Experience Design for Computer-Based Learning Systems: Learning with Engagement and Emotions

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Abstract: Designing learning environments and learning modules for experiences engages learners for a defined time within defined information and activity spaces to improve learning effects and to prevent from tedious learning situations with uniformly shaped standardized learning modules. Methods from experience design, interaction design and instructional design can be combined to create challenging and motivating experiences in learning contexts.

1. Introduction

Computer- and network-based learning (e-learning) has been based on increasingly systematic forms of instruction methods, production processes, authoring tools, learning environments and evaluation strategies. This allowed for a more economic and well defined production of e-learning applications and enabled many, mainly educational institutions to generate and provide learning contents with even low budgets (Kritzenberger & Herczeg, 2002; Hartwig, Hadley & Herczeg, 2003). At the same time the e-learning modules produced obtain a more standardized shape. The more they are uniformly shaped the less attracting, interesting and motivating they are for learners. The learners seem to be more and more connected to a kind of *knowledge assembly line* conveying contents from the learning content providers to the learners. This remembers in some way to the "Nuremberg Funnel". This manufacturing approach might be useful to improve traditional forms of learning in certain contexts by the provision of well-defined and well-shaped electronic and multimedia contents. On the other hand especially younger learners or more extrovert learners are getting bored and distracted by highly structured and uniform ways of learning.

In the area of computer-based interactive applications systems a similar situation can been found since many years. Computer-based work systems have been highly optimized for routine tasks supporting well-defined effective and efficient work. The development of these systems has essentially been based on *user and task analysis* (Hackos & Redish, 1998; Kirwan & Ainsworth, 1992). While this is a consequent way of supporting well defined work, it has been found as an ineffective and distracting way of information and service provision in highly competitive and less defined situations like e-commerce systems. For systems like these design approaches taking user's attention into account seem to be more promising. Davenport and Beck (2002) talk about the *attention economy*. The role of system notifications for human attention as important efficiency and motivation factors have been analyzed by McCrickard and Chewar (2003), who coined the conception of *attentive user interfaces* (AUIs). Under the topic of *experience design* (Grefé, 2000; Shedroff, 2001) engagement of the users has been brought to focus which allows to stimulate and address in much stronger way the interests and emotions of users.

In this contribution the approach of blending *instruction design*, *interaction design* and *experience design* will be discussed in respect to learning applications.

2. The Nature of Experiences in Computer Applications

What are the characteristics of human experience? In a qualitative evaluation we and others analysed contexts in several e-commerce applications and computer games where the test users of these systems reached a mental state that was generally accepted to be something that could be called an *"experience"*. As a result of this evaluation as well as found by some other authors experiences of this kind are often created or accompanied by the following phenomena and characteristics:

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- There is an *attraction* that catches user's *attention* (Shedroff, 2001; McCrickard & Chewar, 2003).
- The situation is *challenging*, i.e. the solution of the problem is not trivial, might be risky in some sense, but there are already *cues for solutions* and there seems to be a *reward*.
- The situation is *dynamic*, i.e. there are observable and often fast changes and movements in the activity and information space that take place even when the user is observing the situation passively. The application is *alive* from the user's point of view and provides many cues and notifications in respect to these changes (McCrickard & Chewar, 2003).
- The state space is *direct manipulative*, i.e. users have certain means and at least basic knowledge how to manipulate the information space and perceive the results immediately (Shneiderman, 1987; Hutchins, Hollan & Norman, 1986). Users have the positive feeling of *control* in respect to the application.
- Users have an impression of being *engaged* into the application and are able to *create effects* (Shedroff, 2001; Hutchins, Hollan & Norman, 1986).
- If there is a tight *connection between mental and physical activities*, the feeling of engagement is even much higher (Ishii & Ullmer, 1997; Winkler, Reimann, Herczeg & Höpel, 2004).
- There is a *search for boundaries* leading into new and unknown areas in the information and activity space (Shedroff, 2001).
- The application is *story-based* in the widest sense, i.e. there are a kind of *actors* (might include the user) and there is a meaningful *narrative* thread through the state space which is partially reached automatically and partially by user's activities (Murray, 1997). There has to be a kind of *dramatic structure* like those early described by Aristotle (Hoffmann & Herczeg, 2003; Schön, Hoffmann & Herczeg, 2003) which leads through an ascending storyline to a *climax* and a *conclusion*.
- The user's competence is *improving* and there is *a steadily flowing progress in competence* (Csikszentmihaly, 1990). The system supports learning and therefore improving skills and knowledge to become faster and more efficient in manipulating the system's objects.
- The activities create *changing and* sometimes *strong emotions*.
- There are *communication connections and social relations to other individuals* within the experience space to create a perception of being part of a social structure (Winkler, Kritzenberger & Herczeg, 2002b).
- Experience has an *extension* (Shedroff, 2001) in space and time that might *bridge to the next experience*.

