

Designing authoring tools for m-learning geo-games

David Johansson and Simon Winter

Center for Learning and Knowledge Technologies (CeLeKT)

MSI, Växjö University, SE-351 95 Sweden

Tel: +46 470 70 80 00.

david.johansson@vxu.se, simon.winter@vxu.se

This paper presents the development of authoring tools for educational games that rely on location-based services. Focusing on the design process, the paper investigates what aspects of the design process can be implemented in an authoring tool to support the design of mobile games. The target group of the authoring tool is active teachers in secondary school, for the most part not having a technical background. The paper describes the design process behind the tool, and shows the result of user-centered design sessions that were conducted with the teachers, as well as the interactive prototype of the system.

Designing authoring tools for m-learning geo-games

David Johansson and Simon Winter

1. Introduction

While mobile technology continues to evolve, new practices constantly emerge. The integration of positioning technology, such as GPS, in mobile devices has resulted in an excellent platform for mobile learning. When location can be added to the factors that are known about the learner, the learning can be customized to fit into the user's current context. There are pedagogical benefits in learning that takes place in situations outside of the traditional classroom setting. (Sharpley et al 2002) According to Lave & Wenger (1991), any activity could be learning, and most of a person's learning comes from performing activities within situations that aren't necessarily defined as such. A mobile device with sensors can be used to support situated learning within "real world" situations, for example using GPS as a sensor of location, to help determine the current context of the user.

Educational geo-games, or location-based games, are games that utilize location information to enhance learning. They can be one step towards supporting situated learning with the use of mobile devices. Consisting of gameplay and location-specific tasks geo-games can provide motivation as well as relevant educational content based on the student's actual context.

Although teachers are curious about the possibilities of new technology and see the potential benefits in situated learning that takes place outdoors, the authoring of this kind of applications is far too complex technically for the average teacher to handle.

This paper presents the design process of an easy to use authoring tool for geo-games, based on Johansson (2008). This can be one part of the solution to managing the technical complexity and would give the opportunity for teachers or other creative people to make their own educational geo-games.

The goal of this paper is to investigate what aspects of the geo-game design process can be automated with an authoring tool. The final prototype of the system illustrates the interaction, and how the authoring tool is supposed to work. It is implemented in Adobe Flash but currently limited in scope, and without backend integration.

2. Background and theory

2.1 Other educational geo-games

The idea behind educational geo-games is that they are supposed to be motivating through interesting gameplay while still having an educational value. The challenge in creating a successful geo-game for education lies in being able to combine the areas of game theory and educational resources with relevant location-based actions (see figure 2.1). Players need to feel motivated, and the educational activities have to have a connection to their current context.

When all three areas are successfully combined, the player can explore the physical world augmented by another dimension of digital content layered on top of it, making new ways of learning possible.



Figure 2.1: Chart of educational geogames

2.1.1 Skattjakt

The geo-game Skattjakt (Spikol & Milrad 2008) combines the sport orienteering with other elements such as problem solving and cooperation. Skattjakt took place on Växjö University campus and was played with mobile phones giving information through the use of pictures, sound and text. The mobile phone client which was based on Adobe Flash Lite (Adobe 2008) made it possible for the players to navigate with the aid of an interactive map with marked locations of the campus area. At the marked locations, the players got tasks that were completed through input on the mobile phone connected to a game server that supplied the logic and scoring for the game. When an answer was incorrect the players could be sent out for a detour for additional tasks. The game was used to teach local history and map reading. Cooperation in groups was supported but there was also the possibility to have up to six different teams compete against each other. Several trials have been run with students aged 12–15.

The authoring tool in the present paper builds upon the game model from the Skattjakt project.

2.1.2 Savannah

Savannah (Facer et al. 2004) was a research project where primary school students got to use geo-games to explore and experience how the animal life can be like in a savannah. The project shows how one can combine mobile learning with games.

