The Human Factor in Multimedia

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Multimedia: The promises

With the help of multimedia, learning is like playing – all fun and leisure. This is what publishers promise selling their edutainment products. "Edutainment", the combination of education and entertainment, 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 learn 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).

All of these breath-taking wonders 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). But it is easy to realize that this cannot be the only truth. Consider, for example, a student who swears that he would study Latin best, when listening to the radio, watching TV, and reading a Latin dictionary. Certainly you won't believe him – so why believe the multimedia industry that any combinations of media lead to better retention?

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.

This model suggests the same recommendations which Johan Amos Komensky (Comenius, 1592-1670) made in his pioneering work about the use of educational media: "Orbis Sensualium Pictus" ("The visible world", 1658). He advised the teacher to present media with the adequate sense - that is, learning lessons about music by hearing, and learning lessons about art by seeing. The foundations of his pedagogy published in the book "Magna Didactica" ("The big didactics", 1657) influenced generations of teachers.

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!

Multimedia: The shortcommings

Multimedia applications shows only little learning effects - or none at all. 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

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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.

The myths of multimedia and hypermedia

Most of the multimedia and hypermedia systems are implemented by computer scientists and technical staff. Therefore, they focus on the technological side of the site and not so much on the psychological and pedagogical aspects. This may be the reason, why several multimedia and hypermedia myths managed to survive more than fifty years of psychological and pedagogical media research. I consider the start of this kind of research to be the publication date of Edgar Dales´ book "Audiovisual methods in teaching" in 1946. Here are the three most popular miss-understandings:

Myth 1: More media leads to a better understanding

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%, problem solving was hardly enhanced, and study time was reduced between 20% to 70%, with an average reduction of time about 30%. Considering all studies included into the meta-analysis, multimedia produced only a small effect (Hasebrook, 1995a). Although, multimedia seems to save some time and reduce simple learning errors, it has not been found to be very effective as a problem solving tool. Clark and 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 of texts and images have not been supported.
Fortunately, however, there are also some promising studies showing that multimedia could potentially 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. Many case studies support this general impression: For instance, the Bank Academy conducted a study comparing a digital TV broadcast with live interaction between students in four German cities and experts in the TV studio to classroom teaching. The learning groups supported by electronic media clearly outperformed classroom teaching (Hasebrook & Steffens, 1997). 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.

2.2 Myth 2: Hypertexts help to convey structural knowledge

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 facilities 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 (cf. figure 1).

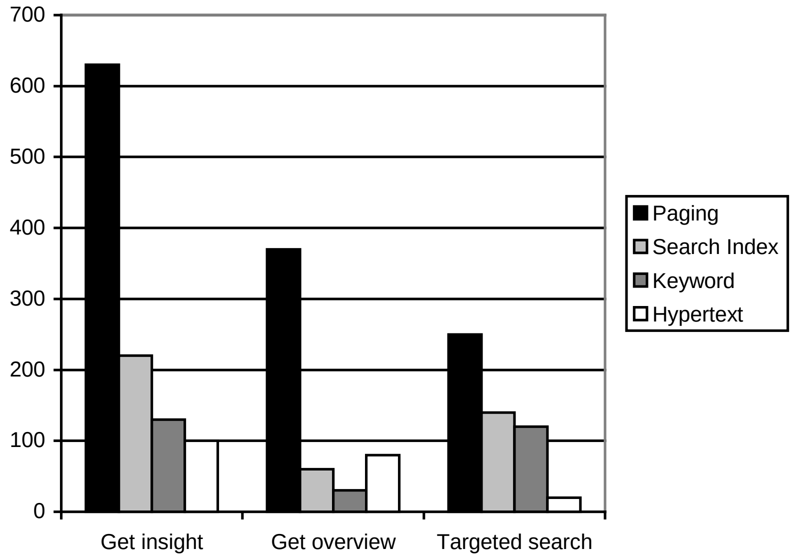

Figure 1: Frequencies of access of program tools of a hypertext system as a function of learning task (Picking, 1994).

Retterer (1991) tested whether the use of hypertext features leads to better understanding. He compared three conditions: The first group studied a written text, the second group red 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 fifth 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". Navigational tools, such as hypertext links and maps, were used most frequently by skilled relearners. Skilled learners preferred informational tools, such as a glossary and a table of contents.