Contexts where experiences emerge are usually rich in content and dynamic in nature. They contain or refer to stories in the widest sense. Users are in an active role and proceed along a temporal and spatial structure trying to explore and master something which is attractive but still unknown for them in some way. In many cases users are at the time of their experience part of a kind of social structure and perceive strong changing emotions.

Mental processes of experiences of similar kind have also been described by Csikszentmihalyi (1990) and called *flow*. People are highly motivated by the impression of a successful step-by-step process leading them into new situations and new challenges, which can be mastered by them.

3. Experience in Learning Processes

If experience is a desirable and motivating mental state of human beings, where they are active, attentive and willing to perform and learn, what are methods to implement learning systems which generate such experiences? Based on methods that have been derived from experience design, interaction design and instructional design, there are some means that might be effective based on the results discussed in the previous chapter.

3.1. Activating Users

The key to a high level of attention and motivation is to *bring the users into an active role*. In learning contexts this can be done in several ways.

Enable the users to develop and articulate their questions and goals and to conquer the learning modules in respect to these questions and goals. Learning systems can create a semantic information and activity space around questions and goals. Examples of this are search engines in the World Wide Web, where users can browse a huge information space along their patterns of interest and control the types and qualities of results they are looking for with the help of search patterns. Even as in the current implementation of the World Wide Web information resources are structured and marked semantically still on a very low level, these search engines and the hypermedia structures lead to interesting and engaging exploration and learning situations.

Allow the users to access learning contents from different perspectives. As an example, in two learning modules in the field of human-computer-interaction provided by two distance universities we implemented four views for the learners: a *history view* (presenting the main topics from a historic perspective), a *learning path view* (a kind of sequential book-like perspective), a *structural view* (the scientific perspective onto the structure of the field) and an *application view* (showing, how the concepts might be used for practice) where the learners can decide from which perspective they like to access the knowledge.

Let the users to decide about the path through the learning materials without loosing the overview of the whole information space and without loosing track of what they already have worked through successfully. This can be done by *providing navigation tools.* This might sometimes even be as simple as giving them a method to tick the table of contents to mark up, what they have already worked through in the learning content. It is better to give the control about the learning progress to the learners themselves than trying to recognise learning elements as finished just by observing the learners browsing the content, since having one ore more context pages displayed does not mean they already understood it.

Provide simulators with tutoring components allowing to experiment with a complex interdependent parameter space that can be controlled by the learners. An approach like this has been followed by *intelligent tutoring systems (ITS)* (Sleeman & Brown, 1982). However, building simulators is a very demanding and expensive task especially in respect to knowledge representation and cognitive learning processes. Therefore most of the simulators have been environments to train sensomotorical skills.

3.2. Storytelling

Learners can be highly motivated if the *learning content will be wrapped into a kind of story* (Laurel, 1993; Murray, 1997). This is already known since a long time, when relevant social and other common knowledge has been communicated and learned via fairy-tales and other metaphoric forms of teaching. However, the translation into digital media is still ongoing.

Create a dramatic narrative structure like Aristotle's suspense model or the ARCS model (Keller, 1987; Schön, Hoffmann & Herczeg, 2003). Examples of concepts like these are comic-like, short animated sequences of human discourse. We implemented this within the medical distance learning application *medin*, where more than 20 courses in medical informatics define a program provided by a virtual university. For example, some medical content elements have been presented as short stories told by a physician talking to a patient.

