Literature on “Digital Adventure Game Based Learning”
M.C. Koops, October 2003

Purpose
The purpose of this paper is to list today’s main theories on (adventure) game based learning and the players in this field. This information is to be used in the investigation to the effect of the “adventure” in Game Based Learning.

Other papers in this series will be:
Literature on “Authoring tools and editors for Digital Adventure Games”
Literature on “The way to learn electricity”
Literature on “The story of game writing”

Introduction
This review provides an overview the most obvious articles about game based learning that are available on the internet at October 2003. References are not correctly listed yet, but they are available in hardcopy. The main articles are by Rieber, Malone and Lepper, Galvis (of the playspace project) and Amory who has completed some adventure game based learning projects and introduced the term “edvanture learning”. Marc Prensky is a widely cited writer of the book “Digital Game Based Learning”, which deals with the subject at a high level. Off course also names as Vigotsky and Kolb turn up as references.

The paper is structured as follows. First I list the theories on play and learning. Second I look into the literature on digital playspaces and finally I list some design rules and tips.

Play
Lately a tendency starts to rise to take play serious as a way of learning. Scientifically this is sustained by e.g. the observation that “enhanced learning”, which is fun can be more effective (Lepper and [Cordova, 92]). Learning by experience is more fun than learning by studying. Observations like this suggest that play may be a way to improve learning. Especially for today’s generation which is raised with (computer) games.

Rieber [Rieber,96] looked into the concepts of play and learning in his famous article “Seriously Considering play”. He lists 4 misconceptions about play:
- Only applies to young children
- Not respectable
- Play is easy
- Activity of play is irrelevant or inconsequent to either formal or informal learning

And explains how the concept of play can be organized around 4 themes (see [Sutton-Smith 1995], for more elaborate analysis)
- Power: competition (chess, football, ..) (adults)
- Fantasy: liberate mind to engage in creative and imaginative thinking
- Self: the experience of play itself is the goal: intrinsically motivated!!!!
- Progress: purpose is to learn something useful (kids)

The progress theme is clearly the most appropriate theme for learning purposes, while the fantasy aspect and the play for its own sake (self) should not be too easily overlooked. They can be responsible for the intrinsic motivation of the player.
Typical characteristics that are defined for games are: interactivity, rules, challenge and risks, fantasy, curiosity, challenge and control (according to [Malone, ‘81]).

**Learning**

Considering the use of games for learning the constructivist theory provides a very interesting perspective. It describes behavior of the learner that often coincides with player’s behavior. A lot of research has been conducted on constructivist learning. Related to play it also occurs in literature as follows.

**Constructivist learning**

Constructivist learning has proven to be effective

Designers of constructivist learning take into account: [Robinson, 98]

- To provide an experience with the knowledge construction process
- To provide experiences encouraging appreciation of multiple perspectives
- Embed learning in realistic and relevant contexts
- Encourage ownership of the learning process
- Embed learning in social experience
- Encourage multiple modes of representation
- Encourage self awareness of the knowledge construction process

As the latest generation of computer games often involves a multiple player concept, the following concepts of collaboration learning might also provide an interesting perspective for further study.

**Digital playspaces**

When digital game based learning is considered, one of the first problems to be addressed is: What does the digital playspace look like?

Malone found that the common elements of computer games are [Malone, ‘81]:

- Fantasy
- Curiosity
- Challenge
- Control

These elements are also expected in computer games.

Three digital playspaces can be recognized according to [Rieber, 96]

**Microworlds:** Small but complete version of a domain of interest

- need no instruction
- presents learner with simplest case (you can start right away)
The most fundamental example of a microworld Rieber mentions is a “sandbox”, focusing on e.g. the domain of ‘volume and density’.

Simulation:
- Determined by content of domain
- Judged on basis of it’s fidelity

Simulations, like ‘flight simulator’, are often very complicated due to the fidelity demands.

