Mobile Urban Drama for Multimedia-Based Out-of-School Learning

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ABSTRACT
This paper describes the notion of Mobile Urban Drama and how a particular production is implemented to support engaging experiences via location-based mobile phone software. Mobile Urban Drama is a general concept that has been adapted for out-of-school learning projects by introducing support for solving assignments and producing multimedia-based documentation for learning purposes. Media production is seamlessly supported through a context-aware media management system. The Mobile Urban Drama project, “HASLEINTERACTIVE”, is presented. It supports biology, geography and math lessons for 7th to 9th graders in schools. The story is an environmental thriller that takes place partly on the pupils’ mobile phones and partly in the real world—in nature, which must be investigated through exercises. The level of pupil engagement is evaluated through interviews with teachers and pupils, as well as an analysis of pupil productivity and produced media materials during the interactive Mobile Urban Drama experience. It is argued how the out-of-school learning features are successfully supported by the system, and we conclude that the level of productivity and engagement is higher than in usual pupil group work.

Categories and Subject Descriptors

General Terms
Design, Experimentation, Human Factors.

Keywords
Mobile Urban Drama, location-based technology, context-aware media management, multimedia production, 2D barcodes, interactive audio, sensor/actuator based interaction, urban computing, engaging experiences.

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1. INTRODUCTION
Mobile Urban Drama is a concept for interactive storytelling that links story elements to the user’s surroundings. In [18], we introduce the concept, which has been developed based on an idea coined by the Theater Katapult. Originally, we introduced the concept and the mobile software platform for general interactive dramas with branching storylines allowing users to make choices or respond to the plot. The first Mobile Urban Dramas were produced for tourist experience purposes in an urban context, where places in the city became the stage settings for the scenes in the drama. For the project described in this paper we have extended this support for interactivity in the Mobile Urban Drama to also cover solving of exercises by producing multimedia documentation for learning purposes. The project is called HASLEINTERACTIVE and it takes place in a natural environment of woods, lakes and paths.

Several previous projects using mobile technologies for learning purposes have been documented in the literature; some examples are AmbientWood [32], HyCon [17], [4], Chawton House [31], Contextual Media [8], uLearn [22], eBag [5], and the RAFT project [30]. For instance, Weal et al. [32] describe the Ambient Wood project, which has developed a mixed reality space located in a woodland in Sussex. The wood has been augmented with WiFi hotspots, and the children used networked PDAs to conduct their exercises and projects in the wood. The infrastructure supports a playful learning experience where children could explore and reflect upon a physical environment that had been augmented with a variety of digital services. Another example is the HyCon project [17], [4], utilising GPS enabled mobile phones to support location-based exercises and documentation of activities on location in nature or urban settings. HyCon has been evaluated in several out-of-school projects [3]. Similar to HyCon, the RAFT system [30] also supports mobile data collection in the field and real time communication with groups in the classroom to support collaborative group work.

Similarly, several recent research efforts apply storytelling concepts on mobile platforms, e.g., [13], [15], [23], [24], [25], [26], [29]. But none of these address a learning context, and there are few examples where coherent interactive dramas on mobile phones have been combined with exercises and documentation for an out-of-school learning context. The previous mobile learning projects only use the mobile technology for presenting exercises and documenting solutions. On the other hand, drama and role-playing have many applications in classroom learning, multiple books on the subject exist, e.g. [11] and [19].
The paper thus introduces a new concept for using Mobile Urban Drama for out-of-school learning projects utilising context-aware media management. In the next section, we motivate why out-of-school learning calls for Mobile Urban Drama, and the rest of the paper documents the potentials in relation to creating an engaging learning experience with greater benefits, where the majority of the pupils are committed and deliver relevant material.

The paper is structured as follows: Section 2 motivates out-of-school learning. Section 3 briefly describes the basic Mobile Urban Drama idea. Section 4 describes the learning concept behind HASLEINTERACTIVE. Section 5 discusses implementation issues. Section 6 evaluates the productivity of the pupils. Section 7 present and discuss our analysis of the experiences and discusses future work. Section 8 concludes the paper.

2. OUT-OF-SCHOOL LEARNING AND NEEDS FOR MOBILE MEDIA

The notion of out-of-school learning was described by Resnick [27] long before mobile phones became widespread. She argues that out-of-school learning takes our practical intelligence into account instead of just focusing on the detached school intelligence. She points to the following issues that make out-of-school learning a necessary supplement to ordinary school learning:

1. “Individual cognition in school versus shared cognition outside.”
2. “Pure mentation in school versus tool manipulation outside.”
3. “Symbol manipulation in school versus contextualized reasoning outside school.”
4. “Generalized learning in school versus situation-specific competencies outside.”