Implement a multidimensional story-telling engine which reacts to user's interests, knowledge and learning history (Hoffmann & Herczeg, 2003). Story-telling structures do not need to be restricted to a simple linear form. They can be structured as well by directed graphs like in *hyperfiction systems* controlled by a story-telling engine and certain discourse parameters and user's actions.

Create computer applications that provide a kind of theatrical stage where drama takes place (Laurel, 1993). Examples of systems like this are in the widest sense *cinematic computing systems* (Kirk, 2003). This new kind of computer applications allow arbitrary user controlled spatial viewpoints via real-time rendering of cinematic sequences presented as computer animations. The concept has been called *cinematic computing* to take into account their predefined story-like structure looking like movies with the important difference, that the user may move around unrestricted in 3D-space or may select predefined (former) visual viewpoints.

Provide activity spaces where activities of agents take place and where users themselves are part of the story. Examples for such activity spaces are *3D computer games* where the users can act among other agents and are able to control or at least influence where the activities take place and how the story proceeds.

3.3. Mixing physical and digital Space into a Mixed-Reality

Instead of separating the new digital world from the physical world, a mixture of both, a kind of *mixed-reality* can be constructed, which engages the learners not only in communication and cognitive tasks but in physical interaction as well.

Activate several human senses synchronously by digitally created multi-sensory stimuli that create the illusion of being part of another world and "propel the imaginations" (Dodsworth, 1998). Virtual, mixed and augmented reality systems are approaches, trying to connect bodily experience with cognitive tasks. Many applications have been implemented to follow these concepts in the area of teaching and learning. The most developed systems of this kind are *flight and other vehicle simulators* used for training purposes.

Connect the learners in the virtual space with their physical space, like in choreographic performances. We used mixed reality concepts in the area of media education in elementary schools. The children were designing, constructing and building multimedia performances by designing and implementing different media and by including a computer vision system to observe the scene and react with the display of digital images and sound synchronized with the performance on stage (Winkler, Kritzenberger & Herczeg, 2002 a/b; Winkler, Reimann, Herczeg & Höpel, 2003). Learning takes especially place during the conception, implementation and test phase of the whole performance. The public performance can be viewed as the verification and climax of a successful learning experience with strong impression of *suspense* and *success*.

Create tangible media connecting "atoms to bits" by enriching physical objects with media properties and vice versa (Ishii & Ullmer, 1997). Tangible media applications often try to enrich visual and auditory computer applications by haptic interfaces. Examples of tangible media for learning purposes can already be found in several areas, like restoring paintings with the help of real and during the teaching phase virtual paper knifes with haptic feedback (Geary, 2003).

3.4. Problem-oriented Learning Strategies

An appropriate selection of these different teaching and learning methods has to be combined into a *problem-specific learning strategy*. The examples of applying these principles mentioned above can be taken as best-practise applications showing that there is already at least a narrow road that could be broadened by extending theories as well as creating new applications to verify these ideas.

With these and some other methods we expect to take important steps towards learning contents and environments that create the perception of experience and at the same time provide mechanisms to convey the construction of knowledge for the learners. As shown in the area of e-commerce systems we think that these methods can be also applied on top of standard e-learning solutions, i.e. it seems to be possible to enrich standard e-learning modules by additional perspectives and access layers (e.g. user-driven learning and story-telling engines). However, in other situations the learning modules have to be designed and implemented from scratch according to a different instructional approach (e.g. mixed-reality systems).

4. Conclusions and Future Work

The methods described are expected to lead to concepts for new forms of learning processes, learning contents and learning environments focused on the experience of the learners. With methods developed or rediscovered in the area of experience design we are able to enrich and extend well known methods used in instructional and interaction design. By creating experiences we can focus user's attention and engage them into information and activity spaces (*experience spaces*) to form motivating contexts for learning processes.

A major problem of this approach are the high costs for the implementation of experience-based learning systems like the ones described. To cope with this problem we have to build frameworks and tools to implement systems like this with a much higher efficiency than today. That this is feasible can be seen in the area of 3D computer games where frameworks, game engines, object archives and software libraries have been implemented that allow to build new, increasingly complex game applications in even shorter time than the first simple computer games.

Our first analysis of experience-based learning and its results will be further tested in several ongoing projects by creating and extending learning modules in distance university programs as well as in school contexts.

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