Learning with multimedia and hypermedia: Promises and Pitfalls

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Learning with multimedia

Multimedia and hypermedia seems to be the learner's paradise: Important facts and complicated structures are understood at a glance. And everything can remembered easily with the help of sounds, animation, and videos. Visual knowledge maps and new forms of navigating the multimedia knowledge space allows incidentally learning about medieval lyrics, the principles of evolution, and the theory of relativity. Not to mention the cyberspace: You can visit archeological places, museums, opera houses, and the human metabolism without leaving your living room (e.g. Jonassen, Beissner & Yacci , 1993; Unsworth, 1996).

Multimedia has been defined in various ways. First, a technical definition: Multimedia is a combination of static and dynamic media in one interactive computer application. Looking at it from a more psychological point of view, multimedia could also be defined as a combination of information presented to different senses (like seeing, hearing, touching) that can be actively influenced by the user (Kozma, 1994). Despite the differences in the definition of the term "multimedia", most researchers would agree that it has had an enormous impact on various aspects of education.

Naive theories of multimedia learning

Most of these promises are based on the general assumption that the more stimulation and the more media is involved, the easier it is to learn. There is hardly a multimedia book or oral presentation that does not refer to charts or other visual aids, because "hearing & seeing" results in better retention rates as compared to "hearing alone". This theory assumes that there is a simple addition of effects of media upon learning (Hasebrook, 1995a). Many of these simple theories of multimedia refer to the famous book "Audio-visual Methods in Teaching" by Edgar Dale which was first published in 1946. Of course, Dale was thinking of musical records, motion pictures, etc, rather than multimedia applications when he was writing his book. He stated that "symbolic information", like words and graphics, are far from direct understanding. "Iconic information", like photographs, movies, or demonstrations, are much more intelligible. Finally, "direct information" derived from simulation, experiments, or goal-oriented experience are the best way to learn.

Nobody has ever tested retention rates for all possible combinations of media. Therefore, the relative importance of those media components for the learning process are uncertain. Furthermore, there are a number other problems related to it:

- What kind of retention is needed (e.g., recognition like in multiple-choice tests, cued recall like in fill-in-tests, or free recall like in interviews)? Only specific forms of learning correspond to certain forms of tests.

- What kind of cognitive resources are needed to understand the information? For example, music does not help very much to understand linear algebra, and colorful pictures are not appropriate to illustrate old Norwegian music.
- What "format" of information has to be displayed? For example, realistic photographs make it hard to understand human anatomy but colored drawings make it easy. The crucial factor is not how multi the media is, but how multimedia is used!

Effectiveness of multimedia

As of today, empirical research has not been able to support the enthusiastic visions of multimedia. In their most recent meta-analysis, Chen-Lin and James Kulik (1991) examined 248 research studies about computer-supported learning. 150 studies failed to show any significant effects. The other studies showed only a slight advantage of multimedia over textbooks or lectures: Error rates of simple retention tests were reduced between 5% to 15% (d=0.3), problem solving was hardly enhanced, and study time was reduced between 20% to 70%, with an average reduction of time about 30% (d=0.7). Considering all studies included into the meta-analysis, multimedia produced only a small effect (d<0.01; Hasebrook, 1995a).

Although, multimedia seems to save some time and reduce simple learning errors, it has not been found be very effective as a problem solving tool. Clark and Craig (1992) investigated several meta-analysis, including the analysis by Kulik and Kulik (1991; Kulik, Bangert-Downs & Williams, 1983; Kulik, Kulik & Cohen, 1980). Their findings also indicate that multimedia applications are not overly effective. Most of the positive effects derive from general organizational and instructional changes in the learning environment.

Fortunately, however, there are also some promising studies showing that multimedia could potentially to facilitate the learning processes. The Software Publishers Association (1995) reviewed the effect of instructional technologies in 133 school studies from 1990 to 1994. They stated that there were better test results, an increase in self-reliance, and a closer interaction between students and teachers. Similarly, Boettcher (1993) collected "101 success stories in higher education" in his book. Thus, multimedia can help people to enhance communication, motivation, and self-efficacy. This, however, does not necessarily lead to better learning rates but it could potentially facilitate the every-day life in schools and universities (Hasebrook, 1996).