The main point is that learning should be supported by concrete experiences of the theories in the context in which they are relevant. Many other learning theories support the idea that learning must be supported in ways, which differ from and supplement the academic tradition that has influenced primary school teaching. For instance, Dunn & Dunn [9] advocate for using different learning styles and Gardner [14] argues for education that takes into account that humans have multiple intelligences.

Many of these points directly prepare the ground for stimulating learning in new manners, for instance through mobile media production and documentation. This is what we aimed to do with the Mobile Urban Drama concept developed for the outdoor school production denoted HASLEINTERACTIVE. In Resnick’s terms she emphasises the strong dichotomy, e.g. between “pure mentation” and “tool manipulation”; and between “symbol manipulation” and “contextual reasoning” [27]. In this paper, we document that we can make a fruitful integration of learning across these dichotomies through the use of mobile phones and dramatic storytelling that relates theoretical concepts and symbol manipulation problem solving to the practical context for biology, geography and math taught in an outdoor school environment.

The work presented in this paper introduces the notion of storytelling to keep the pupils engaged in the subject area and problem solving through coherent dramatic story, that relates to the theoretical concepts they are supposed to couple to their practical experiences in order to bridge Resnick’s dichotomies. Among the main motivations for introducing storytelling and drama in learning is to create engaging experiences (e.g. [10]) and keep the suspense in working on the assignments when pupils are working independently away from the classroom and without direct supervision by teachers. In other words, we wish to keep the pupils in “flow” [7], by being continuously engaged and challenged during their out-of-school activities. The Mobile Urban Drama will be able to keep the suspense while pupils move between posts. Moreover, the drama puts the assignments into a meaningful context, which is recorded as part of the multimedia documentation, so it can be used later, back in the classroom. The following section will introduce the idea in detail.

3. THE MOBILE URBAN DRAMA IDEA

Mobile Urban Dramas are interactive audio plays that let the user be the main character in a drama where the real environment becomes the scenography. In the play, users are equipped with mobile phones, headsets and maps, and experience a drama at that specific location where the users find themselves. They trigger the different scenes of the play through location-based technology such as GPS or 2D barcode “tags” (see Figure 1.a). Furthermore, they receive what appears to be SMS messages and phone calls as part of the play that takes place along a pre-specified, possibly branching path through a cityscape or landscape. These experiences in the “real world” and the effect of a dramatic story contribute to making the user identify him/herself with the main character in the drama, and the user must act as such in order to make the plot progress, e.g. pick up the phone when it rings, or carry out a specific action in the physical world.

The Mobile Urban Drama concept as well as the first three productions have previously been described in [18]. Since then, another three productions have been developed. None of them are alike, since the concept, usage situation and platform are constantly being developed. Particularly, the HASLEINTERACTIVE production, as we discuss in this paper, introduces novel support for learning and documentation as part of the implemented system.

The idea of making mobile audio plays comes from a local theatre company Katapult, who in 2004 commenced making radio plays based on what they call an “AudioMove” concept. The AudioMove concept is structured as a single user experience, while the Mobile Urban Drama concept utilising location-based technologies can be both single and multi user experiences.

Most of the productions are developed in cooperation with public institutions or private companies, e.g. tourist agencies, culture-historical museums or schools, who provide content to the context of the dramas.

In the following section, we will describe the concept of a Mobile

Figure 1: a) A pupil scan a 2D barcode and activate the next scene in the story. b) Each group must work with four biotopes and demonstrate their problem solving, collect materials and produce multimedia documentation.
Urban Drama production called HASLEINTERACTIVE, which unlike any of the other productions is developed for educational purposes for public schools.

4. THE HASLEINTERACTIVE PROJECT
The learning concept HASLEINTERACTIVE is an environmental thriller, which allows pupils from 7th to 9th grade to participate in a new lesson plan where they are going to learn about nature in an interactive and innovative manner. The thriller takes place in the new outdoor school facilities at “Hasle Bakker” (the Hills of Hasle) in Aarhus, Denmark, and the plot constitutes the framework for problem solving in biology, geography and mathematics.

4.1 The Story: An Environmental Thriller
The class has been chosen to help a scientific research team accomplish an important mission. They have been sent on a time journey to the year 2022 when nature is infected with a dangerous virus, which slowly spreads out in the environment. The pupils are the main characters and thus active players in the drama, and they now find themselves in the middle of Hasle Bakker, as the virus has not yet infected this area. Here, they are asked to observe, describe and investigate different biotopes in order to understand the nature when it is healthy and balanced. In this manner, the pupils are going to help finding the key to restoring the balance of nature. The story takes place partly on the pupils' mobile phones and partly in the real world – in the nature, which must be investigated.