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). Additionally, multimedia features, such as animations with audio, rely on the visual ability of the user: Visual literate persons profit from animations, illerate learners do not (Mayer & Sims, 1994). In conclusion, it is necessary to teach users strategies and concepts to use a hypertext. Additionally, it is necessary to adapt the system to individual abilities and the overall learning environment (Lajoie & Derry, 1993).

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."

2.3 Myth 3: Web is easy, print is tough

As web-based training refers to multimedia and hypertext, it is clear from what has been said before that appropriate learning results will not be achieved easily. Salomon (1984) showed that audio-visual media does not lead to better retention automatically: Children considered television to be easy and printed matter to be tough; therefore, they learned from television, only if they were instructed to prove how much they could learn

watching television. Therefore, it is important to activate and engage the learner into the knowledge building process.
The learner, who is not engaged, does not learn: This is the lesson that Jonassen (1993) learned when testing several hypertext indexes and maps. Although he provided well structured hypertext links, maps and tables, the users were not able to grasp the main concepts and to transfer them to related fields. Only one group was superior to all other groups: They had used a hypertext generation tool, called LearningTool, that allowed them to develop their own hypertext map.
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).

Therefore, learning is (almost) not faclitated by use of certain media or multimedia techniques. But multimedia can help the student to be self-motivated and become an active learner.
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). On-line databases can provide up-to-date information while books tend to be out-dated as soon as they are printed.
Homework assignments, such as ´Read the next 50 pages until Monday´, do not make a lot of sense anymore. Instead, students may be more motivated to measure the air pollution in their hometown to find out that it is higher in the center of the town than in the periphery. 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 learning places of the future won't be dim places filled with computers and isolated students in front of the machines. There will be an intensive interaction and communication between teachers, students, and other learning places from all over the world. Newly designed seminar rooms and lecture halls underline this development (Keil-Slawik & Selke, 1998; Hiltz & Benbunan-Fich, 1997).

Using multiple media

There is great number of studies which address specific effects of media like video, photography and audio. Levie and Lentz (1982) compared 55 studies in which texts with and without illustrations were examined. No study showed negative effects. Most studies indicated that there are positive effects on learning rates with an average increase of about 30%. Learning rates were increased, however, for the illustrated parts of the text only. Levin, Anglin and Carney (1987) summarised 187 studies in their meta-analysis. They found that analogies, mental images and mnemonic techniques can increase retention rates up to 50%. Once again, these results stand for the illustrated parts of the text, only. In addition, the texts must not be understood very easily without the help of pictures. Recent studies with electronic textbooks by Mayer and Anderson (1991, 1992), Drewniak (1993), and Rinck and Glowalla (1995) confirm the findings of the meta-analyses: illustrations could potentially facilitate learning but the actual effect is focused on the illustrated parts of the text, the effect very much depends on the content of the text and the picture, the user´s ability and his or her motivation to understand the picture.
Video has been considered to foster learning processes: (1) because dual encoding of pictures and texts are supported (Paivio, 1986; Mayer, 1989), (2) because video provides a vividness which illustrated texts often lack (Livingstone, 1990; Brosius & Mundorf, 1990). But Salomon (1984) showed that audio-visual media does not lead to better retention automatically. Children considered television to be ´easy´ and printed matter to be ´tough´; therefore, they learned from television, only if they were instructed to prove how much they could learn watching television. Furthermore, motion pictures enhance comprehension, if they match the explanatory texts; there is no positive effect, if the pictures elicit strong emotions – e.g. showing violence and illness; using video presentations mostly does not facilitate learning, but switching presentation modes and media does (Brosius & Kayer, 1991; Brosius & Mundorf, 1990). Plowman (1994) points out that digital video can be used to incorporate easy to use explanations and guidelines into multimedia applications. Dynamic media like video and animation are often used to explain and visualise technical equipment or to support science instruction (e.g. Mayer & Anderson, 1991, 1992; Rieber, 1990, 1991). In conclusion, video is not overly effective, but it can potentially enhance learning while visualising technical and abstract systems, and while supporting vividness and elaboration of information (Escalada, Grabhorn & Zollman, 1996).
Duchastel (1992, pg. 69) claims: ´Adaptation is the essence of what is known as pedagogical knowledge´. Many researchers aim to make their multimedia systems more adaptive – and therefore more ´pedagogical´ (e.g. Cox & Brna, 1995). Expert systems and Intelligent Tutoring Systems (ITS) adapt to the learner´s demands, abilities and knowledge – especially in subjects which can be described in formal logic (Bastien, 1992). There is an increasing number of adaptive computer programs which are equipped with media like videos and photographs. Although there are no clear cut borders between expert systems, ITS, and other adaptive multimedia systems, Clancey (1987) differentiates expert system from ITS by two distinct features: (1) the knowledge base of an ITS

