Multimedia for vocational guidance: Effects of individualized testing, videos, and photography on acceptance and recall.

Joachim P. Hasebrook[1] & Markus Gremm[2]

[1]Bank Academy & University for Banking
[2]Medialog Corp.

Abstract

Multimedia could potentially facilitate learning processes: A great number of studies address specific effects of media like video and photography. It has been argued that (1) multiple media does not influence learning, (2) learning gains are due to instructional methods and (3) pictorial superiority has not been supported. Therefore, many researchers aim to make their multimedia systems more effective using ´intelligent´ software technologies to adapt to the learner´s demands, abilities and knowledge. 75 subjects participated in two concurrent experiments. We tested the influence of video, photography and individualized testing on acceptance and recall of information provided by a multimedia encyclopedia about professions and educational programs. Video has no measurable influence in both experiments. Photography supports recall of all facts related to the illustrated professions. Individually calculated career options enhance acceptance and facilitate recall of all facts related to the suggested jobs. In a field study with 75 students, we compared the individual validation of four media for vocational guidance, two multimedia applications and two products of printed matter. Data analyses reveal that the students enjoyed using electronic media, but they rely on printed matter.

Introduction

Despite promising pilot projects the practical use of multimedia in education is disappointing, quite frequently (e.g. Cummings, 1995). Van den Berg and Watt (1991, pg. 119) compared multimedia in competition to a classroom lecture, multimedia supplementing a lecture and multimedia replacing a lecture. They drew the conclusion: ´Objectively the academic performance of (multimedia) users was not different from those attending classroom lectures [...] Although, positive about (multimedia) technology, they indicated that they would prefer to use it as a supplement to lectures and books.´

Meta-analyses support statements like these. Kulik and 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 5% to 15% lower than before (Eta^2=.15), problem solving was hardly enhanced and study time was reduced from 100% to percentages ranging from 80% to 20%, with an average reduction of time to 70% (Eta^2=.35). Considering all studies included into the meta-analysis, multimedia produced only a small effect (Eta^2<.01; Hasebrook, 1995). Although, multimedia seems to save some time and reduce simple errors, it has not been found to be very effective as a problem solving tool. Clark and Craig (1992) investigated several meta-analysis, including the analyses by Kulik and Kulik (1991; Kulik, Bangert-Downs & Williams, 1983; Kulik, Kulik & Cohen, 1980). 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 (Paivio, 1986).

There are some promising studies, however, 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. It was stated that there were better test results, an increase in self-reliance and a closer interaction between students and teachers. Many other studies have confirmed that multimedia applications enhance learning, only if the individual skills and abilities match the demands of the learning task and the functionality of the multimedia system (e.g. Reynolds & Danserau, 1990; Barba & Armstrong, 1992; Barba, 1993; Mayer & Sims, 1994). Therefore, it is necessary to teach users strategies and concepts to use multimedia applications. Additionally, it is necessary to adapt the system to individual abilities and the overall learning environment (Schulmeister, 1996; Larkin & Chabay, 1992).

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 ascertained 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. Pictures used for decorative purposes did not show any positive effects. Special images like statistical graphs were hard to understand without additional instruction or training.

Levin, Anglin and Carney (1987) summarized 187 studies in their meta-analysis. They found that analogies, mental images and mnemo techniques can increase retention rates up to 50%. Once again, these results stand for the illustrated parts of the text, only. And: The texts must not be understood very easily without the help of pictures. Levin, Anglin and Carney (1987) did not find any positive effects of decorative or organizing pictures, either. 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 of 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; Rolandelli, 1989). 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. Further research came up with additional conditions to make audio-visual media more effective: 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 visualize technical equipment or to support science instruction (e.g. Mayer & Anderson, 1991, 1992; Rieber, 1990, 1991). Recent literature does not indicate whether video works best as an advance organizer or a review; both approaches have been used successfully and no significant differences have been found so far (Calvert, Huston & Wright, 1987; Rice, Huston & Wright, 1986). In conclusion, video is not overly effective, but it can potentially enhance learning while visualizing technical and abstract systems, and while supporting vividness and elaboration of information (Escalada, Grabhorn & Zollman, 1996).

Duchastel (1992, pg. 69) claims: ´Adaptation is 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) divides 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).

Many people feel a lack of competence in career decision making. For instance, more than 40% of the German students, who are about to leave school, focus on only ten profession, although the German dual vocational education system provides nearly 300 vocational education programs. Although knowledge based systems are well established tools, there are hardly any implementations of systems for vocational diagnosing and counseling (Ueckert, 1995). Psychological testing procedures including computer-supported diagnosis are used to conduct aptitude tests in personnel selection (e.g. Ghiselli, 1973; Sweetland & Keyer, 1984; Funke, 1993), to implement adaptive testing optimizing economy and performance of personality, aptitude, and ability tests (e.g. Cronbach & Gleser, 1965; Park & Tennyson, 1983; Bennett, 1993), and to perform decision analysis applied to management diagnostics (Nagel, 1993). There are numerous tests which check for individual interests (e.g. Todt, 1967; Irle & Allehoff, 1984), ability (ITB, 1988a+b), and aptitude (Fock & Engelbrecht, 1986). But there are hardly any computer-based, psychological testing procedures addressing vocational guidance. This does not mean, however, that there are no software products available: Counseling software guides list 200 programs, approximately, that are designed to support self assessment, job finding, and job keeping (Walz, Bleuer & Maze, 1989; Katz, 1993). About 100 titles incorporate surveys or self-testing facilities in order to provide the user with information about his or her career alternatives and prospects of career satisfaction.