The pupils navigate by means of maps on their mobile phones. Furthermore, they receive help from Max, a scientific researcher in microbiology and ecology, and from Søren, who is a nature guide as well as a historian specialising in myths and superstition. The story is told primarily by Max, who is in touch with the pupils via the mobile phones – i.e. his lines are recorded as MP3 files on the supplied mobile phones, which creates the illusion of a continuous contact. However, due to a technical error in the pupils’ communication equipment, the signal seems to disappear from time to time. Consequently, the pupils also need to find and scan 2D barcode tags, which are placed in the area (Figure 1.a).

Having scanned a tag, they re-establish the signal to Max, who motivates a number of different studies of the state of nature at four different biotopes: “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 (Figure 1.b). Through their investigations they become an active part of an exciting story where the purpose is to learn about the biotopes and to collaborate in the groups consisting of 2-4 pupils.

Along the way, the pupils encounter some mysterious codes, placed on trees (see Figure 2.a and the posts named c1-c4 in Figure 3). These codes must be decoded with a code form (Figure 2.b), and the results must be typed into the mobile phone. Finally, from the gathered codes, a real sentence arises that reveals an insight into the state of nature. Nature must both be understood and felt in order for humans to live in harmony with it. This realisation is the key to stopping the annihilation of our conditions of life.

The drama has shown to be very realistic for the pupils, which can be illustrated by the fact that the drama was too scary for some of the pupils in the 5th to 6th grade: due to the mysterious sounds from the forest, the pupils did not dare enter the forest in small groups.

4.2 The Framework for Out-of-School Learning
The area of Hasle Bakker has been prepared for an out-of-school learning through two initiatives: a small number of cottages have been built with facilities for different learning assignments, and a number of concrete pillars with large 2D barcodes, that can be scanned by mobile phones, have been placed.

Hasle Bakker is a large varied natural resort with forests, lakes, streams etc. The icon of the area is two large artificial hills facing the ring road west of Aarhus. Three schools are placed near the area. The teachers from the surrounding schools have helped developing several learning procedures for the area, including the mobile urban drama HASLEINTERACTIVE and a series of math courses in which mobile phones and various measurement tools are utilised to solve assignments in the area.

When school classes move out in nature to carry through the learning concept, the institution behind Hasle Bakker provides mobile phones with pre-installed software. Furthermore, the pupils are provided with bags aimed at the investigation of either “soil”, “plants”, “weather” or “animals” which they investigate at each biotope. The bags thus contain notebooks, cards, measuring tape, white cloths, magnifying glasses, petri dishes, pH measuring set, entrenching tools, etc.

Figure 2: a) The pupils encounter a mysterious code. b) The code must be decoded with a code form.
4.3 The Posts

The posts, where the different scenes take place, are located in the hills as shown in Figure 3. This location is carefully selected to fit the drama, but in principle the drama could take place somewhere else with the same kind of biotope characteristics to look for and the same approximate distances between them, given that parts of the drama take place while the pupils walk from one post to another. Hence, it is part of the timing of the drama that you approach specific marks and placed codes.

In order to achieve the pupils’ immersion in the story as well as the assignments, it is essential to spread out the groups so they start at different biotopes—or posts—and follow the same sequence until they have visited all the posts. Furthermore, two groups who both start at e.g. the lake are guided to opposite sides of the lake in order to avoid disturbance from other groups. Everyone hears the same introduction and ending on the story, but the different groups hear different audio files at the same post depending on whether they are going to investigate “soil”, “plants”, “weather” or “animals”. The process of collecting data at the posts is part of the drama, however, the quality or outcome of the assignments is not, and will not be evaluated until the subsequent processing and follow up back in the class rooms.

Figure 3: Overview of the position of the posts in the area. Post 1-4 contains assignments and c1-c4 are coordination points between the main posts.

4.4 Procedure and Equipment

HASLEINTERACTIVE is part of an organised learning procedure that supports a part of the biology, geography and math curriculum outlined by the Ministry of Education. The following subsections will elaborate on the process of the field trip and what role the mobile phones have prior to, during and after the field trip.

4.4.1 Prior to the Field Trip

Prior to signing up for HASLEINTERACTIVE, the teacher must register online for a mandatory course aiming at making the teacher capable of supporting the pupils in the field. The teachers get to try out some of the assignments that the pupils will be exposed to as well as receiving practical information.