Game: like simulation or microworld but:
- Intrinsically motivating
- With fantasy aspects (that make the player believe that’s/he acts in the microworld.
  - Endogenous games interweave the content into the game.
  - Exogenous games place content “next to” the fantasy world (e.g. hangman)

Effective playspaces should also facilitate “self-regulated learning” in some way. [Rieber, ‘96].

Self-regulated learning: Most effective learners self-regulate their learning, so it is worth to strive for self-regulated learning

Self regulated learning needs conditions:
- Environment must be intrinsically motivating
- Learners must be meta-cognitive
- Learners must be behaviorally active

Closely related to the conditions for self-regulated learning are the conditions for the flow state. [Csikzentmihalyi] investigated what he called the mental state “Flow”, where a learner is “going with flow” and forgetting “time and the world around him”. Three conditions for the flow-state are:
- A high challenge level
- Matching high skills level
- Frequent informative feedback

E.g learning to play the violin is a self-regulated learning process and it can easily bring the learner into the flow-state.

Another perspective to self-regulated learning mentioned by [Rieber, ‘96] is Piaget’s.

All these conditions for self regulated learning remind strongly of the game-properties. So maybe the best way to activate self-regulated learning is by games! The games must act in microworlds where the learner does not need instruction and gets simplest case to start with.

- Rieber even suggests to “Use play as a benchmark for evaluating learning environments”
  - “Serious play is not easy to achieve but the reward is intense and satisfying experience

MIT Media Lab often talks about “hard fun”.

In order to make playspaces effective environments for learning finally feedback is mentioned. Feedback is important, but difficult to realize in a supporting yet intrinsically motivating way. [Nathan Bos, 2001] praises the feedback that is realized in the popular computer game SimCity. In this game many instances of informative, intrinsically motivating,
feedback is realized. The controlling feedback is avoided; that is good because controllable feedback can easily kill intrinsic motivation [Lepper, Green and Nisbett, ’73]

Rieber: “Carefull blending of Microworlds, simulations and games offers promise in guiding design for optimal STRUCTURE and MOTIVATION: environment that encourages to play.”

An approach, different from the real computer game idea, but somewhat similar to adventure games is taken by Al-Ubaidi Tarek who describes Situation Learning [Al-Ubaidi Tarek, 00]. Situation learning (SL) is a highly interactive multimedia paradigm. The idea is somewhat similar to e-learning game:

- Highly interactive
- Learning objective is embedded in sequence of different plausible situations (as also is required by constructivist learning concept)
- Student must decide between choices
- Choice determines next step
- While trying to find solutions learners reflect on already gathered knowledge
- Immediate feedback provides evaluations of actions taken (similar to adventure games)

Assignments are non-linear
Equivalent situation prevent boredom
Feedback to learner via “Path evaluation”
Digital Learning Game design

Now I have shown generally where and how digital games are proposed to be used for learning purposes, I conclude mentioning some design rules and hints. Also some important aspects are listed that can be used in the review of a digital games based learning product. What are known processes and checklists for digital gamespace and digital game design?

Rubric for assessing and designing digital playful learning spaces [Galvis, 02]
Determine:
- Intended educational purpose
- Platform
- Audience
- Theoretical orientation (constructivist, behaviorist?)
- Are there non-digital playspaces for the same purposes (What can you learn from it)

Basic aspects according to [Prensky, 01]
- Is it enough fun?
- Do users think of themselves as players i.s.o learners?
- Is the experience addictive?
- What can be learned? Are players knowledge and skills improving with playing time?
- Does the playspace encourage reflection?