Based upon these considerations we have developed an adaptive testing facility to support career decision making by matching interests and preferences with job characteristics. The results of the testing facility do not restrict the users´ problem space, but they focus on relevant information and help to work out the decision making processes – that is to use ´the computer as a tool for learning through reflection´, as Collins and Brown (1988) put it. Additionally, a vocational encyclopedia consisting of eight CD-ROM was produced to inform the user about relevant job characteristics like tasks, work load, income, and so on. Each CD-ROM applies to a certain occupational field like ´Economics and Law", ´Natural Sciences", and ´Construction and Mining´ (Hasebrook & Nathusius, 1997).

While interviewing 118 German experts for career counseling, we learned from the interviews that the experts use rules to guide the counseling process, but they do not rely on any detectable rules when matching career options and personal traits. Thus, we had difficulties to translate their expertise into simple If-then-rules. Our statistical analysis of the expert data revealed that only very few statistically significant factors are discriminating hundreds of career options. We aimed to take advantage of this fact and reviewed statistical methods to match multi-dimensional data sets. We developed a system which embedded the following components (Hasebrook & Nathusius, 1997):

An easy quiz or test about vocational interests and experiences.

Rating data and dimensions derived from a PCA (Principal Components Analysis; Stevens, 1992) of the expert ratings.

An algorithm based on a GLM (General Linear Model) to compare user and expert ratings.

A component to enter additional preferences and to modify the results of the GLM.
Finally, a report module generates an assorted list of suggested professions or careers.
Our testing facility is not designed to mimic the full range of an interpersonal counseling process. Rather, it shall provide the user with a variety of career opportunities which match his or her individual interests and preferences (Hasebrook & Gremm, 1996). The testing facility provides the user with up to 100 simple yes/no assessments. After having responded to 20 items the system signals to the user that it is ready to suggest jobs and educational programs. If the user accesses the list of suggested items he or she may retrieve appropriate entries of the encyclopedia. All occupational fields and many jobs are illustrated by videos and photos in order to elaborate the text and give a realistic impression of work life. Figure 1 displays a block diagram and a screen shot from the CD-ROM which has been used to conduct the experiments reported in this article.

_____

Insert FIGURE 1

_____

Pilot Study

High construct validity gives little support to career decision making and vocational guidance, because psychological constructions do not provide the user with any hints, what information is needed and how to elaborate on them (Seifert, 1994). Therefore, we evaluated our adaptive testing facility for its practical validity – that is, how are the system´s responses accepted by students and counseling experts. 43 students participated in an experiment to investigate the understanding and acceptance of the information provided by the testing facility. We asked the students to rank four different job lists according to their judgment, 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 consisted of random selection. The results show that students are able to judge whether careers match their individual interests or not. They preferred individually calculated job lists compared to random lists ($F[3,122]=11,8$; $p<.001$; $Eta^2=.23$). 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.
This assumption is confirmed by the data displayed in table 1. There is a positive correlation between the students´ judgments 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 skepticism and critics. And skepticism may help to guide the career decision making process more carefully.

_____

Insert TABLE 1

_____

Experiment 1: Photo and Video

Participants. Seventy-five male and female students from different secondary schools and high schools participated in this study. Ages ranged from 15 to 20 years (Mean =17). All students worked individually with the computer equipment. They were paid for their participation.
Design. We tested the influence of the multimedia components, like videos and photographs, on recall of information and individual acceptance by means of a 2x2 factorial design. The factor ´Video´ was a between-subjects variable (watching video before vs. after reading). The factor

´Photo´ was a within-subjects variable (text with illustration vs. without). The subjects were randomly assigned to the two video conditions. The factor ´Photo´ was counterbalanced by a Latin square procedure. The study had two parts: a learning phase and a testing phase. During the learning phase the participants read information about jobs and educational programs. 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.

Materials and Procedure. In the learning phase the CD-ROM ´Career Counselor: Construction and Mining´ (cf. fig. 1) was used to provide videos, photographs, statistical graphics and texts. The video lasted 2.5 minutes and displayed tasks, locations, and tools, which are typically used in the occupational field of mining. An explanatory text provides precise information about professions, tools and work places shown in the film. 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 – one illustrated by a photograph, one without photograph – resulting in a studying time of approximately 30 minutes.

After having watched the video and having read the texts all students filled in a survey about their age, school type and their access to and actual use of a Personal Computer. Thereafter, they received a survey to rate the overall acceptance of the CD-ROM, the texts, and the pictures. They needed 10 minutes to complete both surveys. Finally, they were given a third survey which was not previously announced. The survey was 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 20 minutes to complete the cued recall test. All in all, they needed 60 minutes to complete both the learning and the testing phase.

Results of Experiment 1

Mixed MANOVA were calculated with the between-subjects factor ´Video´ (displayed before reading vs. after reading) and the within-subjects factor ´Photo´ (text illustrated by a photograph vs. no illustration). All MANOVA were performed on summarized scores of acceptance ratings (ranging from 1=rejection to 30=agreement) and recall scores (ranging from 0=no recall to 25=total recall).

Acceptance ratings. The nominal data seem to support a slight advantage for the acceptance of information displayed after having watched a video. The results of the MANOVA, however, show that there are no measurable effects of the factor ´Video´ ($F[1,73]=1.27$; n.s.) and the factor ´Photo´ ($F[1,73]=.78$; n.s.) on individual acceptance ratings. The results are displayed in table 2.

Insert TABLE 2

Cued recall. The data of the cued recall test are summarized in table 3. The statistical analysis resulted in no effect of the factor ´Video´ (F[1,73]=.54; n.s.) and a strong main effect of the factor ´Photo´ (F[1,73]=17.07; p<.001), although the photograph illustrated only one out of three text portions. There was no significant interaction of the factors.

Insert TABLE 3

We performed paired Wilcoxon tests for the single values of the acceptance ratings and the recall tests in order to identify differences within these variables as a function of the factors of our design. The data about income proved to be remembered better than all other information, regardless of all experimental factors (all comparisons p<.05 after alpha adjustment). Corresponding to this result, information about income and tasks were judged to be more interesting than the other information. In conclusion, the experimental factors ´Video´ and ´Photo´ did not influence single parameters but the whole set of variables – but the data about income were considered to be the most important and interesting information (all comparisons p<.05 after alpha adjustment). Figure 2 displays the summarized scores for acceptance ratings and cued recall as a function of the factors ´Photo´ and ´Video´.