The preparation in the classroom focuses on letting the pupils obtain knowledge of concepts such as characteristics (e.g. characteristics of lake water, forest, open fields, etc.), biotopes (what is a biotope?), nutrition, food chain, adaptation and identification in order to establish a pre-understanding of the key concepts. They gain this knowledge through various assignments where dialogue is important. None of the assignments requires usage of mobile phones.

4.4.2 During the Field Trip

Upon arrival at Hasle Bakker, the pupils each receive a mobile phone with pre-installed software and headphones. The equipment is maintained by staff at Hasle Bakker, which ensures that previous content has been deleted and that the batteries are fully charged.

When the teacher has established the groups, all members must synchronise their phones before the drama can commence. Furthermore, the pupils must choose between a boy track and a girl track, which only differs in the recorded voice and not in content. This is done to contribute to a larger degree of sympathetic insight.

Figure 4: Pictures created by the pupils with the video camera on their mobile phones. The materials are later used in the finishing work in class.

During the stay in Hasle Bakker, the drama engages the pupils in studies of the four biotopes as seen from the perspective of either “soil”, “plants”, “weather” or “animals”. At the posts they are asked to conduct different assignments such as drawing what they see, taking pictures of what they find with the mobile phones, and collecting soil tests (see Figure 4). In addition, they take turns at choosing the role of the interviewer, the interviewee or cameraman. The program controls the management of the roles. The interviewer asks questions given on the mobile phone – e.g. “Which animals live here?” 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 utilising the video camera on his/her mobile phone. The produced materials are saved as a local copy on the mobile phones and are then tagged with context information and automatically distributed to a central server by the underlying infrastructure, as we will discuss below. In addition, the mobile phones are used as lifelines to the teacher; if problems occur help is only a phone call away.

The duration of the drama and studies in Hasle Bakker is approx. three hours. The documented materials are continually uploaded to a server so they are accessible to the pupils and teachers when they get back in the class for the finishing work. The pupils return the phones when they have heard the last bit of the drama.
4.4.3 After the Field Trip

Back in the classroom the pupils and teacher can easily retrieve the data from the server. All of the files are named with a date, group number, post number and time of the day.

Based on the data, the pupils process the collected data and recapitulate the concepts as well as the findings. Each group must work with the material (making PowerPoint presentations, documentaries, written reports etc.) and present their results in class, and the teachers can discuss the pupils’ use of the concepts in the video commentary.

5. HASLEINTERACTIVE IMPLEMENTATION

The software used in the HASLEINTERACTIVE drama is based on an implementation of the Mobile Urban Drama concept [18]. As discussed earlier, Mobile Urban Dramas extend the basic idea of audio plays and combine elements from interactive storytelling [21], [28], hyper-fiction [2] and user modeling [20] with mobile and pervasive computing technologies (e.g. 2D Barcode tags and GPS) in order to create a rich model for storytelling that supports close integration with the surrounding environment.

5.1 Mobile Urban Drama Implementation

Conceptually, Mobile Urban Dramas can be represented as a plot graph as illustrated in Figure 5. The plot graph is a directed graph with nodes corresponding to story events and edges specifying the valid ordering of the events. The graph contains one or more start events (S) and end events (E), where the story can begin and end, and any number of edges between the event nodes.

![Figure 5: A simple plot graph. The plot is represented as a directed graph with guards controlling the valid paths. Each node is triggered by an input event (e.g. the user scans a tag) and the node activates a corresponding output (e.g. an audio scene or a new assignment screen on the mobile phone).](image)

A drama can thus be constructed as anything from a linear path through the nodes without any branches to a highly connected graph where the user freely chose the next branch at each node. The basic plot graph allows specification of events in the drama and their ordering, but the graph can also be augmented with a user model and an environment model. The user model is an overlay model [6] on the plot graph and describes the user’s knowledge of the story. The model encodes the events the user has experienced, the ordering of the events and the choices taken at different branches in the story. Based on the user’s current user model, the author can add guards (conditions) to the edges in the plot graph that controls whether or not that specific path will be available to the user. Similarly, the environment model is used to describe the physical environment of the play, e.g., at which physical locations events occur, what technologies are used to trigger the events, and also shared or global state.

The mapping between the plot graph and the actual implementation is straightforward in that each story event (plot graph node) is triggered by a real event in the implementation. Story events are triggered by input from the user or a sensory system and the story event is provided by some kind of output to the user. Inputs may be anything from manual entry by the user, e.g. pressing a button on a mobile phone, to more automated input from a physical sensor, e.g. 2D Barcodes, RFID, GPS or Bluetooth radios – it makes no difference how the input is generated, as long as it can be mapped to unique story events. The output generated from the system can either be audio, e.g. a scene in the drama, or an interactive component that allows the user to interact with the system. For a more detailed description of the Mobile Urban Drama concept see [18].