Components to consider when reviewing digital playspaces [Galvis et al] (see appendix)
- Fantasy / structure
- Feedback
- Sense of control
- Game learning curve
- Accommodation to special needs
- Learning opportunities
- Formal, non-formal and informal; education integration

Steps of game design [Cordova, 92]
- Determine pedagogical approach
- Situate the task in a model world
- Elaborate details
- Incorporate underlying pedagogical support
- Map learning activities to interface actions
- Map learning concepts to interface action

Tips by Simon Egenfeldt, egenfeldt @game-research.com
- Good game universes have different layers that the player can slowly immerse to
- Do not put content into the first ¼ of the game: the player is learning the interface.
Figure 1. Visualization of the Game Object Model. (a - abstract interfaces, b - concrete interfaces).

Figure 2. Components of a Game Description (a. Basic definitions: objectives and story; b. Act definition: act objectives and story line interface; c. Scene definitions: elements, actors and puzzles).
Appendix 1

[Galvis et al] consider the following components in order to conduct a systematic review of digital playspace:

<table>
<thead>
<tr>
<th>Component</th>
<th>Variables to observe</th>
<th>Aspects to be considered</th>
</tr>
</thead>
</table>
| Fantasy/structure/microworlds/playspace | • argument (story) or type of stories that the user can build  
• challenges (posted by the system or defined by the user)  
• characters and their roles  
• tools for intervening in the playspace  
• constraints or resources that can be applied to the playspace | Is the story/argument endogenous to the learning goals, or is it exogenous?  
Are the challenges intrinsic to the learning goals (i.e., directly related to the learning goals), or are they extrinsic (i.e., exogenous) to the goals?  
What role does each of the intervening characters assume? What powers can be acquired/lost by the character representing the user as well as by other characters?  
Are the tools for intervening in the action curious, interesting, powerful, dynamic, varied, or fun?  
Is it possible to change the general conditions of the system, even if they become unreal, illogical, or do not make sense? |
| Feedback | • Behavior of the different components of the microworld and of the intervening tools and characters  
• Changes of states of the playspace according to the intervention of the users | Is feedback intrinsic (inherent to the task being performed) or extrinsic (rewards or penalties given as consequence of the tasks)?  
Is feedback implicit (you derive it from the behavior of the system) or explicit (you are told by the system how you are doing)?  
Is feedback organic (you are given constant visual representation of the state of each component of the system) or responsive (feedback is given when you ask for a response)?  
Is “give up” or “I got it” feedback encouraging? When you give up does the system provide the answer or clues that encourage you to try again? When you get the solution, does the system encourage you to explore other solutions or to find a better solution? |
<table>
<thead>
<tr>
<th>Component</th>
<th>Variables to observe</th>
<th>Aspects to be considered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sense of control</td>
<td>• Fantasy structure&lt;br&gt;• Feedback&lt;br&gt;• Sequence of action&lt;br&gt;• Human computer interface&lt;br&gt;• Level of performance</td>
<td>• What is the user's role in determining the fantasy structure? Can s/he contribute to, create or change the fantasy structure?&lt;br&gt;• Does the feedback allow the user to reflect and rethink the next intervention, or does s/he just react to the action? Is controlling feedback (feedback that does not allow for reflection on the action) an issue?&lt;br&gt;• Who controls the sequence: is it history driven? Menu driven? Combined? Is it a flexible sequence?&lt;br&gt;• Is it possible to adjust colors, sound, music, background, speed, language?&lt;br&gt;• Is it possible to change the level of difficulty of the challenges, the goal to be achieved, or the tools to be used?</td>
</tr>
<tr>
<td>Game learning curve</td>
<td>• Demo of the system&lt;br&gt;• Tutorial of the system&lt;br&gt;• Trial and error of the components and its functioning in the system&lt;br&gt;• Demo of the components and their integration in the system&lt;br&gt;• Help function</td>