Insert FIGURE 2

Co-variates ´usage of PC´ and ´usability of video´. We introduced the individual usage of a Personal Computer as a covariate to the MANOVA (ranging from 0 = ´no experience´ to 5 = ´daily use > 30 min.´). Due to missing data and pairwise exclusion of cases the number of cases range from 69 and 75. We did not find significant influences on acceptance ratings (t[74]= -1.95; n.s.) and recall scores (t[74] =.19; n.s.). Additionally, we asked the students to judge the usability of the video about the occupational field (ranging from 1=rejection to 5=agreement) and used these judgments as co-variates to re-calculate the MANOVA. There was no significant influence on recall scores (t[68]=.83; n.s.). But there was a clear influence of usability judgments on acceptance ratings (t[68]=4.12; p<.01) – mainly resulting in a decrease of the main effect of the (non-significant) factor ´Video´ (F[1,65]=.07; n.s.).

Summary of Experiment 1

Video has no measurable influence on acceptance ratings and recall scores in this study. Photographs used to illustrate texts describing the typical tasks of a job or profession showed no significant influence on acceptance ratings. But they clearly support recall of all facts related to the illustrated job. Although the photographs were not directly linked with information about income and prognostication. The re-analyses using co-variates reveal no additional effects – except the correlation between direct judgments about the (non-significant factor) video and overall acceptance ratings. Therefore, we conclude that there is a local effect of photographs on awareness and information processing, but no global effect on motivational and emotional judgments.

Experiment 2: Individual information

Participants. The same seventy-five male and female students as in experiment 1 participated in this study. All students worked individually with the computer equipment.

Design. In this experiment we tested the influence of an adaptive testing facility and digital video on recall and acceptance by means of a 2x2 factorial design. The testing facility enabled

the participants to enter their interests and to receive a list of suggested jobs and educational programs from the system (cf. fig. 1). 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). The factor ´Photo´ could not be manipulated systematically, because only one third of the encyclopedia entries are linked to job descriptions containing photos and two thirds are not, but all entries could potentially be accessed from the individually generated lists. The subjects were randomly assigned to the two video conditions. The factor ´Job List´ was counterbalanced by a Latin square procedure. During the learning phase the participants read information about jobs and educational programs; during the testing phase, all participants completed two surveys: (1) They rated the overall acceptance of the program, it´s functions and it´s information. (2) They completed a cued-recall task.

Materials and Procedure. We used the same materials and procedures as in experiment 1. Half of the participants started with the procedure described in experiment 1, the other half began with the procedure of experiment 2. All participants passed both experimental procedures. The survey asking for age, school type etc. was omitted, because it has been filled in already, thus reducing the time spent with experiment 2 to approximately 55 minutes.

Results of Experiment 2

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 summarized scores of acceptance ratings (ranging from 1=rejection to 30=agreement) and recall scores (ranging from 0=no recall to 25=total recall).

Acceptance ratings. As in experiment 1 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´ ($F[1,73]=8.38$; $p<.01$). Table 4 displays all acceptance ratings as a function of both independent variables.

Insert TABLE 4

Cued recall. 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. Table 5 summarizes the recall scores as a function of the factors ´Video´ and ´Job List´.

Insert TABLE 5

As in experiment 1, 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). The conclusion is the same as in experiment 1: The experimental manipulations ´Video´ and ´List of jobs´ did not influence single parameters but the whole set of variables. Figure 3 depicts summarized acceptance ratings and recall scores as a function of the independent variables.

Co-variates ´usage of PC´, ´usability of video, and ´usability of job list´. As in experiment 1, we introduced usage of a Personal Computer as a covariate to the MANOVA. Due to missing data and pairwise exclusion of cases the number of subjects ranges from 62 and 75. We did not find significant influences of the variable on acceptance ratings ($t[64]=1.83$; n.s.) and recall scores ($t[64]=-.12$; n.s.). The usability of the video about the occupational field was used as a covariate to re-calculate the MANOVA, too. There was no significant influence on recall scores ($t[65]=-1.59$; n.s.), but a clear influence of usability judgments on acceptance ratings ($t[65]=3.57$; $p<.01$) resulting in a decrease of the main effect of the (non-significant) factor ´Video´ ($F[1,65]=.02$; n.s.). In the first survey of experiment 2 all participants judged the usability of the career options – or jobs – suggested by the testing facility. The scores ranged from 1 (rejection) to 5 (acceptance). We used these judgments as another covariate in the MANOVA procedures. There was no influence of the usability of the testing facility on recall. But we found a significant influence on acceptance ratings ($t[61]=2.78$; $p<.01$) resulting in an increase of the main effect ´Job List´ ($F[1,63]=9.35$; $p<.01$).

_____

Insert FIGURE 3

_____

Summary of Experiment 2

Video has no measurable influence on acceptance ratings and recall scores in both experiments. Individually calculated career options clearly enhance acceptance and support the recall of all facts related to the suggested professions. The re-analyses using co-variates reveal no additional effects of usage of a Personal Computer and usability of the video. Taking into consideration the participants´ judgments about the usability of the testing facility the influence of individual generated information on acceptance is clearly supported. Our conclusion is, that there is a global effect of individually generated information on acceptance, motivation and information processing.