5.2 System Implementation

The software architecture for HASLEINTERACTIVE is implemented as a mobile distributed system as illustrated in Figure 6.

![Figure 6: The HASLEINTERACTIVE architecture. The application and services provide on-location support, while the Web browser interface and the Urban Web Media service provide access to the materials back in the classroom.](image)

The system consists of a mobile application that runs on the pupils’ mobile phones and controls the drama and the assignments. The mobile phone provides the interface for the interactive elements in the drama: scanning tags, synchronising, identifying symbols in the area, navigation, presenting the assignments, media production etc. as illustrated in Figure 7.

Furthermore, a number of services provide shared session support when the pupils are in the field and handle upload and storage of the materials produced during the assignments, as well as access to these materials over the Web when the class returns to the classroom.

The mobile application is implemented on the Java JME platform and deployed on Sony Ericsson W910 and W715 mobile phones. Both models include good camera support for scanning tags and the possibility for using normal stereo headphones, for quality audio output. In order to anchor the individual story fragments to physical locations, the mobile application relies on both 2D barcode tags deployed in the area as illustrated in Figure 1.a. 2D barcodes are two-dimensional barcodes that encode a piece of text; typically a URL and they can be scanned with camera phones that include software to decode the barcode from a
services are implemented with the UrbanWeb framework [16], manages the content produced during the assignments. Both sync across the pupils' mobile phones and a media service that handle group dynamics and keep the story and assignments in place.

The server part of the architecture, as we will discuss below, provides two central services: a session services which is used to handle group dynamics and keep the story and assignments in sync across the pupils' mobile phones and a media service that manages the content produced during the assignments. Both services are implemented with the UrbanWeb framework [16], which is a PHP based framework with specific support for mobile, context-aware applications. UrbanWeb makes it easy to implement services for context-tagged information and it is those properties we rely on in the two services.

5.2.1 Drama Implementation

The Drama Engine in Figure 6, handles the drama implementation. The Drama Engine holds a representation of the plot graph and the events used to trigger the nodes in the graph. The user model and environment model are both implemented in a common Runtime Model where the user’s state and the nodes seen by the user are registered. Events are fired to the Drama Engine by the Event manager each time the user’s context changes. In the HASLEINTERACTIVE application this happens when the user scans a 2D barcode, enters a numeric code, or the system itself generates an internal event. The drama engine evaluates the event by inspecting the plot graph and the current state of the Runtime model, to see if the event is valid in the current state, and which node to load in the story. If the event is valid, the corresponding node will be loaded and the updated state is written to the Runtime Model, which in turn is saved persistently on the phone.

The actual plot graph has been designed to allow a number of groups to experience the drama in the same area at the same time (see Figure 8). All groups listen to a common introduction, but are then split out to four individual coordination points (named c1-c4 in the figure). From here on, the Drama Engine provides four different story lines on the same physical locations, depending on where the groups start. Post 1-4 contains assignments and c1-c4 are coordination points between the main posts. In this manner, we avoid clutter at the posts, as the groups move forward in the story.

5.2.2 Session Management

As HASLEINTERACTIVE is designed for groups of pupils, it is necessary to support real-time session management within the groups. This is necessary both to manage the groups and to handle the material they produce when solving the assignments, but also to synchronise the story so that all group members are at the same place in the story.

The groups typically consist of 2-4 pupils and each group gets a bag containing a special “group tag” that is unique to the bag. When the pupils first start the drama application they are asked to scan the group tag. Once scanned, the group number from the tag is registered in the Runtime Model and the phone registers itself with the Session Service (see Figure 6). Since all the group members scan the same tag from their bag, the mobile application and the Session Service know that they are in the same group.

To keep the drama synchronised across the mobile phones in a group, a number of the inputs are synchronised with the Session Service before the corresponding nodes are loaded on all phones. This prevents “fast” pupils (or just the first one in a group that scans the tag), from hearing the story minutes in advance to the other group members and then having to wait for the others to finish. However, if a phone breaks down or a pupil closes the application there is a built-in timeout on each synchronisation event, so the rest of the group can continue without having to wait indefinitely for the failed phone. If a phone has failed to join the synchronisation a number of times it will be excluded from the group to avoid unnecessary slow down, but the pupil can later join the group again simple by scanning the group tag. Furthermore, if a pupil happens to shutdown the application or the phone, it is quite easy to rejoin the session; since the Runtime Model is stored persistently on the phones and the model contains the group information.
number and drama state, the Drama Engine can quickly jump to the correct position in the story and rejoin the session.