tries to model human knowledge, an expert system does not, (2) expert systems are not equipped to support learning processes, because they do not explain their rule or knowledge bases and the inferences drawn from that bases. As of today, a diverse spectrum of techniques, approaches and philosophies impede the progress in intelligent learning environments (Self, 1992). There are promising results, however, supporting positive effects of intelligent learning environments teaching mathematics and programming (e.g. Weber, 1995; McGraw, 1994). In general, effects of adaptation and system-controlled tutoring have been small or medium sized, yet (e.g. Rosenberg, 1990; Kelley, 1988).

Evaluation of a decision support system

There are several psychological inventories dedicated to measure career development and vocational maturity. We evaluated our testing facility for its practical validity – that is, how are the system´s responses accepted by students and counselling experts. Forty three students participated in an experiment to investigate the understanding and acceptance of the information provided by the system.
We asked the students to rank four different job lists according to their judgement, whether the lists match their vocational interests or not. The students were told that the four lists were generated by four different computer programs. In fact, only one list was calculated by our computer system, three lists contained random selections: a short random list with six suggestions, a long random list with 20 suggestions, and a list with a random selection of 12 popular jobs. The results show that students are able to judge whether careers match their individual interests or not (cf. figure 2): They preferred individually calculated job lists compared to random lists ($F[3,122]=11.8$; $p<.001$). But they were not able to tell them apart from the list which consists of popular jobs which do *not* match their interests. Therefore, the students´ judgements rely on weak criteria (sometimes) leading them to wrong conclusions.

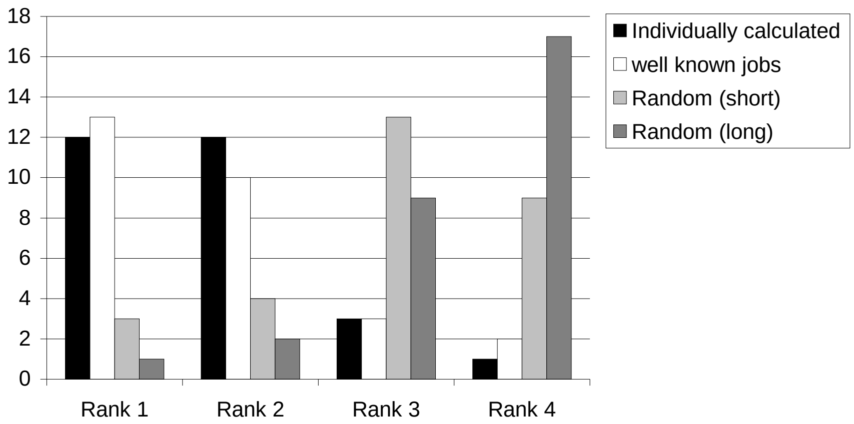

Figure 2. Students prefer individually calculated job lists – but they cannot tell them apart from well known, generally preferred jobs, which do *not* match their interests (n=29).

This assumption is confirmed by the data displayed in table 1. There is a positive correlation between the students´ judgements about (1) how well the suggested jobs match their interests, (2) how well they know the suggested jobs (based upon concrete information), (3) and how well they can imagine what typical professionals are doing. However, there is a negative correlation between all these variables and the actual state of information. The more information the students have got, the less they are willing to accept suggestions – and the less they have got a notion of knowing. Therefore, information leads to more scepticism and critics. And scepticism may help to guide the career decision making process more carefully.

Table 1

Correlation between questions concerning acceptance of the suggested jobs & information about jobs (n=43).

Content of question:	Match	Know	Imagine
Know	0,56		
Imagine	0,42	0,58	
Information	-0,49	-0,36	-0,34

More information makes students more critical and keen to get more information. This is the result of a study in which 156 high school students participated. The students filled in a survey about their actual state of information and their need for information. Figure 3 displays the main results. Those students who were not engaged in information seeking (14%) were not very likely to change their attitude; only 32% of this small group wanted to collect more information. On the contrary, nearly 100% of the best informed group (19%) liked to receive more information about their career options.