Field study: Comparing electronic and printed media

Electronic media for vocational guidance combine various advantages: access to huge amount of data, up-to-date information, and guidance provided by surveys or quizzes. This does not necessarily mean that students enjoy working with electronic media for providing vocational orientation. Therefore, we compared four media for vocational guidance in a recent study (Hasebrook & Wagner, 1998): two of them are multimedia applications and the other two products are printed matter. The multimedia application were (1) a fully interactive point-of-information (POI) with fancy graphics, animation and sound and (2) a more restricted computer-based training (CBT) containing guided tours, texts and digital video. The printed material was (3) a quiz with a graphical layout based on 26 exercises (Quiz) and (4) a comprehensive survey consisting of more than 100 yes/no items (Survey) which was responded to by an individually generated letter.

We measured individual acceptance ratings after having used the four different products with 75 students participating in this study (between 15 and 18 years, Mean = 16). The results show that printed matter are preferred. This result is statistically independent of sex, education, and experience in using a computer. Thus, the students enjoyed using electronic media, but they rely on printed matter. Table 6 summarizes the mean acceptance and validation scores of the four compared products.

_____

Insert TABLE 6

_____

The scores were compared by means of paired Wilcoxon tests; all reported results are significant at least on a level of $p<.05$ after having corrected the alpha error for repeated testing. The results show that the subjects of our study considered the printed survey to be more usable than electronic media (POI: z=4.5; CBT: z=4.8), they liked it (POI: z=3.9; CBT: z=3.5), they preferred to work with the survey (POI: z=3.4; CBT: z=3.4) and they recommended to buy it (POI: z=4.4; CBT: z=4.6). The printed quiz was judged to be useful, but it was not rated as good as the survey: The students liked the quiz better than the POI program (z=3.7) and recommended it (z=3.7). The pairwise comparisons show that printed media score better than electronic media. In general, the participants of our study rated the survey to be the most valuable and the POI application to be the least valuable product.

Summary of Field Study

Teenagers are considered to have a general preference for electronic media. This study, however, shows that they are ´critical´ users of computer-based programs: They enjoy watching videos and photos but they rely on comprehensive printed material which gives them the opportunity to discuss their career options with their parents and friends. It is important to note that we found the clear differences of the acceptance ratings of the four products only in the final judgment: When asked for a rating directly after having worked with the respective product, the students rated all products to be „medium“ or „good“ (mean 2.3). Thus, subjects need clearly defined alternatives in order to come up with reasonable acceptance ratings.

General Discussion

It is possible that we were not able to catch subtle changes in acceptance using simple rating procedures. Therefore, we performed interviews with 15 individuals who had participated in both experiments: The students enjoyed watching the digital video, but they considered it not to be very useful in giving them an impression of work life: The average usability rating of the video was 2.1 (with 1=no usability and 5=high usability). Our data supports other research about audio-visual media which reports only weak effects on learning, if the video is not precisely linked to particular pieces of information (e.g. Livingstone, 1990; Escalada, Grabhorn & Zollman, 1996). Video may provide advantages as an educational medium, if used as an advances organizer. But acceptance and recall clearly depends on the individual usability ratings of the video.

We were somewhat surprised to find a positive influence of photographs on the recall of all information related to a career, although only one part was illustrated by a photograph. Furthermore, we did not find significant effects of videos and photographs on acceptance, nor any interactions of the experimental factors. Comparing our research findings to other findings reported in the literature we would recommend to use more ´simple and cheap media´ like photographs which are definitely connected with particular pieces of information provided in the multimedia system (e.g. Levie, Carney & Anglin, 1987; Mayer & Anderson, 1991, 1992).

Individually generated information clearly supported both acceptance and recall of vocational information. The effects were enhanced, if individual differences in usability ratings were taken into consideration. Our findings match other research results indicating that individually adapted information enhance motivational and learning processes within computer-supported learning environments (Bastien, 1992; Weber, 1995; Cox & Brna, 1995). The weak effects of audio-visual media, the strong emphasis on a close connection of pictorial and verbal information and the strong effects of individual relevant information were independent of subject variables like computer experience and usability judgments – although the students generally show great interest in data about income.

These findings can be seen in correspondence to the use of computer media by young adults: Young people tend to favor information with a high personal relevance and entertaining values (cf. Hasebrook & Wagner, 1997). The distribution of access to and actual use of computers in

our sample suggests that it can be generalized for young Germans, at least: Our results match the data derived from other German studies: 14% used a computer more than 30 minutes a week, 21% worked with a computer daily, 53% once a week, and 12% never used a computer – similar distribution has been found in other studies (e.g. Hoelscher, 1994; Lukesch, 1989).

Future research should focus on the interaction of individually generated information and well designed packages of visual and verbal media. The interaction of dynamic media like videos and static media like photographs has to be examined more carefully in terms of internal and external resources spent to produce and to use them. Furthermore, the complex interactions of individual judgments about relevance and usability of information with acceptance and performance measures in testing and multimedia environments provide a rich research field which stands at its beginnings, yet.

We would like to suggest a model for the integration of the empirical findings reported in the literature and found in our experiments: Initially, Multimedia information is encoded in simple text and image bases; using more sophisticated elaborating and inferencing processes mental and situational models can be generated based on the information in the text and image bases (Hasebrook, 1998). Information selection and encoding from short term memory leads to separated encoding of verbal and pictorial information in the long term memory (Baddely, 1990; Paivio, 1986). There is a tendency to understand pictures „at a glance“ resulting in a simple representation that is not linked to verbal information (Weidenmann, 1988, 1994). Deeper processing of images can be elicited by teaching appropriate learning techniques (Drewniak, 1992) and obvious links between pictures and verbal explanations. These higher levels of processing can help to generate appropriate static and dynamic mental models (Hegarty, 1992; Johnson-Laird, 1983).

Many authors suggest that deeper understanding means that sequential verbal information is highly interconnected with analog pictorial information (e.g. Mayer & Anderson, 1991, 1992). Supporting understanding, then, demands the construction of semantically connected pieces of text and pictures, activating appropriate pre-knowledge, providing learning strategies for multimedia, and changes of media and learning perspectives to support the construction of comprehensive mental models (Albrecht & O´Brian, 1993). Research like our experiments and others (e.g. Mayer & Sims, 1994) support the consideration of individual differences in abilities and interests in order to enhance the understanding processes.

