Can Autobiographical Memories Create Better Learning? The Case of a Scary Game
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Abstract: We all have a few distinctive memories from school – fond or horrid, close or distant, from class or from recess. But because our minds tend to conserve space and only register new and unusual information, most days and lessons just dissolve into a blur. Therefore, autobiographical memories are usually a poor indication of what anyone has learned in school. Here, we attempt to conceptualize the interplay between dramatic experience and conceptual learning in terms of memory processes. We present a scary Mobile Urban Drama (Hansen et al. 2008, 2011), “The Chosen Ones”, designed to teach 7-9th graders science in the great outdoors. Using theories of how episodic and semantic memory formats interact, we ask if the memorability of the game, also have an influence on how players retain the kind of fact-based information that our schools are so fond of testing.

Keywords: Episodic Memory, Semantic Memory, Autobiographical memory, Mobile Urban Drama, Out-of-school environments

1. Introduction
It should be uncontroversial to claim that games and dramas are well-poised to scaffold learning through the right combination of motivation, challenge-structures and well-designed feedback. It is also fair to say that most learning-games include components of fun and psychological engagement.

More controversially, however, it can also be claimed that the learning-game industry is largely driven by popular enthusiasm and common-sense assumptions about how learning and cognitive engagement works. Indeed, the usefulness of digital learning-games has been accepted in schools and training programs without much documentation for how – and if – they work, which is problematic to the long-term credibility of our booming field. To start close to home, our mobile urban drama “The Chosen Ones” has been evaluated though user-feedback like 95% of all other training programs, but recent studies have shown that such subjective measures have very weak – if any – correlations with actual learning outcomes (Juun & Nedergaard 2009). And anyway, asking teachers and students to rate their satisfaction and self-assess learning usually only gauges how good an experience the game was - i.e. if they subjectively recall the game as more fun, engaging and memorable than usual school-days. Hint: Most games are! This is what we have come to term the “Circus Problem” of learning designs. If the object is simply to give the kids and their teachers a nice break from the classroom, then a trip to the circus would be just as rewarding – and much less costly in design-hours and documentation.

In an expansive field, individual designers need to document their game’s ability to convey information and facilitate transfer in addition to being an attractive experience. Indeed, the latter should really only be viewed as a happy by-product at best, and a distraction at worst (Henriksen 2010). This is a daunting challenge, but we do not believe that measures of fun and engagement need to be discarded altogether, because they may tell us a great deal about how students will remember the situation as part of their autobiographical self-experience. Although people seem to remember some situations over others, there has been precisely little research on how the memory systems for autobiographical episodes and semantic information play together in experience-based learning. This is what we aim to explore, kicking off our research-project with the theoretical outline presented here.

2. The Chosen Ones – a Scary Mobile Game
HASLEINTERACTIVE engages 7th-9th grade pupils through a dramatic story: The class has been chosen to help a scientific research team accomplish an important mission. The story is set in the year 2022 where nature has been infected with a dangerous virus, which slowly spreads in the environment. The main characters, groups of 2-4 kids find themselves in the middle of The Hills of Hasle, as the virus has not yet infected this area. Here, they are asked to observe, describe and investigate different biotopes in order to understand nature when it is healthy and balanced. The
pupils meet the scientists Max Larsen on their mobile phones, who tells them to do a series of particular studies in “The open field”, “the forest”, “the lake” and “the forest lake”. At these four biotopes the pupils examine the area and create photos and video documentation of their work, but they also loose contact with Max form time to time, and are left all alone to search for 2D-barcodes to scan in order to re-establish the link. Through their investigations they become an active part of the story, as they discover strange signs in the woods, and realize that nature or some supernatural force might be trying to tell them something. Towards the end, a supporting character on the soundtrack is attacked by something in the area, and the players must flee to a high hill, where they can finally decode the message formed by the strange signs: Nature in all its forms must be both understood and respected, if we are to remain its honoured guests.