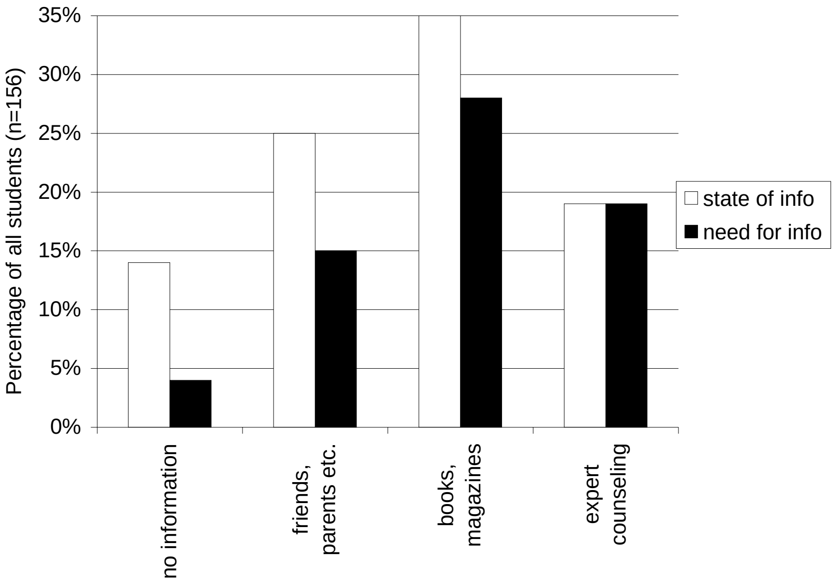

Figure 3. Students who gathered more information were keen to get even more: All of the best informed students (19%) wanted to receive more information. However, only 32% of the students, who are currently not engaged in information seeking (14%), plan to do so in the future (n=156).

Digital video and individual testing

In an additional experiment we tested the influence of the adaptive testing facility and digital video on recall and acceptance by means of a 2x2 factorial design. Seventy-five students participated in the study. The testing facility enabled the participants to enter their interests and to receive a list of suggested jobs and educational programs from the system. Additionally, all participants received a fixed list of jobs. The factor ´Job list´ was a within-subjects variable (individually generated list vs. fixed list). The factor ´Video´ was a between-subjects variable (watching video before learning vs. after learning). During the learning phase the participants read information about jobs and educational programs while during the testing phase, all participants completed three surveys: (1) they rated the overall acceptance of the program, it´s functions, and it´s information, (2) they completed a cued-recall task, (3) they filled in a survey about personal data, like age, school, and individual use of a personal computer.

In the learning phase the vocational multimedia encyclopaedia on CD-ROM was used to provide videos, photographs, statistical graphs and texts. The video lasted two minutes and displayed tasks, locations, and tools, which are typically used in the respective occupational field. This video was shown either before reading or after reading any text. Each particular career was introduced by three texts: (1) the first text described tasks, half of them were illustrated by a photograph depicting workers with adequate tools in a typical location, (2) the second text described the income wages in the course of the career illustrated by a bar chart, (3) the third text described prognostic data like unemployment rates, structure of age groups, and usability indices of educational programs on the job market. All rates and indices were illustrated by line drawings. It took the students about five minutes to read each text. All participants read descriptions of two careers resulting in a studying time of approximately 30 minutes. After having watched the video and having read the texts all students filled in the surveys. The third survey was not previously announced and contained a cued recall test consisting of six tasks: (1) remember the exact name of the first profession, (2) recall the exact name of the second profession, (3) remember the income of both professions and indicate whether it was more, less, or near the average income, (4) recall the unemployment rate of both professions and indicate whether it was a positive, negative or neutral indicator, (5) recall the structure of age groups of both professions and indicate whether it was interpreted as a positive, negative or neutral sign, (6) remember the usability index of both professions and indicate whether it was considered to be positive, negative, or neutral. It took the students about 30 minutes to complete the surveys. All in all, they needed 60 minutes to complete both the learning and the testing phase.