References

Albrecht, J.E., & O`Brien, E. (1993). Updating a mental model: Maintaining both local and global coherence. Journal of Experimental Psychology: Learning, Memory & Cognition, 19, 1061-1070.

Baddeley, A.D. (1990). Human memory. Theory and practice. Hillsdale, NJ: Lawrence Erlbaum.

Barba, R.H. (1993). The effects of embedding an instructional map in hypermedia courseware. *Journal of Research on Computing in Education, 4(25)*, 405-412.

Barba, R.H., & Armstrong, B.E. (1992). The effect of HyperCard and interactive video on earth and space science students´ achievements. *Journal of Educational Multimedia and Hypermedia, 1*, 323-330.

Bastien, C. (1992). Ergonomics for hypermedia software. In A. Oliviera (Ed.), *Hypermedia courseware: Structures of communication and intelligent help* (pp 183-187). Heidelberg: Springer.

Bennett, R.E. (1993). Toward intelligent assessment: An integration of constructed-response testing, artificial intelligence, and model-based measurement. In N. Frederiksen, R.J. Mislevy and I.I. Bejar (Eds.), *Test theory for an new generation of tests* (pp 99-123). Hillsdale, NJ: Erlbaum.

Brosius, H.B., & Kayer, S. (1991). Der Einfluß von emotionalen Darstellungen im Fernsehen auf Informationsaufnahme und Urteilsbildung. *Medienpsychologie, 3*, 236-253.

Brosius, H.B., & Mundorf, N. (1990). Eins und eins ist ungleich zwei: Differentielle Aufmerksamkeit, Lebhaftigkit von Information und Medienwirkung. *Publizistik, 35*, 398-407.

Calvert, S.L., Huston, A.C., & Wright, J.C. (1987). Effects of television preplay formats on children´s attention and story comprehension. Journal of Applied Developmental Psychology, 8, 329-342.

Clancey, W.J. (1987). Methodology for building an intelligent tutoring system. In G.P. Kearsley (Ed.), *Artificial intelligence and instruction* (pp 193-227). Reading, MA: Addison-Wesley.

Clark, R.E., & Craig, T.G. (1992). Research and theory on multi-media learning effects. In M. Giardina (Ed.), *Interactive multimedia learning environments. Human factors and technical considerations on design issues* (pp. 19-30). Heidelberg: Springer.

Collins, A., & Brown, J.S. (1988). The computer as a tool for learning through reflection. In H. Mandl & A. Lesgold (Eds.), *Learning issues for intelligent tutoring systems* (pp. 1-18). Heidelberg: Springer.

Cox, R., & Brna, P. (1995). Supporting the use of external representations in problem solving: The need for flexible learning environments. *Journal of Artificial Intelligence in Education, 6(2/3)*, 239-302.

Cronbach, L.J., & Gleser, G.C: (1965). *Psychological tests and personnel decisions* (2nd ed.). Urbana: University of Illinois Press.

Cummings, L.E. (1995). Educational technology – a faculty resistance view. *Educational Technology Review, 4*, 13-18.

Deidesheimer Kreis (1993). *Feststellung der Studieneignung im Rahmen der Hochschulzulassung. Studienfeldbezogene Verfahren zur Feststellung der Studiereignung bei Hochschulzulassungsentscheidungen in Numerus-clausus- und anderen Studienfächern*. Bericht für das Bundesministerium für Bildung und Wissenschaft, Bonn.

Drewniak, U. (1992). *Lernen mit Bildern in Texten. Untersuchung zur Optimierung des Lernerfolgs bei Benutzung computerpräsentierter Texte und Bilder*. Münster: Waxmann.

Duchastel (1992). Towards methodologies for building knowledge-based instructional systems. *Instructional Science, 20(5/6)*, 349-358.

Escalada, L.T., Grabhorn, R., & Zollman. D.A. (1996). Applications of interactive digital video in a physics classroom. *Journal of Educational Multimedia and Hypermedia, 5(1)*, 73-97.

Fock, M. & Engelbrecht, G. (1986). *MOT, Ergebnisse der Validierungsuntersuchungen und der Vorarbeiten für die Entwicklung eines studienfachbezogenen Auswertungsverfahrens*. Nürnberg: Bundesanstalt für Arbeit (Psychologischer Dienst).

Funke, U. (1993). Computerunterstützte Eignungsdiagnostik mit komplexen dynamischen Szenarios. *Zeitschrift für Arbeits- und Organisationspsychologie, 37(3)*, 109-118.

Ghiselli, E.E. (1973). The validity of aptitude test in personnel selection. *Personnel Psychology, 26*, 461-477.

Hasebrook, J. (1995). Lernen mit Multimedia (Learning with multimedia). *German Journal of Educational Psychology, 9(2)*, 95-103.

Hasebrook, J, (1998). Einsicht statt Aufsicht. Zuschauen beim Lernen und Lehren. In B. Strauß (ed.), Zuschauer (pp. 57-92). Göttingen: Hogrefe.

Hasebrook, J., & Nathusius, W. (1997). An expert advisor for vocational guidance. Journal of Artificial Intelligence in Education. 8(1), 21-41.

Hasebrook, J., & Gremm, M. (1996). Berufliche Interessen bei Jugendlichen (Vocational interests in young adults). *German Journal of Educational Psychology, 10(2)*, 85-97.

Hasebrook, J., & Wagner, J. (1997). Subjektive Bewertung von gedruckten und elektronischen Medien zur Berufsorientierung. Medienpsychologie, 9(2), 89-104.

Hegarty, M. (1992). Mental animation: Inferring motion from static displays of mechanical systems. Journal of Experimental Psychology: Learning, Memory, and Cognition, 18(3), 1084-1102.