The children were sent out on a 100 by 50 meters large playing field, each equipped with a GPS-enabled PDA. They would later assume the role of lions using their handheld PDAs as a mediator to experience the virtual savannah. One major part of the gameplay consisted of collaboration among children in order for the “lions” to be able to attack their prey and survive on the savannah. Using the PDA together with headphones the children could sense their environment, with different sounds and pictures of the savannah that were triggered at different zones of the playing field. The game also included something that the developers called *the Den*, which was a computer that logged all the activity of the game, making possible for the students to see and reflect on their behavior after the game session, and in that way learn about animal behavior.

The project Savannah shows how mobile games can be used within education. A few conclusions that were made emphasized the importance of being able to combine formal education with the gameplay (ibid:407).

2.2 Other authoring tools

Just as educational geo-games overlap into different areas so do the authoring tools designed to make them. An authoring tool needs to be based on theory about game authoring tools and educational resources together with location toolkits. Cf. fig. 2.1.

2.3 Interaction design

The project is designed according to user-centered design, as described e.g. in Cooper (2004). The process of user-centered design can be broken down into three steps (Sharp et al., 2007), where step two and three is an iterative process that leads towards the goal set by the designer.

1. Identifying and understanding the needs
2. Create a design that meets the needs
3. Evaluate the design

Using prototypes for testing and exploration should also precede all programming because it is an effective way of creating a new product, both through the perspective of time and cost (Sharp et al. 2007:530).

3. Method

In this paper, it is investigated how the design process for educational geo-games can be supported by an authoring tool. To make sure that the pedagogical aspects of the games were supported, seven design sessions were carried out with active teachers. A prototype was created, taking into account the teachers thoughts, needs and goals. A paper-based prototype evolved, which after a few evaluation sessions into a prototype created in Adobe Flash. An iterative design process followed, consisting of evaluation sessions and redesign until the prototype met the user goals. This method is in line with the concept of co-design (Penuel et al. 2007:3):

We define co-design as a highly facilitated, team-based process in which teachers, researchers, and developers work together in defined roles to design an educational innovation, realize the design in one or more prototypes, and evaluate each prototype's significance for addressing a concrete educational need. (Penuel et al. 2007:3)

3.1 Design sessions

During the design sessions the teachers shared their thoughts about how they would like to incorporate geo-games into the school curriculum. Different features of both games and the authoring tools were also discussed. Some proposed features that the designer felt would be useful and realistic to implement were kept for the prototype, while others were not. In order to define the requirements of an authoring tool for making geo-games several teachers from different schools in Växjö were consulted during a total of seven design sessions. The teachers had different backgrounds (see figure 3.1), mostly within science subjects. Six out of

seven sessions were held with teachers that earlier had taken part in geo-game projects as AMULETS (Kurti, Milrad & Spikol 2007) and Skattjakt (Spikol & Milrad 2008). Since the main part of all participating teachers had been involved in previously mentioned projects, they were already familiar with the concept of geo-games. As the teachers did not have very deep technical knowledge, they were informed about what gameplay concepts would be realistic to implement.

Three sessions were held with secondary school teachers, one session with primary school teachers and three sessions with teachers at university level. All sessions were documented on video and were reviewed during the design work, although not all formally transcribed, except for the parts focusing on co-design, as complete transcription was not necessary to achieve the design results.

Person	Teaching level	Subject area
A	Secondary school	Mathematics & Physical education
B	Primary school	Mathematics & Social studies
C	Primary school	English & Social studies
D	Primary school	Social studies
E	University	Biology
F	Secondary school	Science
G	University	PhD Student, Media technology

Figure 3.1: Participants

Session	Person	Needs & goals	Lo-fi prototype evaluation	Hi-fi prototype evaluation
Session 1	A	needs & goals		
Session 2	B, C, D	needs & goals		
Session 3	E	needs & goals	paper prototype	
Session 4	F	needs & goals	paper prototype	
Session 5	G			flash prototype
Session 6	E			flash prototype
Session 7	A			flash prototype

Figure 3.2: Design sessions

In the last five of the seven design sessions the teachers were exposed to prototypes, simulating the interaction with the authoring tool (see figure 3.2). The prototype was at first based on paper, as it is not advised to use software-based prototypes in the early development stage (Sharp et al., 2007:531). A low fidelity prototype encourages exploration and modification as it is more easy to make significant changes to, in contrast to a high fidelity prototype which requires significant investment in resources. After two sessions with the paper prototype, a software prototype was developed in Adobe Flash, taking into account the teachers' needs and goals, both from their experience interacting with the paper prototype and from discussions in earlier design sessions.