In our tests, we found the session management to be very important in order to keep the flow in the story across the group and to avoid that the groups manually had to synchronise e.g. by starting a scene at the exact same time or waiting for all group members to scan a tag at the next post. Throughout our evaluations we found the simple group joining mechanism to work well and not cause problems that may arise when using sensors to determine group dynamics. For example, Benford et al. [1] discuss a system where groups are dynamically created for pupils within a certain area (measured with GPS), but some pupils may be left out of a group because they are not within a system specified area when the groups are formed, even though their own perceived locations are the same.

5.2.3 Multimedia Content Management
Another important aspect of the system is to keep track of the produced materials. At each post the groups are presented with an assignment that is divided into two parts: first the pupils are asked to examine the specific location and look for e.g. animals, plants, the lighting conditions or soil conditions. This first part is time-limited to five, ten or fifteen minutes and is synchronised across the group’s phones. During this time the pupils gather materials and take pictures of their findings. In the second part of the assignment, the pupils are asked to pick different roles, either as interviewer, interviewee, or cameraman and based on their choices they are presented with different task in the phone interface, i.e., the interviewer should ask the interviewee questions about their findings, the interviewee should present the materials, and the cameraman records the interview on video with the mobile phone.

Based on our prior experiences with creating mobile media applications for education [17], we have learned that the focus in the application should be on the answering of assignments by producing media and not on the technical aspects of producing the media, e.g. how the camera works or how to get the materials uploaded from the phone for later use. With this in mind, the mobile application has been designed with a Media Producer component that provides the interface for recording photos and videos and uploading them from the phone, as depicted in Figure 6. When the pupils take a photo or record a video, the file is tagged with a timestamp, the group’s location and the group number. It is then stored on the phones file system and added to an upload queue. A background process monitors the queue and uploads the files to the Media Service on the server. This all happens in the background and the pupils do not have to wait for the network upload to finish and are therefore not slowed down during the assignment work, but can continue right away. The queue is implemented with a persistence mechanism on the phone, so if something goes wrong during the upload in the field, the application can be started at a later time to finish the upload of the produced materials.

The Media Service also provides a Web interface, so the teacher can download all the materials produced by a class during the field trip. As the materials are tagged with context-information, e.g., location, creation time and group information, the service can sort the materials, so the groups get the right materials. In this manner, the service becomes the bridge between the on-location activities, i.e. support during the field trip, and the off-location activities that are performed after the trip, back in the classroom.

6. EVALUATING THE MOBILE URBAN DRAMA EXPERIENCES
After the first tests we have looked at how well the drama has worked in relation to engaging the pupils and motivate them to solve the required assignments and how well the system supports the documentation task.

The learning concept HASLEINTERACTIVE has been evaluated qualitatively through interviews with teachers and pupils who had experienced the procedure. In addition to the interviews, we have also made quantitative assessments of how well the system supported the field trip, by looking at how much material the classes produced during the trips and whether or not the material was useful in the context of the assignments.

6.1 Interviews with Teachers
Three times two interviews with teachers were performed. The interviews were base on four classes that had experienced the entire pre-, during- and post-procedure in the fall of 2009. The pupils were 7th to 9th graders (age 13-16) and the teachers taught the classes in biology, physics and mathematics. The three teachers were interviewed (with semi structured questions) in Hasle Bakker immediately after the field trip; and were asked about their experiences in class prior to the trip as well as about the experience in Hasle Bakker. Approximately one month later, the teachers were interviewed again over the phone and were asked questions about the procedure after the field trip and their work with the materials back in the classroom. The duration of the interviews ranged from 15 to 60 minutes.

All of the teachers were generally exited about the lesson plan, and they all had good overall experiences with sending the pupils out independently in their groups. They all found that the pupils seemed committed and that they learned something. One of the teachers said: “it is obvious [a good idea] to use mobile phones, which they are in control of to a much larger degree than I am”. Another teacher also noted that the pupils took responsibility for their own learning to a much larger degree than he normally experienced during group work in the classroom: “some groups all of a sudden had to take responsibility for their own learning and had to learn something. I find that really exciting... and it is good for the pupils as well”.

Another general theme in the interviews was the field trip as a shared experience for the pupils that could be used to explain more theoretical material later on with outset in the experience and assignments performed during the trip: “one of the biggest advantages has been that we have achieved a common set of references, when we talk about something. We have all been at the same location and I can use this as examples when I try to explain something that the pupils have difficulty imagining if they never have been in a forest or never have seen these things”, explained one of the teachers.

