good results.

We used the task scores as indicators of learning outcome, a possible questionable measure. For instance, in the case of Divergers, did they learn more due to their higher click rate? In that case, Storix would support their learning style even more efficiently than our results already indicate.

A quite different observation also sheds light on the value of Storix as a learning tool. A few weeks after our experiment, the teacher took their class on an excursion to the Fortress. He reported that they actively used knowledge gained from solving the tasks, and vigorously explored the surroundings in search of even more information. The teacher also commented that the pupils demonstrated interest and enthusiasm well above the expected level for such a trip.

5 Conclusion

Our primary research question was: Does spatiotemporal stories work as learning tools? Through observations and comments, we experienced that the Storix tool can be used as a refreshing supplement to books, traditional LMS applications, and web sites. The pupils in the 7th grade did not experience conceptual or technical problems in using the advanced tool. Moreover, since the group results corresponded to, and for several teams also exceeded, the expected scores, we think that Storix works well regarding learning outcome. We have also demonstrated that the pupils are able to deduce spatial and temporal information from the map and timeline alone.

The second research objective was to gain insight in navigational behavior. All groups used a variation of means to fulfill tasks, and we observed that the pupils easily chose the most appropriate tool for a specific tasks. Still, we noticed that the Divergers group navigated in a more explorative manner than the Convergers.

Our third question regarded learning styles. Pupils enter a learning situation with an already developed learning style. However, the learning environment is not neutral; the pedagogical design, the tools being used, and the tasks to be solved, are all constraints that affects the learning situation. In our experiment, we found that the pupils followed one of two distinct navigation strategies. One strategy was quite analytical and focused, using mainly the table of content for navigating, while the other strategy was more holistic and explorative, generating a lot browsing and clicking in the map and on the timeline. The navigation strategies matched the two different learning styles that the teacher used for classifying the pupils, the Convergers and the Divergers.

The task scores for the Convergers group were at the expected level. However, the Divergers performed significantly better than the teacher had foreseen. Using the task scores as indicators of learning outcome[4], we draw the conclusion that Storix supports both these learning styles well, in other words, in a *one size ts all* manner. Moreover, in the case of the Divergers, we believe that the open design of Storix, with it's variety of navigational means, contributed to their unexpectedly good performance.

All in all, using spatiotemporal storytelling as a case, we have found evidence of how pupils in primary school may benefit from an educational tool that enables different learning styles. This conclusion will be a departing point for further studies of spatiotemporal storytelling.

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[4]We are, however, aware of the limitations of this approach.