Hoelscher, G.R. (1994). *Kind und Computer. Spielen und Lernen am PC*. Heidelberg: Springer.

Institut für Test- und Begabungsforschung (Eds.) (1988a). *Test für medizinische Studiengänge* (2nd ed.). Göttingen: Hogrefe.

Institut für Test- und Begabungsforschung (Ed.) (1988b). *Der neue TMS. Originalversion des Tests für medizinische Studiengänge im besonderen Auswahlverfahren* (2nd ed.). Göttingen: Hogrefe.
Irle, M., & Allehoff, W. (1984). *Berufs-Interessen-Test II (B-I-T II)*. Göttingen: Hogrefe.
Jöreskog, K.G., & Sörbom, D. (1989). *LISREL 7: User´s reference guide*. Chicago, IL: Scientific Software International.
Johnson-Laird, P.N. (1983). Mental models. Cambridge: Cambridge University Press.
Katz, M.R. (1993). *Computer-assisted career decision making.* Hillsdale, NJ: Erlbaum.
Kelley, J. (1988). Limits of intelligent tutoring systems. *International Journal of Educational Research, 12(8),* 863-873
Kerka, S. (1987). *Adult career counseling: An interactive model. Overview.* ERIC Digest No. 65 (access number ED289996).
Kulik, C.-L., & Kulik, J.A. (1991). Effectiveness of computer-based instruction: An updated analysis. *Computers in Human Behavior, 7*, 75-94.
Kulik, J.A., Bangert-Downs, R.L., & Williams, G.W. (1983). Effects of computer-based teaching on secondary school students. *Journal of Educational Psychology, 75*, 19-26.
Kulik, C.-L., Kulik, J.A., & Cohen, P. (1980). Effectiveness of computer-based college teaching: A meta-analysis of findings. *Review of Educational Research, 50*, 252-544.
Levie, H.W., & Lentz, R. (1982). Effects of text illustration: A review of research. *Educational Communication and Technology Journal, 30*, 195-232.
Larkin, J.H., & Chabay, R.W. (Eds.) (1992). *Computer assisted instruction and intelligent tutoring systems: Shared goals and complementary approaches.* Hillsdale, NJ: Erlbaum.
Levin, J.R., Anglin, G.J., & Carney, R.N. (1987). On empirically validating functions of pictures in prose. In D.M. Willows & H.A. Houghton (Eds.), *The psychology of illustration: Vol. 1 basic research* (pp. 51-85). New York: Springer.
Livingstone, S. (1990). *Making sense of television. The psychology of audience interpretation.* Oxford: Pergamon Press.
Lukesch, H, (1989). Video im Alltag der Jugend: Quantitative und qualitative Aspekte des Videokonsums, des Videospielens und der Nutzung anderer Medien bei Kindern, Jugendlichen und Erwachsenen. Regensburg: Roderer.
Mayer, R.E. (1989). Models for understanding. *Review of Educational Research, 59(1),* 43-64.
Mayer, R.E. (1992). Cognition and Instruction: Their historic meeting within educational psychology. *Journal of Educational Psychology, 84(4),* 405-412.
Mayer, R.E., & Anderson, R.B (1991). Animations need narrations: An experimental test of a dual-coding hypothesis. *Journal of Educational Psychology, 83(4),* 484-490.
Mayer, R.E., & Anderson, R.B. (1992). The instructive animation: Helping students build connections between words and pictures in multimedia learning. *Journal of Educational Psychology, 84(4),* 444-452.
Mayer, R.E., & Gallini, J.K. (1990). When is an illustration worth ten thousands words? *Journal of Educational Psychology, 82(4),* 715-726.
Mayer, R.E., & Sims, V.K. (1994). For whom is a picture worth a thousand words? Extensions of a dual-coding theory of multimedia. *Journal of Educational Psychology, 86(3),* 389-401.
McGraw, K.L. (1994). Performance support systems: Integrating AI, hypermedia, and CBT to enhance user performance. *Journal of Artificial Intelligence in Education, 5(1),* 3-26.
Nagel, S. (Ed.) (1993). *Computer-aided decision analysis: Theory and application*. Westport, CT: Greenwood.
Paivio, A. (1986). *Mental representations: A dual-coding approach*. New York, Oxford: Oxford University Press.
Park, O., & Tennyson, R.D: (1983). Computer-based instructional systems for adaptive education: A review. *Contemporary Education, 2*, 121-135.
Plowman, L. (1994). The ´primitive mode of representation´ and the evolution of interactive multimedia. *Journal of Educational Multimedia and Hypermedia, 3(4),* 275-293.
Reynolds, S.B., & Dansereau, D.F. (1990). The knowledge hypermap: An alternative to hypertext. *Computers & Education, 14*, 409-416.
Rice, M.L., Huston, A.C., & Wirgt, J.C. (1986). Replay as repetitions: Young children´s interpretation of television forms. Journal of Applied Developmental Psychology, 7, 61-76.
Rieber, L.P. (1990). Using computer animated graphics in science instruction with children. *Journal of Educational Psychology, 82(1),* 135-140.
Rieber, L.P. (1991). Animation, incidental learning, and continuing motivation. *Journal of Educational Psychology, 83(3),* 318-328.
Rinck, M., & Glowalla, U. (1995). Was nützt Multimedia? Eine empirische Effektivitätsprüfung bei der Darstellung quantitativer Daten. In E. Schoop, R. Witt & U. Glowalla (Eds.), *Hypermedia in der Aus- und Weiterbildung. Dresdner Symposium zum computerunterstützten Lernen* (pp. 107-117). Konstanz: Universitätsverlag Konstanz.
Rollandelli, D. (1989). Children and television: the visual superiority effect reconsidered. Journal of Broadcasting and Electronic Media, 33, 69-81.
Rosenberg, R. (1990). A critical analysis of research on intelligent tutoring systems. In The Education Technology Anthology Series: *Expert systems and intelligent computer-assisted instruction* (pp 184-190). Englewood Cliffs, NJ: Educational Technology Publications.