4. Results

4.1 Results from the design sessions

This part of the paper will explain how different features of the authoring tool materialized from the co-design sessions.

4.1.1 A game based on stations

In some areas the teachers had similar ideas regarding what the games could look like. For example all teachers agreed that building a game that consists of a series of tasks and events triggered at different geographical areas would be a game design approach simple enough for them to grasp. Looking at the transcripts from the recordings of the sessions we see these and similar ideas:

Session 1

- (A) The gameplay could be like if you have a certain number of tasks at each station. As long as you do the tasks correctly you will get a new task. If you give the wrong answer you will get sent to the next station. The tasks could also get harder, let's say that you have five tasks for every station and each task will be harder than the next one.

There are different types of game design principles. For example in the geo-game Skattjakt, players are sent on detours as a "punishment" when they fail to complete a task. The prototype supports this principle by providing the game designer the ability to assign separate actions depending on the task is correct or not, by using the actions "*ifCorrect*" and "*ifFalse*". It is then up to the designer to make the tasks for different cases, for example he could make every following task after a correctly solved one harder, as suggested by Teacher A, and for every incorrect task the difficulty level could get easier.

Here, it can be noted that the remarks of the teachers can lead to games that do not consider the motivational aspects of the players. It is important to provide a good "flow" experience (Csikszentmihalyi 1991) in order to keep up the motivation. A game where a faulty response leads to a harder task is likely to make the player dissatisfied.

Session 2

- (C) What I think would be a fun idea is kind of like a treasure hunt that doesn't need to be one question on top of another. You come to an area and you do something, find out something that is required in order for you to even get to the next area. Exactly how it's supposed to be done I don't know, but I think this would be the most exciting, that there is some type of clue that leads you forward.

(...)

- (D) You get to do a task in the outdoor environment and find out the size of the area of this object, or how much it weighs or whatever, and the sum of what you have calculated leads to another clue and then it starts to be really cool.

- (C) Exactly, that's what I have been thinking as well, that's when it starts to get really fun.

Again, the principle that is suggested by Teacher C is supported by using the elementary actions “*ifCorrect*” and “*ifFalse*”, and designing separate tasks for different answers, each leading to the solving of the main task.

Teacher D requested ways of using the mobile device to measure distance and area. This was requested recurrently by other teachers during other design sessions. Consequently a distance measuring tool was implemented in the prototype.

Session 3

(E) What I’m thinking of now is that maybe if you had coordinates for certain flowers that the teacher had been out and spotted earlier, that wood anemones grow there. Then if one had a coordinate, now I don’t know how close you can take?

(Designer) About ten meters.

(E) About ten meters, well that is good.

(E) I thought that the ideal would be if you got one... if you could as a teacher collect... walk about and see... well... and then you put in those coordinates, there grows the wood anemones, there grows cowslip, there grows (...) and so on. Could you for everyone, to make the kids really stay and look at them, there have to be like a... you have to like...

(Designer) Have a task?

(E) Yes, you check what color the flower have, how many petals... (...) are the leaves lobate or non-lobate, are there more than one flower on each.

(E) And later that you as a teacher could enter in answers, so that if those that inputs correct on this... there are many possibilities that I have thought about, there should appear a picture of a wood anemone, and then later they should answer if this picture is correct to what... what you have in front of you. And then it notifies if they have answered yes then they get that wood anemone, so maybe you during this time you have learned to recognize a wood anemone.

Teacher E had a lot of ideas, most of which were implemented in the authoring tool. First E wanted to be able to define coordinates where certain flowers are growing, which is possible by visually marking areas on the map of the authoring tool.

E also wanted to be able to enter answers to tasks, which is what other teachers requested as well. The prototype authoring tool can manage tasks that can be answered by inputting text or choosing from multiple- or single-choice questions.