“The Chosen Ones” is part of the HASLEINTERACTIVE project. HASLEINTERACTIVE is an out-of-school learning project based on the Mobile Urban Drama framework (Hansen et al. 2008, Hansen et al. 2010) - a concept that lets the user be the main character in a drama where the real environment acts as the scenography. It is thus closely related to Alternate Reality Games (ARG) and Live Action Role-Play (LARP), and other pretence-game types (as per Harviainen & Lieberoth, 2011). 7th to 9th grade users are equipped with mobile phones with pre-installed software, and experience the drama mainly through their headphones, tailored specifically to their physical location at any given moment. They are guided by information on the screen, and trigger different scenes of the audio-play through location-based technology such as registering 2D barcodes. Furthermore, they receive unforeseen messages and phone calls that add drama along the way.

The plot constitutes the framework for problem solving in biology, geography and mathematics tasks and takes place in the outdoor school facilities at “Hasle Bakker” (the Hills of Hasle) in Aarhus, Denmark. The story itself is an environmental thriller, which is experienced by negotiating in nature, which must be investigated through exercises. The Mobile Urban Drama software framework has been adapted for the out-of-school learning process by introducing support for solving assignments and making small movie-clips. Media production is seamlessly supported through a context-aware media management system.

Figure 1: Mobile phone interface of the HASLEINTERACTIVE application. The interface provides elements for storytelling, way finding, exercises, and multimedia upload to a shared server.

HASLEINTERACTIVE supports a part of the biology, geography and math curriculum outlined by the Danish Ministry of Education. A special "learning kit" has been produced for teachers who wish to use the drama as part of their teaching. The kit includes learning materials and exercises, which cover
part of the curriculum and which can be used during the field trip to the Hasle Bakker area. Prior to the field trip, the teacher must register online for a mandatory course, so they can support the pupils in the field. The teachers get to try out some of the assignment and receive practical information.

A deployment of “The Chosen Ones” is divided into three sections; one before visiting the area, one during the visit and one back at school after the trip. This “1-2-1 deployment” (Henriksen 2010) integrates the episode in Hasle Bakker with its intended curriculum through explicit reflection (as per Beard & Wilson 2002; Kolb, 1984).

The preparation in the classroom lets the pupils obtain knowledge of key concepts such as characteristics (e.g. characteristics of lake water, forest, open fields, etc.), biotopes (what is a biotope?), nutrition, food chains, adaptations and simple methods of investigation in the field. They gain this knowledge through various assignments where dialogue is important. None of the assignments requires usage of mobile phones. During the stay in Hasle Bakker, the drama instructs the different groups of pupils to focus on either “soil”, “plants”, “weather” or “animals” as they investigates the biotopes. Depending on the area, they are asked to conduct different assignments such as drawing what they see, taking pictures with the mobile phones, and collecting soil tests. In addition, they take turns at choosing the role of the interviewer, the interviewee or cameraman. The program on the mobile phones controls the management of the roles. The interviewer asks questions scripted by the mobile phone – e.g. “Which animals live here?”, “What do they eat?” or “How does the soil smell? And how does it feel?” The interviewee describes the conditions, and the cameraman makes sure that the process is well documented utilizing the video camera on his/her mobile phone. The produced materials are tagged with contextual information and automatically distributed to a central server by the underlying software infrastructure.

After the field trip, back in the classroom, the pupils and teacher can retrieve the produced data from the server. All of the files are named with a date, group number, post number and time of the day. Based on this data, the pupils process the collected data and recapitulate the concepts as well as the findings. Each group must work with the material (do Google research, make PowerPoint presentations, documentaries, written reports etc.) and present their results in class, so the teachers can coach their use of the concepts from the video commentary.

The HASLEINTERACTIVE design provides a mobile distributed system for synchronization of a running drama across mobile phones in a group, as well as automatic distribution of produced media files. The architecture is illustrated in Figure 2.

![Figure 2: The HASLEINTERACTIVE architecture. The application and services provide on-location support, while the Web browser interface and Media service provide access to the materials back in the classroom.](image-url)
The system consists of a mobile application that runs on the pupils' mobile phones and controls the audio drama and the assignments. The mobile phone provides the interface for the interactive elements in the drama: scanning 2D barcode tags (location support), synchronising, identifying symbols in the area, navigation, giving the assignments, media production etc. Furthermore, a number of services provide shared session support when the pupils are in the field, and handle online upload and storage, as well as access to materials when the class returns to the classroom. For more detailed information about the technical implementation of the mobile application and the service, please refer to the discussion in Hansen et al. (2010).