Salomon, G. (1984). Television is ´easy´ and print is ´tough´: The differential investment of mental effort in learning as a function of perceptions and attribution. *Journal of Educational Psychology, 76*, 647-658.
Schulmeister, R. (1996). *Grundlagen hypermedialer Lernsysteme. Theorie, Didaktik, Design*. Bonn: Addison-Wesley.
Seifert, K.H. (1994). Improving prediction of career adjustment with measures of career development. *The Career Development Quarterly, 42*, 353-366.
Self, J. (1992). Unrevealing the learner model mystery. In F.L. Engel & D.G. Bouwhuis (Eds.), *Cognitive modeling and interactive environments in language learning* (pp 17-25). Heidelberg: Springer.
Software Publishers Association (1995). *Report on the effectiveness of technology in schools, 1990-1994*. Washington, DC: SPA.
Stevens, J. (1992). Applied Multivariate Statistics for the Social Sciences. Hillsdale, NJ: Erlbaum.
Sweetland, R.C., & Keyer, D.J. (1984). Test – a city. Kansas City: Test Cooperation of America.
Todt, E. (1967). *Differentieller Interessentest (DIT)*. Bern: Huber.
Ueckert, H. (1995). Expertensysteme. In W. Sarges, (Ed.), *Management-Diagnostik* (2nd ed., pp. 789-796). Göttingen: Hogrefe.
Van den Berg, S., & Watt, J.H. (1991). Effects of educational setting on student responses to structured hypertext. *Journal of Computer-Based Instruction, 4(18)*, 118-124.
Walz, B.R., Bleuer, J.C., & Maze, M. (1989). *Counseling Software Guide*. Alexandria, VI: AACD.
Weber, G. (1995). Individual selection of examples in an intelligent learning environment. *Journal of Artificial Intelligence in Education, 7(1)*, 3-31.
Weidenmann, B. (1988). Psychische Prozesse beim Verstehen von Bildern. Bern: Hans Huber.
Weidenmann, B. (1994). Wissenserwerb mit Bildern. Bern: Hans Huber.

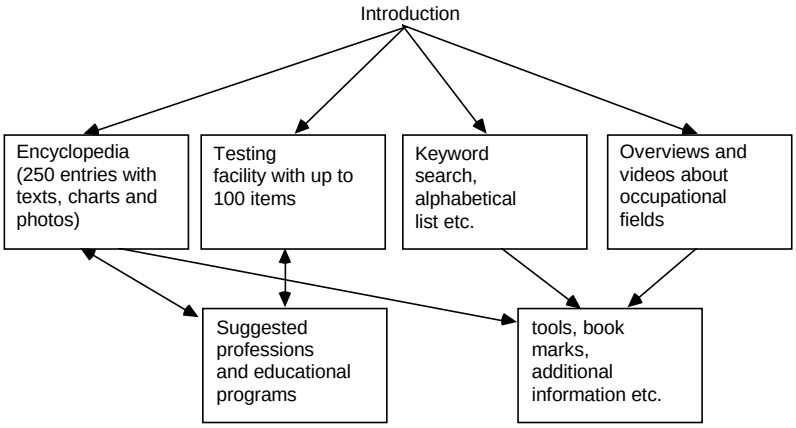

Figure 1. Block diagram and screen shot of the CD-ROM ´Career Counselor" with Yes/No quiz, list of suggested professions and information from a vocational encyclopedia (screen displays an entry of the encyclopedia).

Table 1
*Correlation between questions concerning acceptance of the suggested jobs & information about jobs (n=43).**

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

*: All correlations differ significantly from 0 ($p<.05$).

Table 2

Acceptance ratings as a function of video (displayed before vs. after reading) and photo (text illustrated by a photo vs. no illustration); scores range from 1 (rejection) to 5 (agreement).

	Photo			
	Yes		No	
Watching Video	Before	After	Before	After
Tasks, motivating	2.9	2.6	2.8	2.7
Tasks, valuable	2.1	2.2	2.3	2.2
Income, motivating	3.0	2.6	2.4	2.4
Income, valuable	2.7	2.3	2.3	2.3
Prognosis, motivating	2.7	2.5	2.4	2.3
Prognoses, valuable	2.3	2.2	2.4	2.3
Summarized score	15.7	14.3	14.6	14.2

Table 3
Cued recall as a function of video (displayed before vs. after reading) and photo (text illustrated by an photo vs. no illustration); scores range from 0 (no recall) to 5 (total recall).

	Photo			
	Yes		No	
Watching Video	Before	After	Before	After
Recall job title	2.7	2.4	2.4	2.3
Recall income	1.8	1.6	2.2	2.0
Recall age groups	2.0	1.7	1.5	1.5
Recall usability index	1.9	1.6	1.7	1.5
Recall unemployment	1.9	1.8	1.9	1.7
Summarized score	10.3	9.1	9.7	9.0