Since all teachers seemed to agree on that the game should be based on different areas or stations consisting of tasks, this was among the first things that were decided about the prototype. It also acted as the foundation that the prototype functionality would be designed around.

4.1.2 Actions

Having the design sessions also helped with building the action library for the authoring tool. One teacher addressed the problem about having multiple groups playing the same game simultaneously:

Session 4

(F) It can be so that they must go back to one to get the next coordinate (...) or that they get the next coordinate whichever is available. So then maybe you should have a function like which is the closest station available, so it's not just randomized so to speak which coordinate is free so that they don't have to run from there to there (F points all over the map).

When playing geo-games based on stations there might be a problem when several teams are playing at the same time. Teacher F proposed a feature that was not implemented in the prototype, but still has great potential. F wanted the game to have a system that keeps track of stations that are free so different teams will not get sent to the same station or task simultaneously. The prototype supports different types of actions and could be extended with many more. Instead of calling on the action "*gotoTaskX*" which gives the player access to a specific task, the game designer could use an action as "*gotoAvailableTask*", which first would check if the closest station is free from other teams.

4.2 Presenting the authoring tool

Figure 4.1 shows the interface of the prototype authoring tool that was developed. The screenshot currently shows that a geographical area has been marked on the map and a task named "1a" is being made and connected to that specific area. Placed in the top part of the window are the tool's main functions. In the window to the left of the map, the tasks are designed using a WYSIWYG approach, where every screen represents the end result on the mobile device. The bottom of the screen consists of a series of tasks that the designer can navigate through by clicking, as in figure 4.1.