"The Chosen Ones" was designed with an implicit understanding of the need to integrate game-experiences with a curriculum through non-fiction links with students' everyday practices. A whole amalgam of learning-theories on learning were used in the design, including notions of learning-styles (Dunn & Dunn 1993), flow (Rha et al 2005), and experience-based reflection (Beard & Wilson 2003; Kolb 1984). These are most clearly visible in the classroom-practices before and after the actual game (the 1’s in the 1-2-1 deployment), while the game-architecture itself was predominantly based on ideas about what our Mobile Urban Drama technology might offer to out-of-school experiences. In the end, the dramatic side was deemed too scary for younger kids during trials, and testimonials from both students and teachers praised the overall experience in terms of drama, fun and engagement (i.e. Hansen et al. 2010). But will that make a difference to acquiring science knowledge, or is it pure cheesecake on the way to “proper” school-learning? Documentation on actual learning outcomes of the slightly scary and very unique game is not available form the first year of deployments, so our current mission is to remedy that, with the first data hopefully ticking in later in 2011.

In the following we therefore focus on our guiding theory of how the memorability of a learning design may affect how well a student can access his/her new knowledge afterwards. We suggest that autobiographical memory may matter, even when learning is narrowly defined as "the extent to which participants change attitudes, improve knowledge, and/or increase skill […]" (Kirkpatrick & Kirkpatrick 2005). We first discuss the missing link between memory and education, and then attempt to present theories on memory formats and memory consolidation in a relatively straightforward way. Finally we link them to the effects of learning designs like “The Chosen Ones”. We focus on how distinctive experiences create episodic “anchors” for semantic knowledge, and how these two memory formats may become integrated as scary experience is translated into knowledge.

3. Memory and learning

Cognitive theories of memory are rarely considered in relation to school learning. This segregation can be traced back to the 60s and 70s, where several psychological approaches headed off from behaviourism in very different directions. Our current educational psychology grew out of increasing awareness about how important it is to consider practices, experiences, social relationships and individual differences in the learning setting (e.g. Vygotsky 1926/1992, Dewey, 1938). Simultaneously, scientists and philosophers influenced by Gibson’s ecological psychology (1950) and early experiments in AI-design (e.g. Schank & Abelson 1977) stimulated a new boom of research ion mental processes like memory, perception and reasoning, which had been all but banned as black-box thought during the behaviourist reign, where only outer responses were deemed valid objects of inquiry. The situated learning perspective materialized in response to these computer-inspired "cognitivist" theories, which failed to encapsulate the social organization of learning processes e.g. when people acquire a tradesman’s craft. By the end of the 20th century educational and cognitive psychology were considered all but alien disciplines, and were taught and examined in very different settings. In 1999, however, cognitive angles were suggested to the National Academy of Sciences as a fruitful new avenue of exploration in education (Bransford et al. 1999), and the hybrid-field of educational neuroscience (e.g. Howard-Jones 2010) now tries to realign the study of learning with a qualified understanding of how the brain works. Centrally, after a decade of brain-enthusiasm, we face the daunting task of killing off the many alluring but scientifically problematical “neuromyths” that have emerged among teaching professionals across the board (for a review, see Howard-Jones 2010). Memory, however, has yet to be a focus in this new cross-disciplinary effort.

Granted, it can be difficult to see the difference between learning and memory when the words are applied in everyday discourse. In asking “What did you learn in school today, little child ‘o mine” the
mother is actually inviting her offspring to run through the school-day in his mind’s eye, and pick out salient events or well-known daily activities. In reality, the child is therefore very unlikely to accurately assess what has been learned, and if he will be able to use those tibbits of skill and knowledge later in life. Much learning is tacit, and many skill-and-drill methods expect students to do things over and over again before they master a particular subset, but not to remember the training itself. Episodic memories from the school-day therefore have little to do with learning math, but yet they are what the “little child o’ mine” is likely to tell his mum about. In other words, we like to talk about learning in episodic-autobiographical terms, but we test it using semantic tasks(!).