<td>• Is there a demo of the playspace that captures the attention and that can be skipped after the first time?&lt;br&gt;• Is there a tutorial on demand, a step by step procedure that helps users become familiar with the system, its parts and properties?&lt;br&gt;• Is it possible to try new parts or components of the system before using them? Can you learn about the system from the experience?&lt;br&gt;• Is it possible to get a demo or ask to see the different parts or components of the playspace?&lt;br&gt;• Does the system provide clues or feedback when the users are lost or unsure of what to do next? Is this help in the form of an illumination with indirect light or a direct suggestion on what to do next?</td>
</tr>
<tr>
<td>Component</td>
<td>Variables to observe</td>
<td>Aspects to be considered</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>----------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Accommodation to special needs</td>
<td>• Input / output devices&lt;br&gt;• Information&lt;br&gt;• Learning styles&lt;br&gt;• Expression technologies&lt;br&gt;• Collaboration and communication tools</td>
<td>• Does the digital space offer multiple stimuli and react to multiple devices?&lt;br&gt;• Are there multiple ways of presenting, on demand, information generated by the digital space?&lt;br&gt;• Is it possible to accommodate the interaction with the digital space to different learning styles? Are there multiple learning strategies available for achieving common goals?&lt;br&gt;• Does technology allow the user to express his/her ideas in different ways? Does it provide multiple means for student expression?&lt;br&gt;• Is it possible to synergistically communicate and collaborate with others in order to achieve common goals?&lt;br&gt;• Does the digital playspace support asynchronous or synchronous interaction among peers, teachers or outsiders?</td>
</tr>
<tr>
<td>Learning opportunities</td>
<td>• Knowledge, abilities, skills, attitudes, … that can be learned using the digital playspace&lt;br&gt;• Metaknowledge or principles about learning that can be learned&lt;br&gt;• Reflection and discussion about the experience&lt;br&gt;• Creativity and problem solving&lt;br&gt;• Personal development&lt;br&gt;• Social behavior</td>
<td>• What content and process knowledge, abilities, skills, attitudes can be learned? Form part of the formal (e.g., to obtain a title) curriculum? … of the non-formal (e.g., to obtain or keep a job) curriculum? … of informal (e.g., lifelong learning) curriculum?&lt;br&gt;• What heuristics, rules of thumb, or general principles for problem solving can be learned using this digital playspace?&lt;br&gt;• Does this digital playspace provide grounds for interesting discussions based on reflection about the playing experience? (e.g., relationship issues in The Sims, political issues in SIMCITY, engineering problems in Contraptions.)&lt;br&gt;• Does this digital playspace contribute to the development of creative ways of viewing the subject matter or the problems under consideration?&lt;br&gt;• How might this digital playspace contribute to user’s identity formation, self-confidence or other aspects of personal development?&lt;br&gt;• Does this digital playspace encourage anti-social behavior? (e.g., egosum, violence, treachery?)&lt;br&gt;• Does it encourage positive social behavior such as cooperation, team building, etc.?</td>
</tr>
<tr>
<td>Component</td>
<td>Variables to observe</td>
<td>Aspects to be considered</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Formal, non-formal and informal education</td>
<td>• Appropriate educational setting</td>
<td>• In which educational setting (school, work, home) is it more natural/appropriate to use this digital space?</td>
</tr>
<tr>
<td>integration</td>
<td>• Home-school connections</td>
<td>• Is the playspace adaptable to either the classroom or computer lab? For instance, can a classroom with just two computers effectively use the playspace?</td>
</tr>
<tr>
<td></td>
<td>• Information to be used by educators</td>
<td>• Does this playspace support home-school connections? What aspects should be shared, discussed, or shown to parents and teachers?</td>
</tr>
<tr>
<td></td>
<td>• Openness from the educational perspective</td>
<td>• Does this digital space provide information to educators (teachers, trainers, or parents) concerning the user's performance and activities?</td>
</tr>
<tr>
<td></td>
<td>• Educational support to users and facilitators</td>
<td>• Is the digital space flexible enough so that educators can impose different goal structures or educational resources upon it? Does the playspace support standards and district curriculum for the school/grade level?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Are there resources, such as a professional development community, that would support the educational use of this digital space?</td>
</tr>
</tbody>
</table>