THE ROLE OF NAVIGATION AND MOTIVATION IN E-LEARNING – THE CRIMP-APPROACH WITHIN A SWEDISH-GERMAN RESEARCH COOPERATION

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Abstract

Software programs are widespreadly used in education which is undoubtedly a result of the rapid development of hard- and software. This technological development enables software developers to create hypermedia environments. Hypermedia offers a great potential as a framework for modern e-learning tools as it allows the incorporation of constructivistic learning strategies. However, hypermedia systems have to cope with severe drawbacks such as cognitive overload and navigational problems. Therefore, the question arises how to create efficient computer based learning environments. Scientific research on print material can provide helpful hints as well as the promising approach of the cognitive theory of multimedia learning. But further scientific investigations are necessary to bridge the gap between those studies and the complexity of real hypermedia systems in order to reveal if their predictions are applicable to more realistic complex settings.

CRIMP (Criteria of Evaluation of Audiovisuals in Multimedia Productions) is one of five projects within a German-Swedish research network called VASE (Visualization and Simulation Environments to Solve Difficult Learning Situations). Its partners are the Learning Lab Lower Saxony (L3S) and the Swedish Learning Lab (SweLL). CRIMP will investigate navigation, motivation and predictions of the cognitive theory of multimedia learning by evaluating the impact of four different versions of a complex hypermedia learning environment on learners in Germany and Sweden.

The increasing importance of e-learning in education

The amount of e-learning-tools in its different forms has been expanding rapidly during the last 20 years. An important reason is undoubtedly the fast development within the PC-hardware sector which in turn influenced the software. First, powerful hardware settings facilitate the operation for users by graphical user interfaces. Second, it gave the technological basics for an evolution of simple and monomodal e-learning-tools (i.e. software was based exclusively on visual text) up to hypermedia systems.

According to Gerlič and Jaušovec (1999), there has been an explosion of computer-based multimedia applications in education in recent years. The incorporation of pictures, movies and sound is characteristic for multimedia components and their implementation in e-learning material seems reasonable because on-screen text is hard to read when compared to traditional printed material (Weidenmann 1997). However, the increase of use of online-learning is slower than expected and its future development will most probably differ between sciences and arts (Beck, Glotz et al. 2000).

A huge amount of studies has evaluated the efficiency of e-learning environments. Kulik and Kulik (1991) found in their meta study evidence for an advance of computer-based learning as compared to traditional learning styles. Similar results have been reported about the use of computer technology in schools (e.g. Software Publishers Association 1995) and universities (e.g. Kazmerski and Blasko 1999, Steyn, du Toit et al. 1999). However, other studies reported different results. Fricke (Fricke 1991) found only slightly or no differences. Merchant, Kreie et al. (2001) investigated in their study a multimedia computer based training (CBT) which turned out to be less effective as compared to other instructional methods. Generalizable statements about e-learning tools compared to traditional learning styles seems to be difficult due to the variance in software tools and traditional learning styles (Draschoff 2000 and references herein).

Merchant, Kreie et al. (2001) stress the importance of further research into what factors might affect the success of computer mediated learning environments. Since the heterogeneity of software tools is high, this is a difficult task (Schulmeister 1996). Additionally, the efficiency of computer mediated learning tools depend on several factors, e.g. the topic of the software (Korfiatis, Papatheodorou et al. 1999) and the learning style (e.g. Smith and Woody 2000). Brünken and Leutner (2000) and Mayer (1997) give an overview about the different factors leading to individualized aptitude of the user.

The role of motivation

Spitzer (1996) claims that motivation is a central aspect in instruction. It seems to be obvious that high motivation will enhance attention and therefore learning success. This assumption does not have to be the case, because "good feelings" during learning sessions are not necessarily an indicator for learning effectiveness (Holzinger 2000).

Generally, users find the presentation of new media interesting and stimulating. This Hawthorne-effect has to be taken into account while evaluating e-learning software because it diminishes after a certain use of the software and might therefore lead the researchers to false conclusions during the initial phase of the evaluation (Schulmeister 1996). It do not seem to be reasonable to assume that multimedia motivates learners per se (Weidenmann 1997).

Whereas some researchers state that the analyses of motivational aspects is becoming an important task in research of multimedia based e-learning tools (Astleitner 2000, Leutner and Brünken 2000) others claim that the factor motivation is overestimated or may have even a negative impact on learning effectiveness due to a distraction effect (Kerres 2001 and references herein).

The role of navigation

The first attempts to use computers in education had only a simple navigation implemented. Their teaching path was mainly fixed and linear. Hypermedia is the most recent way of using computers in education and its main criterion is the possibility to navigate free among the teaching material. Hypermedia systems have the power to build a framework for a modern constructivistic e-learning environment. However, hypermedia systems may incorporate severe drawbacks:

- The freedom may cause students to lose touch with educational aims by the "serendipity-effect". This effect describes the phenomenon that users become distracted by non-relevant information while browsing through the hypermedia network (Holzinger 2000).
- Losing the educational aim may also be a result of the "lost in hyperspace" phenomenon which describes the problem of disorientation.
- Hypermedia may cause a cognitive overload if the learner has to deal on three different levels with the system (Kuhlen 1991):
  - information on the content level
  - navigation on the structural level
  - system functions on the system level (hard- and software)

Holzinger (2000) points out, that different mechanisms may be helpful in order to avoid the "lost in hyperspace" problem:

- classical navigational aids (table of contents, glossary, index)
- multimedia specific tools (e.g. site maps)
- bookmarks
- guided tours
- "fish-eye view"

Möller and Müller-Kalthoff (2000) showed that the integration of graphic navigational aids do not automatically lead to better understanding or improved memory achievement. Their results reveal an interaction effect of navigational aid and domain-specific prior knowledge because navigational aids promoted a stronger improvement for persons with low prior knowledge.