This distinction is well known to cognitive psychologists. There are different ways of experiencing and processing memory. Endel Tulving (1972; Wheeler et al 1997) now-classic content-based heuristic has undergone several evolutions, but we can still understand episodic memories as what “renders possible conscious recollection of personal happenings and events from one’s personal past […]” (Wheeler et al. 1997: 332): “A special kind of mind-brain achievement that bears only a superficial resemblance to other things that can be classified under the rubric of memory” (331). In contrast, he defined semantic memory as the general store of knowledge a person has (Tulving 1972). In accordance with this framework, we view memory formats as particular capabilities in the mind-brain, which most likely have separate neural substrates. As seen in fig. 3, autobiographical knowledge is assumed to include both.

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**Figure 3:** Taxonomy of Long Term memory and associated brain structures, adapted from Squire 1995

Connections in the brain are continually strengthened or weakened as we interact with the world, including the many communities of practice we take part in, so the time from perceptual encoding to recall must be understood as an iterative journey with many mediating processes along the way. In classical terms, strengthening information enough to stay in long-term memory is known as “consolidation” (see figure 4). But brain processing does not happen in hermetically sealed modules that queue up nicely to have their go. Rather, the brain works via parallel distributed processing, which means that any and all activations vie for prevalence and can come to influence one another. In this way, episodic images and semantic knowledge can exist as separated activations or integrated wholes. But memory is more than a computer-like process. Most psychologists seem to agree that remembering the past and projecting ourselves into the future is a central part of who we are as humans. This well-known sense of shared or personal history can be called autobiographical memory. Importantly, it involves interactions between semantic facts (e.g. knowing your age, your birth-date) and more lifelike episodic elements (e.g. recalling scenes from a childhood birthday) (Berntsen 2009). And just like an episode may be modified through the on-going process that is memory, autobiographical identity is not set in stone. We continuously construct it based on the situations we
find ourselves in: The goals we strive for, the people we are with, the setting we inhabit. This view of memory as a complex and distributed practice meets educational psychology theories more than half-way.

Figure 4: Simple memory process model

Although the popular understanding of “forgetting” assumes that information is simply lost, many studies have shown that a lot of information might still be available even while retrieval fails (i.e. Schacter 2002). According to the encoding specificity principle (Roediger & March 2003), recall occurs with greater likelihood when cues overlap between the encoding context and the recall-situation. Because exams tend to rely wholly on semantic cues, they may not be ideally poised to elicit recall from learning-situations where inputs were mostly procedural or episodic (e.g. a deployment of “The Chosen Ones” without preparation or debriefing - which sadly happens due to teachers’ busy schedules). This ‘state-dependency’ of memory (Markowitch & Staniliou 2011) leads us to believe that episodic memories can be useful access-points for knowledge and may act as nodes for social negotiation, but that most of the curricular information must be “translated” into a format more suitable for our school-culture to count.

4. Why Should Memory Matter in Learning Games?

We can talk about learning without paying much attention to memory-theory, and many educational psychologists do a tremendous job without, but examining designs like “The Chosen Ones” through this lens allows us to zoom in on 1.) memory formats and 2.) steps along the consolidation-process. Particularly, the unique and slightly scary autobiographical qualities of the experience may allow us to discern if episodic memories for the situations in Hasle Bakker can aid in learning, or if they should be discounted as by-products, mental cheese-cake or dangerous noise on the way to acquiring the intended test-friendly semantic knowledge.

