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ABSTRACT

The purpose of this media study sought to determine whether similar patterns are found (1) when interviewing a larger number of participants and (2) when focusing on a specific content area. Thirty-eight undergraduate students enrolled in an undergraduate computer education class in a large Midwestern university volunteered to participate in individual interviews. During the interview, a preconceptions questionnaire was used to evoke students' perceptions of the ease of learning from books, television, and interactive video. There were three questions for each learning domain (intellectual, verbal, psychomotor, and attitudes). Television was rated as significantly easier than computers and books for learning attitude skills. Although computers were rated as slightly easier than television for the learning of intellectual skills, the difference was not significant: both media were rated as significantly easier than books in the learning of intellectual skills. Television was rated as the easiest medium from which to learn psychomotor skills and students perceived it to be easier to learn verbal information from computers and books than from television. Contains 16 references. (AEF)

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Title:

Factors Contributing to Students' Preconceptions of Mediated Science Instruction for Various Domains of Learning

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IR 017970

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Factors Contributing to Students' Preconceptions of Media

Computers are becoming an integral part of teaching; yet books remain the primary source of conveying instructional content. Television and videotapes also are used to provide realistic pictures, moving images, audio narration and music to supplement instruction. And multimedia provides the opportunity to combine features of each of these three media.

Although the commonly accepted viewpoint is that "...media are mere vehicles that deliver instruction but do not influence student achievement any more than the truck that delivers our groceries causes change in our nutrition" (Clark, 1983, p. 445), Kozma (1991) has challenged and expanded this commonly held view and proposed that the "capabilities of a particular medium, in conjunction with methods that take advantage of these capabilities, interact with and influence the ways learners represent and process information and may result in more or different learning when one medium is compared to another for certain learners and tasks " (p. 179).

Kozma (1991) defines media in terms of it's technology, symbol systems, and processing capabilities. The technology, or hardware, primarily affects the location at which instruction can occur. The symbol systems of a medium include the way it presents verbal and visual information. Processing capabilities refer to the ability of a medium to provide random access to information, learner control over the pacing, and other arithmetic and logic functions. Although the technology is assumed to have minimal effects on learning, the symbol systems and processing capabilities of media may affect the nature of the information gained and the way the information is processed. Kozma further states that "whether or not a medium's capabilities make a difference in learning depends on how they correspond to the particular learning situation- the tasks and learners involved [italics added]- and the way the medium's capabilities are used by the instructional design" (Kozma, 1991, p. 182.

Research indicates that learners' beliefs about an instructional delivery system may be one factor that affects the cognitive processing of content delivered through that medium (Krendl, 1986; Richey, 1992; Salomon, 1983; Salomon & Leigh, 1984, and others). Research conducted with sixth grade students found that the perceived ease of learning from a medium was negatively correlated with achievement (Salomon, 1983; Salomon & Leigh, 1984); however, research conducted with post-secondary learners has found a significant positive correlation between the perceived ease of learning from a medium and achievement scores (Cennamo, Savenye, & Smith, 1991; Richey, 1992). For example, Richey (1991; 1992) used path analysis to examine the causal influence of a number of variables on the achievement scores of over 600 participants in industrial training programs. She found that "on the average, sixty percent of the outcomes of these training programs can be predicted by the adult learners' entering characteristics and perceptions, most of which are directly or indirectly related to one's perceptions of the training delivery system" (Richey, 1991, p. 16). These results suggest experienced learners may be accurately aware of the ease with which they learn from a particular medium.

But what influences learners' attitudes toward media? Why do learners view one medium as easier or more difficult than another for a particular task? Recognizing the learners' voices in what makes it easy to learn a particular task from a particular medium may provide instructors and materials developers with important practical implications for their design and development efforts.

Earlier research (Salomon, 1984; Salomon & Leigh, 1984; Krendl, 1986) found that learners' preconceptions of the ease or difficulty of learning a lesson depended on the medium of presentation; however, other researchers have found that the perceived ease of learning a lesson from a particular medium was also dependent upon the topic of the lesson (Beentjes ,1989) and the learning domain (verbal, intellectual, attitude, or psychomotor) of the instructional objective (Cennamo, 1993b).