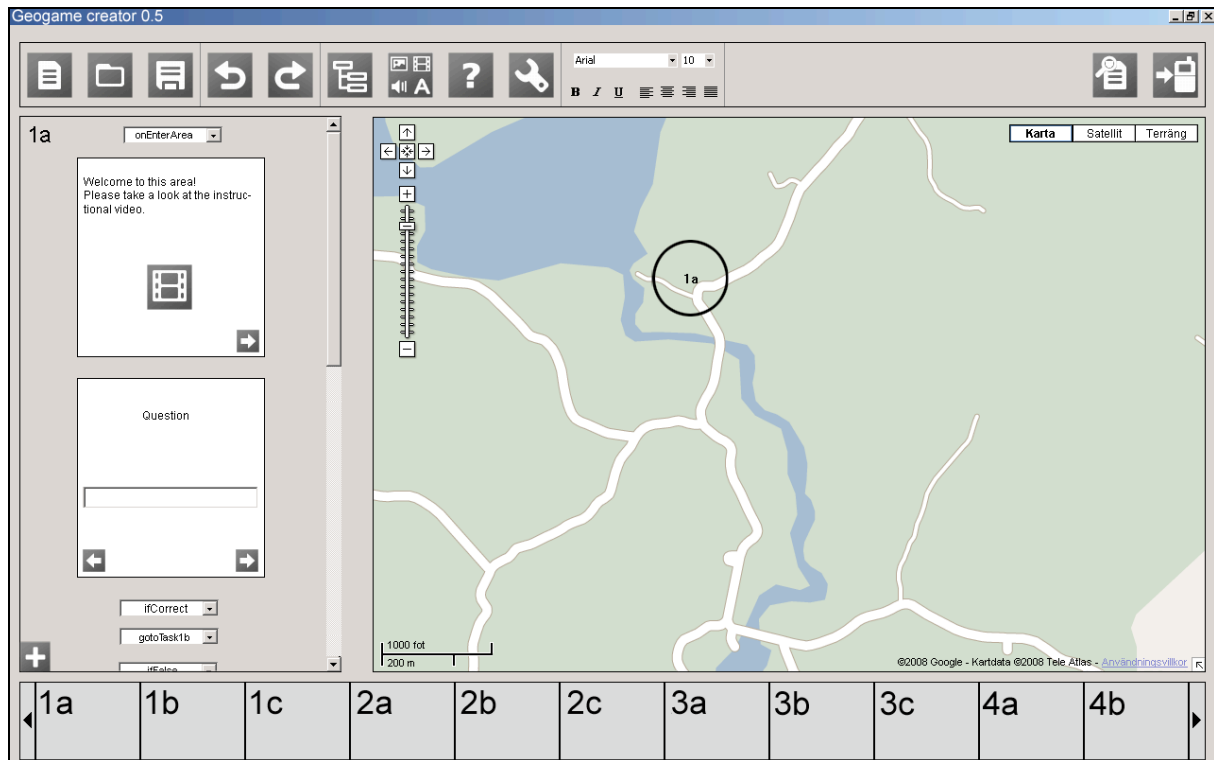


Figure 4.1: Screenshot of the authoring tool

The creation of a geo-game with the authoring tool can be divided into four steps, all seen in figure 4.2.

1. New project

When starting a new game project the user can choose between two map methods, Google Maps or importing a custom one from an image file.

2. New task

To create a new task the user clicks “New Task”, which then is named. Then the tool asks the user to define a geographical area by making a marking on the map (see figure 4.1). When the area has been marked an empty screen appears, which correspond to the final result on the mobile device. By choosing from a drop-down menu different actions can be selected, such as onEnterArea, meaning that the action will trigger when the player is within the defined area, or if onExitArea is chosen the event will happen when the player leaves the area.

By choosing Import media the designer can import video, images, sound and text, for example to give instructions before a task. It is also possible to use the text tool to input text directly into the screen.

The tool supports management of questions and answers. Using “Q&A” the designer can specify questions in the form of single- and multiple-choice as well as letting the player answer by inputting text.

Apart from being able to import media files and managing questions, the designer can also control functions on the mobile device (see fig 4.2). It is possible to include functions, such as camera, map, distance measuring tool and different sorts of communication with other players through voice, video or instant messaging. The designer can also decide exactly when to make the functions available for the player,

so they can act as a reward. These functions are made available to the player through icons on the screen of the mobile device.

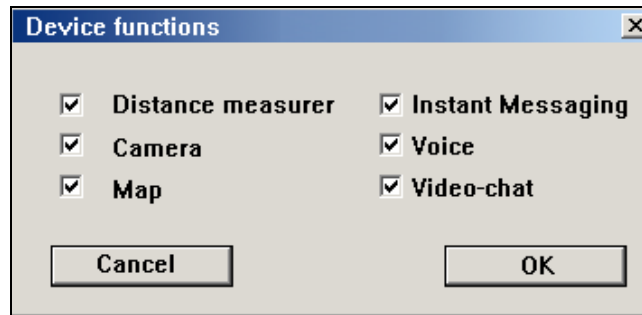


Figure 4.2: Device functions

3. Emulation

In order to avoid having to test the game outdoors on the mobile device, an emulation feature was implemented in the prototype. Using the emulator the designer can, in a convenient way, experience the gameplay and still be able to go back to correct any potential errors.

4. Export

The designer can export the game to a mobile device directly from the authoring tool, either via Bluetooth, a serial connection or via a text message containing a WAP download link.