Mixed MANOVA were calculated with the between-subjects factor ´Video´ (displayed before reading vs. after reading) and the within-subjects factor ´Job List´ (individually generated vs. fixed). All MANOVA were performed on summarised scores of acceptance ratings (ranging from 1=rejection to 30=agreement) and recall scores (ranging from 0=no recall to 25=total recall). There was no measurable effect of the factor ´Video´ on acceptance ($F[1,73]=1.80$; n.s.). But there was a main effect of the factor ´Job List´ ($F[1,73]=8.38$; $p<.01$). Whether the students watched a digital video before or after learning, did not influence their performance in the cued recall test ($F[1,73]=.28$; n.s.). But the factor ´Job List´ clearly influences learning ($F[1,73]=13.86$; $p<.001$) resulting in higher recall scores, if individually generated information was provided. The MANOVA reveals no interactions between the both factors. We performed paired Wilcoxon tests for all acceptance ratings and recall scores in order to identify differences within these variables as a function of the experimental factors. Once again, information about income proved to be remembered better than the other information. These findings were independent of the experimental factors. Information about income and tasks were judged to be more interesting than the other information (all comparisons: $p<.05$ after alpha adjustment). Therefore we concluded, that the experimental manipulations ´Video´ and ´List of jobs´ did not influence single parameters but the whole set of variables. Figure 4 depicts summarised acceptance ratings and recall scores as a function of the independent variables.

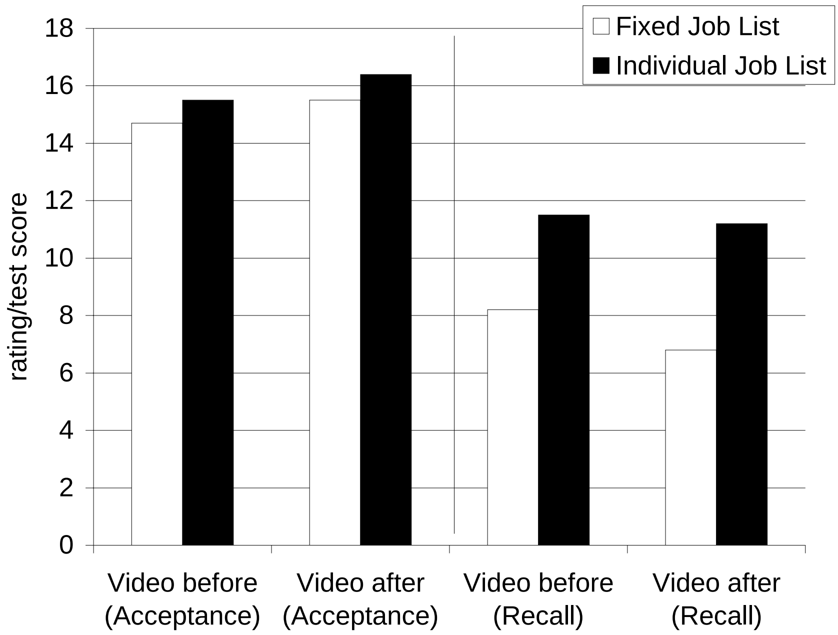

Figure 4. Acceptance ratings and cued recall as a function of list of jobs/educational programs (individually generated list vs. fixed list) and video (displayed before vs. after reading); acceptance scores range from 6 (rejection) to 30 (agreement); recall scores range from 0 (no recall) to 25 (complete recall).

From theory to practice: Tele-learning in bank training

The banking sector is leading in the development and adoption of electronically supported workplace training and is now moving towards distance education and integrated multimedia learning environments to cope with the scale of vocational training and communication requirements. As of today, many distance learning projects are realised by means of conventional media, such as printed matter and telephone hotline. There is a emerging consent that banks have to invest in and provide access to a complete range of training programmes for their employees from basic skills to high-end management and technical skills training. We consider electronic performance support systems (in the form of on-line media and self-directed learning environments) to be the only effective solution in terms of cost, time and logistics.

Integrating digital business-TV

Digital TV has not become very popular in Germany, yet. There are two Pay-TV channels with all in all 1,7 Million customers. Big media trusts, like the Bertelsmann group, partly withdraw from the market. Most recently, the Bertelsmann and the Kirch group signed a contract to co-operate and to support one standard for digital TV. Therefore, all companies providing digital TV are focusing on business TV with conditional access for closed user groups. Additionally, feedback channels are implemented using telephone and Internet access. A German broadcasting company provides a technique to connect Internet servers and TV set-top-boxes which will be used by the Bank Academy to facilitate co-operation and data transfer in educational programs of banks.
Bank Academy runs two Web sites (http://www.bankakademie.de and http://www.hfb.de) and hosts the European Network „VETNET“ (Vocational Educational Training Network of the European Educational Research Association, EERA: http://www.bankakademie.de/vetnet) and the Task Force Multimedia of the European Bank Training Network (EBTN: http://www.bankakademie.de/ebtn-tfm). All Web sites are implemented and maintained by Bank Academy.
Bank Academy has developed a series of CBTs and educational computer simulation games which has been used in bank training courses in Germany and abroad. Up to now, German, Polish, Slovakian, and Russian versions (English and French in preparation) of the simulation games have been developed. CBT programmes and simulation games are used in short-term bank training courses, in our Bank Specialist Diploma Course, and in vocational training courses, especially in eastern European countries.