Some shortcommings of multimedia studies

Why is it that multimedia shows only little learning effects? One big problem is related to the issues of what multimedia exactly is, how it is tested, and what it is compared to. Joliceur and Berger (1986), two researchers from a software corporation, tried to collect studies about the efficacy of commercial multimedia applications and defined three simple conditions: (1) The results should clearly derive from the application and not from a cluster of technical and organizational factors. (2) The learning effects should be measured by a reasonable kind of test. (3) The results should be compared to some kind of control group, such as reading a textbook or watching a movie. Despite the extensive research Joliceur and Berger (1996) conducted, they only found 47 studies meeting two conditions and only 2 studies meeting all three conditions.

Another problem with multimedia learning is that most programs are of poor quality, not more than colored textbooks with disturbing sounds and tiny videos. Multimedia educational technology software is often a glittery version of old technology. This is not a new phenomenon. Early educational software fell into the same trap. Developers depended on the attractiveness of the computer to make simple page-turning software more compelling. Computer-aided instructions often use the following paradigm: the learner gets some information and then is tested on his or her knowledge; if the learner fails, the process is repeated. Obviously this has three basic flaws: (1) The only motivation is to pass the test. (2) the learner is exposed to the content without an understanding of the context or the possibility to take different point of views. (3) The paradigm emphasizes the identification and retention of concepts, rather than their appropriate use (Hasebrook, 1995a+b).

Improving multimedia applications

How can the effectiveness of multimedia over any other form of learning be improved? There are three important factors: (1) Interactivity, (2) communication, and (3) individualization (or adaptability). Multimedia and hypermedia can elicit the motivation to learn about a subject like mathematics, natural sciences, or archeology. An enormous amount of information can be stored and accessed easily. Interactive systems can support the responsible use of electronic media and international communication, such as language learning when students from different countries communicate via e-mail or computer conferences. Computer applications can adapt to preferences, knowledge, and abilities of single students (Hasebrook, 1995b).

In a most recent study, we tested the influence of an adaptive testing facility and software video on recall of information and individual acceptance by means of a 2x2 factorial design. The testing facility enabled the participants to enter their vocational interests and to receive a list of suggested jobs and educational programs from an vocational multimedia encyclopedia (Hasebrook & Graßl, 1995). Additionally, all participants received the same list of jobs. The subjects were randomly assigned to the two video conditions: One group watched the video before reading further informations, the other group wachted the video after having read the informations. The study has two parts: During the learning phase the participants read informations about jobs and educational programs; during the testing phase, all participants completed the following surveys: (1) They rated the overall acceptance of the program, its functions, and its informations. (2) They completed a cued-recall task. Table 1 displays summarized scores from these surveys. The results confirm that video enhances acceptances ratings but does not influence recall. Recall is clearly enhanced, however, when studying individualized materials compared to general informations.

Table 1: Acceptance ratings (0=complete accepctance, 25=complete rejection) and cued recall (0=no recall; 25=complete recall) as a function of list of jobs to be learned (previously fixed list vs individually generated list) and video (displayed before vs after reading).

	Job/Education			
	Previously fixed		Individually generated	
Watching Video	Before	After	Before	After
Accecptance	10,3	9,5	9,5	8,6
Cued Recall	8,2	6,8	11,5	11,2

Combinations of off-line multimedia and on-line databases can provide up-to-date information while books tend to be out-dated as soon as they are printed. Hypermedia does not restrict the learner to fixed structures. Carefully designed animation, feedback facilities, and simulations can help teachers overcome the weaknesses of study materials and to focus more on the learning and communication processes. The universities and school of the future won't be filled with computers and isolated students in front of the machines. There will be an intensive interaction and communication between teachers, students, and other schools or universities from different countries. Computers and multimedia applications are important tools to support this development – but at least: technology solves technological problems, only (e.g. Hasebrook, 1994; Keil-Slawik, 1996).

Learning with Hypertext

Hypertext is considered to be very promising to support complex learning processes (Conklin, 1987). Picking (1994) observed users of a hypertext stack about Jazz music while solving different tasks: To get a brief overview users stick to the paging facilites and the subject index; to perform a goal directed search they rely on key words and indices; only if the users are free to get an impression of the system, they use hypertext links more frequently. Retterer (1991) tested whether the use of hypertext features leads to better understanding. He compared three conditions: The first group read a written text, the second group read the same text on a computer screen, the third group studied with a hypertext, which contained links between that parts of the text where names and cities are mentioned and that parts where they were explained. Retterer (1991) found that learning with hypertext leads to the best results. Crain (1994) compared lectures, video, and hypertext in a course about public relations. She found video to be the worst learning condition when tested immediately after having finished the course. She found no differences, however, four weeks later.