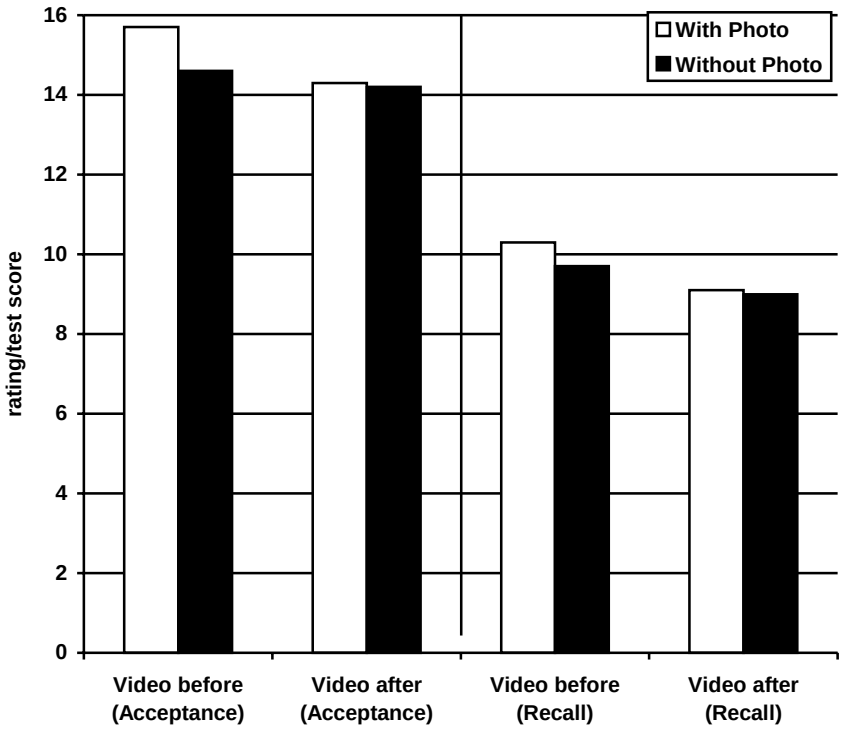

Figure 2. Acceptance ratings and cued recall as a function of ´Photo´ (with illustration vs. no illustration) and ´Video´ (displayed before vs. after reading); acceptance scores range from 1 (rejection) to 30 (agreement), recall scores range from 0 (no recall) to 25 (total recall).

Table 4

Acceptance ratings as a function of list of jobs/educational programs (individually generated list vs. fixed list) and video (displayed before vs. after reading); scores range from 1 (rejection) to 5 (agreement).

	Job/Education			
	Previously fixed		Individually generated	
Watching Video	Before	After	Before	After
Tasks, motivating	1.9	2.4	2.4	2.5
Tasks, valuable	2.8	2.8	2.7	3.0
Income, motivating	2.5	2.4	2.5	2.6
Income, valuable	2.5	2.6	2.6	2.7
Prognosis, motivating	2.4	2.5	2.7	2.7
Prognosis, valuable	2.6	2.7	2.7	2.9
Summarized score	14.7	15.5	15.5	16.4

Table 5
Cued recall as a function of list of jobs/educational programs (individually generated list vs. fixed list) and video (displayed before vs. after reading); scores range from 0 (no recall) to 5 (total recall).

	Job/Education			
	Previously fixed		Individually generated	
Watching Video	Before	After	Before	After
Recall job title	2.4	1.9	2.6	2.8
Recall income	1.5	1.3	2.8	2.5
Recall age groups	1.5	1.3	1.8	1.8
Recall usability index	1.4	1.1	2.0	1.9
Recall unemployment	1.4	1.3	2.3	2.2
Summarized score	8.2	6.8	11.5	11.2

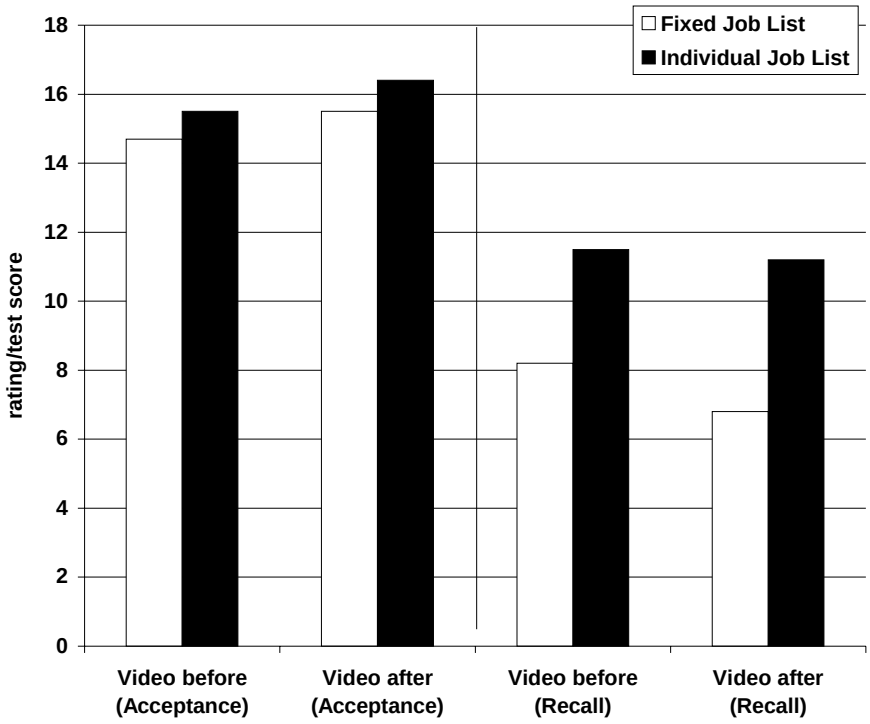

Figure 3. Acceptance ratings and cued recall as a function of list of jobs/educational programs (individually generated list vs. fixed list) and video (displayed before vs. after reading); acceptance scores range from 1 (rejection) to 30 (agreement); recall scores range from 0 (no recall) to 25 (complete recall).

Table 6

Means of the subjective validation of two electronic media (1. Point-Of-Information, 2. Computer-Based Training) and printed matter (3. Quiz identifying occupational fields, 4. survey with response letter), scores range from 1 (rejection) to 5 (agreement).

	Statement				
	like to medium	like „look and	like recomm-	product is v	would buy p
1. POI	2.24	2.13	1.96	2.02	1.99
2. CBT	2.24	2.19	1.78	1.96	2.03
3. Quiz	2.95	2.79	2.89	2.87	2.75
4. Survey	2.97	2.88	3.00	3.04	3.05