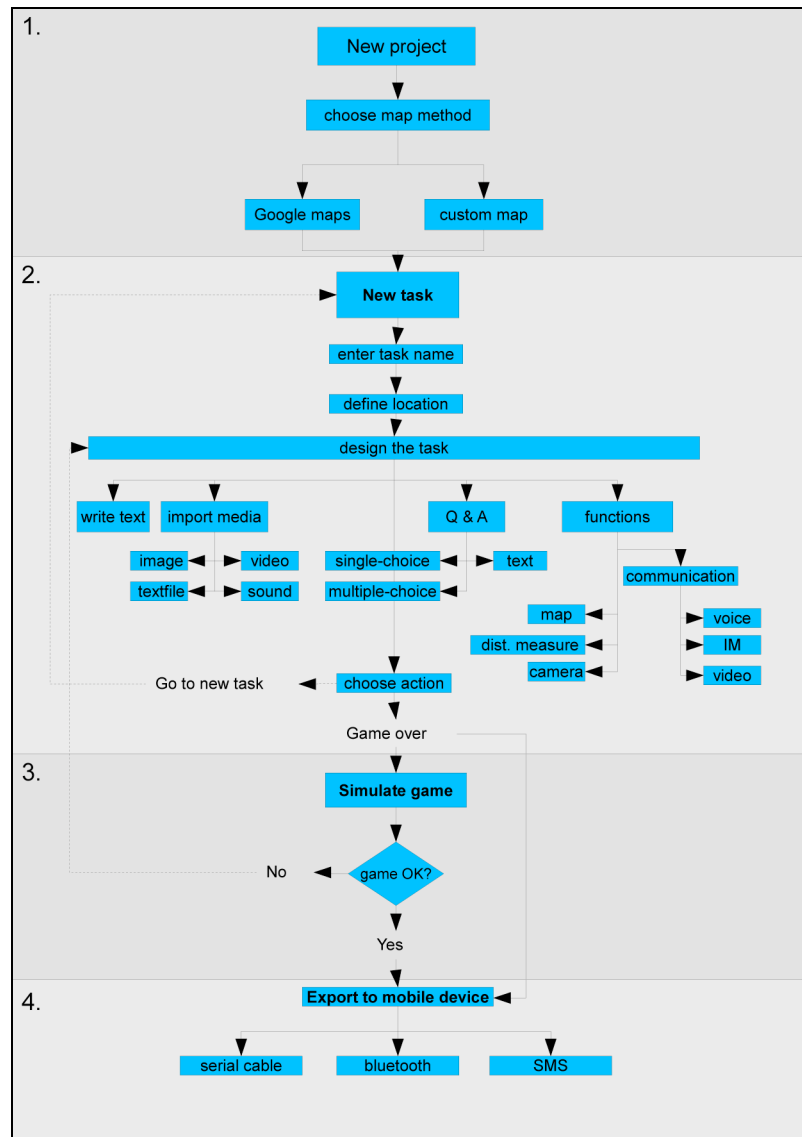


Figure 4.3: Overview of the geo-game design process

4.3 The game flow

A sample game flow of a participant, called Paul. The game starts when Paul seeing a start screen. He is instructed to move to an area that has been marked out on the map displayed on the mobile device. The map shows his current position and where he should be going.

1. When Paul gets to the location, an event is automatically triggered. On the screen an icon which represents a video clip is displayed. Paul clicks on the video clip in order to start it. The video instructs him on the task and when he has understood his mission he clicks right arrow to go to the next screen (see fig 4.4).



Figure 4.4: Instructions by video

2. On the following screen he can read a shortened version of the task and he gets a text box to input his answer. By examining the nearby environment Paul finds out the correct answer and inputs it in the textbox. He then gets a confirmation that the answer is correct and again he gets access to a map where the next location is displayed.
3. At the location he gets a new task. He is supposed to measure the sides of a certain place. To do this he activates the distance-measuring tool that has been made available to him. He measures the distances and calculates the area. The answer he inputs happens to be faulty. He is therefore advised to perform the calculation again. Paul then realizes that he got a decimal wrong and inputs a new answer, which turns out to be correct. The game is now finished and he is informed that he should get back to the starting position.

4.4 Automated design aspects

- **Coordinates**
The authoring tool manages the geographical coordinates by letting the user mark areas on a map based either on Google Maps or a custom image file.
- **Tasks**
The tool manages tasks as questions and answers. Different events can be defined depending if the answer is correct or not, through simplified programming.
- **Layout**
By adding content to the screens in figure 4.1, the layout is managed through a WYSIWYG kind of approach. The user does not need to write any code. All content is added through the interaction with the authoring tool.
- **Digital media files**
The user can connect media files such as video, sound or text to a geographical area and also manage properties regarding playback of the files.
- **Functions and communication**
The user can decide and control when the player should get access to features as the distance measure tool and the communication tools. It is also possible to manage the user privileges for saving content on locations.
- **Emulation**
With the authoring tool it is possible to emulate a game on a virtual mobile device in order to be able to test it without first having to export it.
- **Export**

The authoring tool supplies three different ways of transferring the game to mobile devices, either via Bluetooth, serial connection or by sending a text message containing a WAP link.