Many authors claim that hypertext studies convey different or contrary results, because study setting and user skills are not sufficiently regarded. Glowalla and Hasebrook (1995) conducted studies about the effect of user skills and study setting on the use of hypermedia courseware. 52 students participated in a hypermedia learning course, that consists of five consecutive lessons. All of them were novice hypermedia users. In the first lesson they are "unskilled learners", in the fith lesson they were "skilled learners". Four month later, 43 of these 52 students attended a relearning course. All students received exactly the same course materials and configuration of features of the hypermedia system as in the learning sessions. The students practiced different relearning strategies in the lessons 2 to 4. Therefore, in the first lesson they were skilled learners, but "unskilled relearners". In the fifth lesson, they were "skilled relearners".

Table 2: Percentage of users that use a particular tool as a function of study setting and user skills (Glowlla & Hasebrook, 1995).

	Study			
	ing*		ing*	
	unskilled	skilled	unskilled	skilled
Navigational tools				
Paging	100%	100%	10C	100%
Browsing	11%	9%	9	20%
Informational tools				
Contents	49%	38%	3C	42%
Glossary	49%	68%	2C	18%
Clipboard	9%	3%	2C	20%
Mean	44%	44%	36	40%

*: Percentage of users, who used a certain tool.

Table 2 displays how the navigational and informational tools of the hypermedia system were used as a function of the different learning and relearning conditions. Browsing tools were used most frequently by skilled relearners, informational tools were used more often during learning than during relearning. Many other studies have confirmed that hypertext enhances learning, only if the individual skills and – especially verbal – abilities match the demands of the learning task and the hypertext system (Reynolds & Danserau, 1990; Barba & Armstrong, 1992; Barba, 1993; Mayer & Anderson, 1992). In conclusion, it is neccessary to teach users strategies and concepts to use a hypertext. Additionally, it is neccessary to adapt the system to individual abilities and the overall learning environment (Schulmeister, 1996).

Learning with Hypermedia

The use of hypermedia is often recommended when a learning task requires selective and fast information access. In two experiments we compared complete relearning to selective relearning (Glowalla, Häfele, Hasebrook, Rinck & Fezzardi, 1992; Glowalla, Hasebrook, Häfele, Fezzardi & Rinck, 1992). All students took part in a hypermedia course about the psychology of human memory containing 300 screens (or cards) in five consecutive lessons. In a strict selective relearning strategy, students studied exactly those parts once again, which they were no longer aware of, whereas in the complete relearning task the hypermedia document was studied completly for a second time. The results show, that the amount of relearning was similar in both conditions (cf. figure 1). Our students preferred selective relearning, because it was easy to use and it saved them time. In a third experiment we compared selective relearning to user-controlled relearning with the hypermedia system. Again, the amount of relearning was similar, but user-controlled relearning took more time. However, it was much faster than complete relearning (cf. figure 1). Comparing the complete relearning strategy directly to relearning with hypermedia one would infer, that the hypermedia system is the most efficient method, although a simple selective relearning strategy is more efficient.

Clark & Craig (1992) reviewed several meta-analysis about the efficacy of multimedia supported learning. They draw the following conclusions: (1) Multiple media are not the factors that influence learning, (2) the measured learning gains are most likely due to instructional methods, (3) the aspects of picture superiority and dual coding have not been supported. There are only few empirical studies which evaluate the on-going use of hypermedia in higher education. One example is the report of Berg and Watt (1991) who compared hypermedia in competition to a classroom lecture, hypermedia supplementing a lecture and hypermedia replacing a lecture. They draw the conclusion (pp 119): "Objectively the academic performance of (hypermedia) users was not different from those attending classroom lectures... Although positive about (hypermedia) technology, they indicated that they would prefer to use it as supplement to lectures and books."

Conclusion

Psychological studies show that multimedia and hypermedia has potentials to enhance and facilitate learning and working. Most of the recent multimedia systems, however, show small positive effects or none at all. The effective use of multimedia is influenced by many internal and external factors, like motivation, knowledge, mode and contents of media, learning strategies, features of the task, etc. Of course, the way "efficacy" is defined has a strong impact on the multimedia design. An adventure game, for example, made completely transparent is boring, making business tools non-transparent may offend their proper use. Therefore, no simple criteria can guide the effective application of multimedia and hypermedia.