Regarding the use of a dramatic story in a lesson plan, all of the teachers said that the narrative contributed in a positive manner as it made the experience more engaging and made natural science more eatable to the pupils. Thus, they found it justifiable to cook up a story that was pure fiction. The drama they experience between the posts keeps the pupils busy and “on the assignments”. Furthermore, it did not seem to be a problem for any of the pupils that drama and factual assignments were mixed together. As one teacher explained, when asked about this: “I don’t think we should
Moreover, utilising drama in school lessons also seems to have the positive side effect that the pupils would talk more about the biotopes when being interviewed. Some of the interviews can be characterised by the fact that the pupils feel obliged to say something about the question posed when they are “in character”—even if they do not know the answers. Some of them even made up titles for themselves as experts in the field as a playful approach to the experience.

Interviews with the teachers also showed that one of the main challenges is that the finishing of the process is often de-emphasised due to various reasons. Some of the teachers did not find that they had enough time with the class. Furthermore, they felt the proposed assignments back in the classroom were not specific enough to utilise for the finishing work.

6.2 Pupil Interviews

Furthermore, we have interviewed two groups of pupils; one group consisting of three girls and a boy, and one of three boys. The groups were asked six structured questions after having experienced the drama. On the question, “How did you like it?”, the first group said: “It was really fun and different”; and a boy from the other group said: “I think it has been very exciting. It’s a different way of learning. That you have to listen to a story and then almost have to rescue nature”. Both of the groups liked the fact that they had to listen to the story and empathise with it during the experience. “It’s more fun than if we had been told the story before going, it wouldn’t have been the same”, said one of the girls. On the experience, a boy from the second group said: “It’s better than just having to sit down inside a classroom and learning something of a blackboard – and just sitting and having to read something and cram something”. Furthermore, they found that it was easy to find their way. Both of the groups were keen on trying it again, and would recommend it to others.

6.3 Assessment of the Produced Multimedia Materials

Apart from the interviews, we also evaluated the learning concept by analysing the material that was produced by the four classes. The four classes were divided into a total of 22 groups. A quantitative analysis of the produced material shows the following (see Table 1): The 22 groups have produced 644 images (on average seven per group). As concerning the pictures, 509 images (on average 23 per group) can be characterised as being relevant to the assignment work. The rest are pictures taken for “fun”. This means that 80% of the produced images are relevant to the assignment work.

The same goes for the commentary produced videos. The 22 groups produced 221 video clips (on average ten per group). 150 (on average seven per group) can be characterised as being relevant to the assignment work. Some of those we have chosen to characterise as irrelevant to the assignment work have the nature of being test shots where someone gets stuck and the commentary is being repeated. There are few videos that are pure nonsense.

Five groups produced significantly fewer materials than the average. Three of these groups have actually solved the assignments with the submitted materials, which primarily are video reports, documenting their efforts. But the remaining two groups may be characterised by having delivered a weak response. We have not had an opportunity to assess the long-term learning effect of the lesson plan. However, in the coming years the concept will be tested and developed for more interdisciplinary courses and different ages.

7. MEETING THE OBJECTIVES OF OUT-OF-SCHOOL LEARNING

When reflecting on HASLEINTERACTIVE, the project has shown its benefits in several respects. We will now discuss these and relate them to the four objectives for out-school-learning that we introduced in Section 2.

Utilising a narrative proved to support an engaging learning experience that made the school curriculum more palatable to the pupils. The pupils were continuously engaged and challenged during the procedure, also when moving from one post to another. The fact that the experience is based around a narrative and that this is location specific supports the objective of “situation-specific competencies outside”. The pupils are forced to navigate the area and relate to the features of the physical environment, which frame both the story and exercises. Furthermore, the teachers did not think it was a problem that fiction and facts had been mixed. The fact that the drama puts the assignments into a meaningful context makes the experience more engaging and thus increases the value of the learning experience. Guided by the drama characters Max and Soren, the pupils were able to work on their own and take responsibility for their own learning. These aspects thus support both the objectives of “Contextualized reasoning outside school” and “Shared cognition outside”.

### Table 1: Materials produced by 22 groups of pupils.

<table>
<thead>
<tr>
<th>Group #</th>
<th>Relevant for assignment*</th>
<th>Videos</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
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<tr>
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</tr>
<tr>
<td>22</td>
<td>36</td>
<td>44</td>
</tr>
</tbody>
</table>

*Subjective assessment: Relevant means that the media is focused on the assignment or the learning concepts are used by the pupils, e.g., that it is not just photos of the pupils, misfired shots into the ground, retakes of the same video, or all photos of the same subject.

to the assignments. However, the teacher felt that the responses were above the level the two groups tend to have when working in groups. Considering that the pupils have been sent into the field on their own and have had to work independently with relatively demanding assignments, the commitment has been quite good when 90% of the groups has been maintained in the dramatic progress and has delivered relevant material.