4.5 Action library

When transforming the design suggestions from the teachers participating in the co-design sessions to geo-games, it is important to develop an action library for physical locations. The action library defines what the system can do based on the users presence at a certain given location. For example, the action “onEnterArea” specifies that the player enters the area.

Another action, “onAreaTime”, could keep track of how long time the player has been at the location, and be used to trigger events at predefined times.

Teachers also came with suggestions for actions, such as having one that keeps track of what nearest stations are free from other players (gotoAvailableTask) (see transcript in section 4.1.2).

5. Conclusions and future work

Although GPS is only one of many possible sensors for determining context, much can be done with just knowing the users current position. Having a well developed action library implemented in the authoring tool will therefore help with creating educational geo-games fitted to the user’s context.

Future work includes creating more location-based actions, but also actions for other types of sensors than location as well. Other sensors could be used to sense movement, sound, light, temperature, humidity, smell, pollution, electromagnetic fields, a person’s heart-rate and many other things. Some of these are used for manipulation of photographs in Håkansson et al (2003).

By extending the authoring tool to support more sensors together with useful actions, the context of the user will get more defined and this is a step towards tailoring the learning to the individual student’s needs.

6. References

- Adobe (2008) Adobe Flash Lite
Available: <<http://www.adobe.com/products/flashlite/>>
- Cooper, A. (2004) *The Inmates Are Running the Asylum: Why High Tech Products Drive Us Crazy and How to Restore the Sanity* (2nd Edition), Indianapolis, Pearson Higher Education.
- Csikszentmihalyi, M. (1991) *Flow: The Psychology of Optimal Experience*, Harper Collins, New York
- Facer, K., Joiner, R., Stanton, D. Reid, J., Hull, R., Kirk, D. (2004) *Savannah: mobile gaming and learning?*
Journal of Computer Assisted Learning 20, pp399–409.
Available: <http://www.equator.ac.uk/var/uploads/Savannah_paper2004.pdf>
- Håkansson, M., Ljungblad, S., and Holmquist, L. E. (2003) Capturing the invisible: designing context-aware photography. In Proceedings of the 2003 Conference on Designing For User Experiences (San Francisco, California, June 06 - 07, 2003). DUX '03. ACM, New York, NY, 1-4
Available: <<http://doi.acm.org/10.1145/997078.997101>>
- Johansson, D., (2008, forthcoming) Att designa författarverktyg för geo-spel inriktade mot mobilt lärande.
Unpublished B.A. thesis. MSI, Växjö University, Sweden.
- Kurti, A., Milrad, M., Spikol, D. (2007) *Designing Innovative Learning Activities Using Ubiquitous Computing*.
Proceedings of the 7th IEEE International Conference on Advanced Learning Technologies. IEEE
Computer Society, Los Alamitos, USA
Available: <http://ieeexplore.ieee.org/xpls/abs_all.jsp?arnumber=4281042>
- Lave, J. & Wenger, E. (1991) *Situated learning : legitimate peripheral participation*, Cambridge, Cambridge Univ. Press.
- Penuel, W.R., Roschelle J., Shechtman, N. (2007) *Designing formative assessment software with teachers: An analysis of the co-design process*. *Research and Practice in Technology Enhanced Learning*, 2007. 2 (1): p. 51-74.
Available: <http://ctl.sri.com/publications/downloads/RPTEL_co_design.pdf>
- Sharp, H., Rogers, Y. & Preece, J. (2007) *Interaction design : beyond human-computer interaction*, Hoboken, NJ.
- Sharples, M., Corlett, D. & Westmancott, O. (2002). The Design and Implementation of a Mobile Learning Resource. *Personal and Ubiquitous Computing*, 6, 220-234.
- Spikol, D., Milrad, M. (2008) *Combining Physical Activities and Mobile Games to Promote Novel Learning Practices*. Proceedings of the IEEE international conference on "Wireless, Mobile and Ubiquitous Technologies in Education. Beijing, China.
Available: <<http://ieeexplore.ieee.org/iel5/4489771/4489772/04489785.pdf>>