A field study on digital TV

In January 1997 the BANKAKADEMIE and Pro 7 broadcasted a digital TV production, which was received by 43 students in Hamburg, Berlin, Frankfurt, and Munich. The TV production is part of the curriculum „Bankfachwirt (IHK)“ (bank specialist, exam credited and conducted by the Chambers of Industry and Commerce) and it was accompanied by news an newsgroups in the Internet (URL http://www.bankakademie.de).
Acceptance and performance in terms of factual, structural and behavioural knowledge was tested using surveys and interviews. The measurements were compared to control groups of 38 students from traditional learning environment, such as workshops and seminars. Main results of these comparisons were: Students preferred interactive digital TV, about 60% were ready to spent private funds for broadcasting equipment, and the participants of the TV course clearly outperformed the control groups in the tested knowledge domains ($F[1,60]=10,8$; $p<0,01$; cf. figure 5).

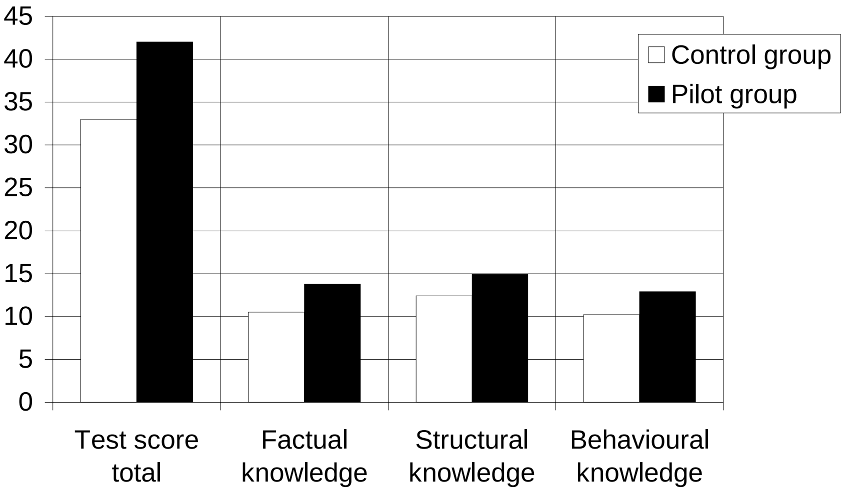

Figure 5. In a field study with 43 students watching a digital TV course and 36 control subjects attending traditional seminars learning results obtained by the TV course were much better than learning by traditional means.

Conclusions

Psychological studies show that multimedia has enormous 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.

Future research has to focus on the interaction of key aspects of learning. This implies that simple experimental settings which aim to study main effects, such as comparing two types of media, are not too promising. Furthermore, study settings have to cover a broad range of criteria reaching from basic brain research to practical needs in schools, universities and business. Relevant advances in networked multimedia computer environments will emerge, if recent results of basic research are applied explicitly and the evaluation criteria meet the demands of the practical use of computer environments (cf. Glowalla & Hasebrook, 1995).

I want to conclude with an example illustrating the kind of research we are focussing on. We are testing a complex learning environment based on Hyperwave technology (http://www.hyperwave.com) in a major German bank. We are examining the following factors:

(1) User engagement, e.g. self tests and surveys, learning tasks and instructions, such as learning for a test, solving a work problem.
(2) User interface for information selection and interpretation, e.g. linked hypertext, hypermedia maps and hypertecture.
(3) Information access and indexing, e.g. keyword index, catalog built by human expert and knowbots.
(4) Use of media, e.g. graphs and animations with and without explanations, which are provided as additional texts or audio files.

There will be four different groups of 80 users each working with different versions of the bank training system. We hope that the results of the study will give us a closer look on how human beings interact with different kinds of meaningful information displayed by different user interfaces embedded in different contexts.

We are sure that more than recent visions will come true: Computers won´t be like humans, but they will be partners in an on-going communication and learning process. Rules and systems for a real men-computers dialogue will emerge in the near future. This will not result in a simple extension of the antropomorphism that can be observed, if tools like hypermedia, virtual reality or AI-based dialogue system are used. Inter-connected computer systems will learn to support understanding in the human users, and they will bring meaning to electronic media.

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