We have not had an opportunity to assess the long-term learning effect of the lesson plan. However, in the coming years the concept will be tested and developed for more interdisciplinary courses and different ages.
Learning takes place in the physical environment in which the investigations are carried out, and exercises and results are discussed as part of the group work.

Regarding the technology we found three aspects to be significant: first of all, session management provided a behind-the-scenes synchronisation within the groups and helped maintain the flow of the story and assignments, as the pupils did not have to focus on this aspect, but could concentrate on solving the assignments. Thus, again the objective of “Shared cognition outside” is actively supported through the system, as synchronisation between group members is automated and the role dynamics encourages collaboration between the group members.

Secondly, media production was specifically supported from within the drama application and provided the functionality for both recording video and photos and uploading the materials in work instead. This also meets the objective of “Tool manipulation have to focus on the technology, but could focus on the group within the drama application and provide the functionality for”

Thus, again the objective of “Shared cognition outside” is actively supported through the system, as synchronisation between group members is automated and the role dynamics encourages collaboration between the group members.

Finally, access to the materials in the classroom after the field trip, is very important. It is equally important that delivery of the produced materials from the phones to the classroom computers is automated by the system, as this otherwise can take a lot of time, which could be spent on teaching and group work. Therefore, the Web access to the media proved to be an important component in the system. However, one problem that became evident during the interviews concerned the contextualisation of the produced media files. At the moment the files are tagged with a timestamp, a group number and location information (based on the post in the area). But the teachers found that the pictures could be difficult to utilise after the field trip as they lack context regarding the specific assignment. A picture of e.g. a lake may not be eloquent enough. After a few weeks it may be difficult for the pupils to remember why they took the specific pictures and thus, to use them in the following presentation and dialogue with the teacher. Thus, an adjustment in future work may be to enable annotations to the pictures, which could help the pupils remember, or to add more specific information, e.g., the assignment number or the assignment text, so establishing the context of the produced material would be easier.

Another important aspect of the technical support was that the staff in Hasle Bakker managed the phones. This meant that the phones were always ready to go, with installed software etc. when the classes arrived in the area. Thus, no time had to be spent, on the teachers’ behalf, to set up the phones and make sure everything worked. While not directly related to the implemented system, it was, however, important for the overall pre-, during- and post procedure and the experience during the field trip.

With regard to the lacking or sparse finishing of the procedure, a solution in a future version could be to let the character of Max continue in the follow-up stage, making the proposed assignments more specific. The connection between the narrative and the work after the field trip could be enhanced by e.g. conducting a “Max Replay Epilogue”, where the pupils could have a brush up on the context by watching a recapping Flash file on their computers. Here, Max could recap the context for a specific assignment or question (with speak and pictures of the area) and thus make it more engaging. This could make the whole procedure more cohesive, and obstruct the neglect of the important follow-up.

8. CONCLUSION

This paper has introduced a novel concept of location-based interactive storytelling – Mobile Urban Dramas – on mobile phones for out-of-school learning. The HASLEINTERACTIVE case being presented in the paper is a full implementation of the concept being used by teachers and pupils on a regular basis. It supports biology, geography and math lessons for 7th to 9th graders. Out-of-school learning has as an objective to stimulate the pupils’ practical intelligence as a supplement (or replacement) of classroom learning. We have argued that the use of mobile phone-based learning software can bridge the qualities of classroom learning and out-of-school learning. HASLEINTERACTIVE utilises location-based interactive storytelling on mobile phones as a means to maintain engagement and improve the learning experiences. The story is the framework for assignments being solved in course of fieldtrips and the fieldtrip is documented with multimedia data, which is handled seamlessly both during and after the fieldtrip by the underlying infrastructure.

According to the teachers and analysis of material produced, the pupils in general maintain a better productivity and in turn learning on the field trip, than in traditional group work and field trip activities. The pupils found it fun and exciting, and liked the different way of learning. Experiences show that the concept is practically feasible, such that teachers can plan a pre-during-after process with a minimum of overhead in setting up phones, assigning them to groups, and collecting materials. The evaluation points to the need for a better coupling of the documentation (pictures, video and text) to the parts of the assignments being solved. On the development front, we are looking into means of making the environment more responsive in terms of embedded sensors/actuators in the area, such that the mobile phones can communicate e.g. via Bluetooth. This can both support the performance of solving assignments and support new dramatic effects in the environment.

9. ACKNOWLEDGMENTS

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