How to design and implement multimedia modules – the need for experiments and a cognitive multimedia theory

The value of a hypermedia learning environment depends, besides navigation properties, on the value of its single components which in turn depend on the content and its instructional presentation. This straightforward statement points out the requirement of answers about the following two questions:

- What is valuable content?
- What is a valuable instructional design?

The question about the value of the content cannot be answered in general. Content developers have to adopt the content for each e-learning tool separately as it has to match the necessities of the user in focus. Too simple content as well as too complicated information does not facilitate learning (see Holzinger 2000).

In order to evaluate the value of the instructional design experimental settings are necessary which investigate and compare the effectiveness of special aspects under controlled and constant circumstances. Two drawbacks have to be taken into account for evaluation studies (Schulmeister 1996):

- Artificial experimental settings might lead to artificial results which cannot be transferred into the real world
- The number of investigated variables in these studies has to be very restricted because otherwise statistical analyses become impossible since the number of test persons is a limited factor.

Schulmeister (1996) came to the conclusion that, due to the large amount of relevant variables, a serious experimental design cannot be done. However, even if it is problematic, experimental studies for the evaluation of the impact of important factors in e-learning software tools are necessary and seem to be possible if one concentrates on relevant variables which have to be selected on a theoretical basis (Draschoff 2000). A theory of multimedia learning provides researchers with suitable predictions. These hypotheses can be used as a guideline for asking the right questions and overcomes therefore the criticism of Schulmeister (1996).

Support for computer-based multimedia applications develops from cognitive theories. Especially the cognitive processing of pictorial information in acquiring knowledge is one of the major topics in the present discussion about learning with multimedia (Brünken, Steinbacher et al. 2001). Mayer and his colleages have established a cognitive theory of multimedia learning (e.g. Mayer and Sims 1994, Mayer 1997, Mayer and Moreno 1998, Mayer, Heiser et al. 2001) that seems to be able to serve as a guideline for the research of an enhancement in effectiveness in multimedia modules. Schnotz and his colleagues presented a similar model (Schnotz and Bannert 1999, Schnotz, Böckheler et al. 1999). Both models differ mainly in their assumptions about the internal processing in the human mind.

In practice, costs for production of multimedia components are important. Therefore, efficiency is of greater relevance than effectiveness because (unlike effectiveness) it takes into account the bear of costs (Kerres 1997). The additional expenditure for the creation of computer-animations in e-learning environments instead of still pictures has to be justified by a better learning outcome (Kerres 2001). Especially the development of high-quality three-dimensional computer-animations for their use in multimedia e-learning environments is doubted by Kerres.

The approach of the CRIMP-project

In order to evaluate the impact of e-learning tools, different questions have to be taken into account (Glowalla and Schoop 1992):

- What is the amount of knowledge acquired by the user?
- What time amount is acquired to elaborate the software?
- What learning style will be used?
- What is the opinion of the user about the e-learning tool?

We are addressing these issues in the CRIMP-project.

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CRIMP uses an experimental approach in order to unravel questions about the effectiveness and efficiency of learning in a hypermedia environment. Therefore experiments are carried out together with pupils, the target group of the used e-learning environment (see below). Until now, more than 50 pupils in Germany were involved in the project, a number that will be enlarged further on in Germany. Similar experiments are planned for the evaluation with Swedish pupils in the next year.

The role of navigation

One central topic of CRIMP is its focus on questions about the role of navigation, which will be evaluated by log-file analyses of experimentally modified versions of an existing hypermedia software. This software "The Cell 2: The Powerhouse" deals with a topic of cell-biology and is the winner of the "digita 2002", one of the most important prices for multimedia products in Germany.

- Since there are different opportunities to navigate through this hypermedia product log-file analyses document what kind of navigation will be really used during a session.
- Is the navigation dependent on computer literacy or learning style? Both factors will be evaluated by questionnaires before presenting the software.
- Does the "lost in hyperspace" (Conklin 1987, Tergan 1997) phenomenon occur and is it dependent on the prerequisites of the users, i.e. learning style and computer literacy?
- How efficiently is the hypermedia software used for a target oriented task? Is the hypermedia structure useful or will users be distracted by other, extraneous content?

The role of motivation

The question of motivation and arousal will be evaluated by the production of four different versions of a module of the hypermedia software "The Cell 2: The Powerhouse" thus leading to four slightly different versions of this hypermedia software. Whereas one version includes two three-dimensional models and a content page with a three-dimensional look, the other versions are gradually reduced in their complexity. The smallest version consists only of a two-dimensional content screen. However, the content in each four versions does not differ because it is presented by equal auditory speeches.

- Do additional three-dimensional animations or close-up views foster motivation and therefore learning output?

A short introduction instructed the pupils to look explicitly on this module. Afterwards, retention and transfer questionnaires check how many of the content has been incorporated. The test-persons are additionally able to state their impression of the module and the software in general.

The role of animations

The third theme of CRIMP deals with the design of animations and their effectiveness for learning. Therefore, another module of the hypermedia software was established in four different versions. The versions build a 2x2 factorial design with one factor being degree of reality (two-dimensional or three-dimensional) and the other factor being visual cueing elements (with or without). Since these versions are embedded into the complex hypermedia environment this experiment bridges the gap between studies focussing solely on single modules and the reality and complexity of modern e-learning tools.

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