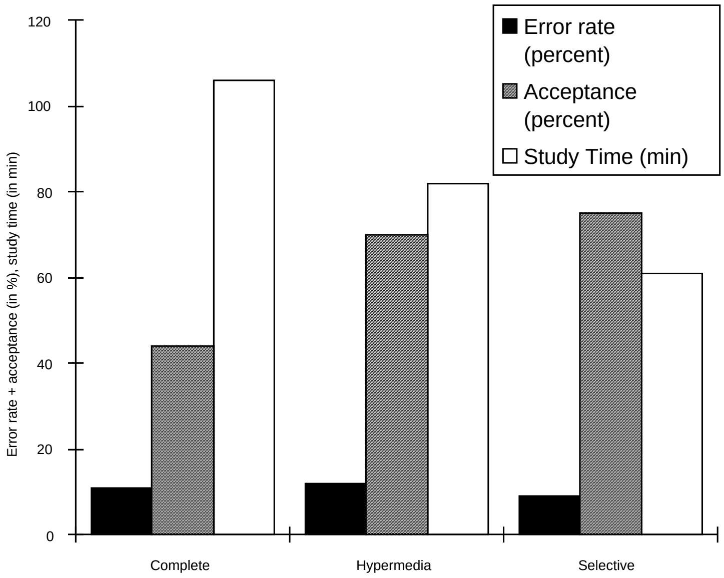

Figure 1: Error rates, studying times, and acceptance rates comparing complete, selective, and hypermedia learning.

Making multimedia applications effective means to start from the user's perspective: Mostly, this implies to conduct a study about needs and abilities of the users of your product. One may start to collect information by making a table of contents. Then start all over again. What visual scenery or what story does apply to your idea? Let the user interact with your system, and let the user guide the system - not vice versa. Be surprising without being unconventional. Don't bother to make your system "intelligent" but make any effort to support the in-born intelligence of the user. Multimedia and hypermedia applications should not be designed to provide "something for everyone", but it should provide exactly the type of information that is needed to enhance a particular learning situation.

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Talk to be held on:

Fifth European Congress of Psychology, Dublin (Invited symposium „Improving human resources learning and training inside telecommuterland“ by José M. Prieto, Spain).

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Dear colleagues:

The Preliminary Programme of the 5th European Congress of Psychology includes a symposium on "Improving Human Resources Learning and Training Inside Telecommuterland". This congress will be held in Dublin from July 6th to 11th 1997. I am just the convenor of this symposium.

You and 17 colleagues from all around the world contacted me during this summer. Now I proceed to come down to details.

This symposium in Dublin and other future symposia to be held in San Francisco 1998 (APA Convention and 24th ICAP) provide us with an opportunity to share our interests in Internet, in Hypertext, in online networking :

a) to improve the educational syllabus of psychology students;
b) to favor the continuous training process of graduates and practitioners in psychology in their respective fields of expertise;
c) to develop new tools and psychological approaches in the domain of adult learning as well as human resources training and development.

In the APA Convention in Toronto and in the IUPsyS Congress in Montreal, for instance, the formal identity of this new field was absent in the Scientific Program. It was however present through individual contributions to Poster Sessions or through demonstrations at the Exhibit Hall.

The main focus of this symposium is to understand the potential of information technologies, of digital technologies, of hypertext technologies, of Internet and Usenet as a whole, for the provision and support of learning environments offfering new possibilities for higher education and continuous training.

Theoretical and empirical contributions on the way people interact with these information sources, on the role of individual and group differences, on efficient or inadequate cognitive strategies, on linear versus nonlinear organization of learning, etc are welcome.

The deadline for the submission of abstracts is December 2nd 1996.
This symposium is already included in the program. I will be pleased to receive the title of your potential contribution if you would like to become involved.

I keep awaiting for your comments

Regards.
I do have some copies of the Final Annoucement. Copies will be forwarded also by request from the secretariat of this Congress that can be reached at psi@iol.ie

Learning with multimedia and hypermedia: Promises and Pitfalls

Tele-Learning and Banking: Connecting Internet and Intranet