While transfer in education is viewed as the ability to mobilize skills and knowledge faithfully and/or flexibly in a context of practice, cognitive psychology is much more concerned with the kinds of cues that lead people to recall particular elements – sometimes due to intentional searches, but often involuntarily (i.e. Berntsen 2009), and a multifaceted learning-episode in the real out-of-doors may therefore provide a plethora of access-routes to knowledge. In reality, most day-to-day interactions never reach long-term stability as independent episodic memories. Although one’s first few visits to a science-classroom may be discriminable soon afterward, retrieval of specific episodes becomes difficult with the passage of time and with continued lessons in the same classroom (Roediger & March 2003: 489). Instead, series of similar lessons are assimilated into a single “script” (Schank & Abelson 1977) or “schema” (Bartlett 1932). Individual days are simply not remembered after a while. For this reason, most semantic information learned in school has no episodic anchors like those provided by “The Chosen Ones” and other unusual designs. Such scripting may sound like a bad thing, but it helps us navigate fluently and easily in situations, and allow us to remember important things, by also allowing forgetting. “General-school-day-information” needs not be stored over again, but elements may be remembered if they will enhance the script further or if they are interesting - e.g. the first sudden schoolyard-kiss from a giggling classmate. In their original artificial intelligence framework, Schank and Abelson suggested that this sort of information could be placed on a special “weird list” for later remembering. We believe that the spooky narrative designed into Hasle Bakker through mobile technology provides precisely this “weird-factor”, which protects the experience from getting filed with all other “walks-in-the-woods”.
But, of course, there is a risk that only the weird stuff will be remembered, instead of becoming a bridge to the curriculum. The schoolyard-kiss probably has no ties to anything learned in school that day. This sort of interference is a real danger in any rich natural learning environment filled with potential attention-grabbers, but even more so when fun and scariness is built into the design. Therefore the 1-2-1 deployment which consolidates episodic and semantic knowledge under the practice-heading of “science class” is very important to cement the intended knowledge (for a discussion and critique of fun and realism in learning-games, see Henriksen 2010). When “The Chosen Ones” is debriefed back in the classroom, information stored in episodic and semantic formats get activated together. Semantic facts because they are part of the tasks presented by the teacher, and episodic time-travels because of the “weirdness” of the event. Both are cued by the videos, soil samples, and written notes produced by the kids themselves during the game, which is uniquely crucial. We believe that this interaction between memory formats and artefacts results in something close to Karmiloff-Smiths (1992) concept redescription and Miller’s (1956 cit. in Roediger & March, 2003) notion of recoding: The on-going process-in-practice amalgamates episodic imagery and semantic fact-knowledge into a hybrid, which the mind can navigate more easily and with maximal inference. The mix predicts better recognition and better chances of cue-overlap in the world, so the knowledge may now be accessed by comparably more routes than information stored only in the semantic book-to-brain format. Centrally, the experiences acquired with more episodic weight may now be expressed in the required semantic format which school-tests like so much.

Further, it is likely that the temporal and spatial organization of an experience like “The Chosen Ones” can package information in a way that allows students to access tacit knowledge embedded in the game structure itself by mentally time-travelling back to Hasle and strategically reliving bits of the game. To give an everyday example, you may be able to gradually recall more and more of a remarkable talk you heard at a game-conference last year, by thinking through the presentation point-by-point, starting with the most distinctive image. This well-known generative recall-strategy (Rubin 2006) has rarely been studied in relation to learning, but for an activity-theory based example, see Bærentsen (1995). We call this the “key hypothesis”, because episodic memories may come to act as keys to semantic information through re-living of unique spatial and temporal features.

5. Future perspectives and concluding remarks

“The Chosen Ones” is an example of a unique experience in school life, based on sound didactical designs and facilitated by the use of location-based technology, bringing a drama to life in the out-of-school environment at Hasle Bakker. We are confident that the theory outlined above will lead us to many interesting empirical insights.

Based on the understanding of memory-formats found in cognitive psychology, we venture the guess that singular and slightly scary events like “The Chosen Ones” will transmit and consolidate knowledge differently than most everyday-like episodes. But the real challenge is anchoring the curriculum knowledge in the event. The mobile embedding of the drama in real-life science-tasks combined with the 1-2-1 deployments may achieve this effect, but how well remains to be seen. Institutions and companies who plan on acquiring learning games for education should hold their designers accountable for this integration – even if it means moving beyond game-programming and into a hybrid field. We look forward to examining this very complex relationship in upcoming research using measures for memory retention, individual psychological differences and memory strategies, and even brain-imaging.

A word of caution: the use of unusual episodes shouldn’t be overdone. Indeed, the “script vs. weirdness-effect is dependent on its ability to stand out in the students’ experience. If unusual, engaging and fun designs were employed on an everyday basis, the special potency offered by autobiographical recall would be diminished. Thus, we are confident that a design like “The Chosen Ones” is in its right place as a supplement to more conventional Danish school-activities.

The human enjoyment of a good and memorable experience should never be discounted. Fun and social activities have many intrinsic values in themselves. But if we are to take the circus problem seriously, we need to see what the evaluation-reports of fun and engagement really tell us: “This was a unique experience. I am excited. I will tell my friends about it later. I may even remember it spontaneously from time to time. ...And because of this, I just might gradually translate my experience into some sort of knowledge”. 

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