Recently a series of studies has been conducted to determine factors influencing learners' perceptions of the ease of learning a particular task using a particular medium. In an exploratory study (Cennamo, 1993a), 12 preservice teachers completed a self-report questionnaire assessing their preconceptions of the ease of achieving various learning outcomes (psychomotor, affective, verbal, intellectual) using the media of interactive video, computers, books, and television. They were interviewed to determine the reasoning behind their ratings. Analysis of the interview responses indicated that for different domains of learning outcomes, learners used different criteria for rating a medium as easy or difficult. Consistent with Kozma's (1991) theory, learners' ratings of the ease of learning a particular task using a particular medium were influenced by the a) capabilities of the medium (such as the symbol systems and processing capabilities), b) characteristics of the learner (such as past experience and personal preferences), and c) characteristics of the task (such as complexity of the learning objective). However, the particular factors that were perceived to be of major importance varied depending on the medium and domain of learning outcome.

The current study attempted to validate and extend the prior study. The purpose of this study was to determine whether similar patterns are found a) when interviewing a larger number of participants and b) when focusing on a

specific content area. Whereas interviews were conducted with only 12 participants in the previous study, 38 interviews were conducted in the current study. In addition, the questionnaire used to elicit verbal responses in the previous study contained learning objectives from a variety of content areas. In the current study, the interview questions have been restricted to objectives from the science content area.

Methods

Participants

Thirty-eight undergraduate students enrolled in an undergraduate computer education class in a large midwestern university volunteered to participate in individual interviews. Of the 38 participants, 34 were female and 4 were male. Twenty-four (63%) were Education majors, 11 (29%) were majoring in Child Development and Family Services, and three (8%) were majoring in other areas. 42% were seniors (16), 45% were juniors (17), and 13% (5) were sophomores.

Materials

During the interview, a preconceptions questionnaire was used to evoke students' perceptions of the ease of learning from books, television, computers, and interactive video. It included a cover sheet that operationally defined each medium in order to ensure that all participants interpreted the terms "books", "television", "computers", and "interactive video" in the same manner (see Appendix). The students were asked to rate the difficulty of learning 12 tasks using each of the four media on a five-point Likert scale and to orally justify their ratings. One represented "very easy" and five represented "very difficult". The questions were similar in format to those used by Beentjes (1989), Salomon (1984), and Cennamo (1993a; 1993b). This questionnaire included questions such as:

- How easy would it be to learn to weigh a sample to the nearest 1/10 of a gram using a digital scale from

a book?	*very easy*	1	2	3	4	5	*very difficult*
television?	*very easy*	1	2	3	4	5	*very difficult*
a computer?	*very easy*	1	2	3	4	5	*very difficult*
interactive video?	*very easy*	1	2	3	4	5	*very difficult*

There were three questions for each learning domain (intellectual, verbal, psychomotor, and attitudes). The following questions stems were included:

Verbal information
- How easy would it be to learn to list three rules you should follow when working in a chemistry lab from...
- How easy would it be to learn to define terms that describe the basic units of matter including atoms, elements, molecules and compounds from...
- How easy would it be to learn to label the parts of a cell from...

Intellectual Skills
- How easy would it be to learn to balance a chemical equation from...
- How easy would it be to learn to determine the results of a genetic cross using a Punnett square from...
- How easy would it be to learn to develop and test a hypothesis when conducting an experimental study from...

Psychomotor Skills
- How easy would it be to learn to measure a liquid sample using a graduated cylinder from...
- How easy would it be to learn to weigh a sample to the nearest 1/10 of a gram using a digital scale from...
- How easy would it be to learn to mount and correctly focus a slide on a microscope from...

Attitude Skills
- How easy would it be to learn to voluntarily choose to wear safety glasses while working a in a chemistry lab from...
- How easy would it be to learn to appreciate the biological diversity of the natural world from...
- How easy would it be to learn to choose to treat the environment in a respectful manner from...

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Numerical responses were averaged across domain and medium to provide an average score for each medium /domain combination. For example, there was an average score for books/ verbal, books/ intellectual, books/ attitudes, and books/ psychomotor. Chronbach's alpha yielded an acceptable overall reliability coefficient of .79.

Procedures

During the seventh week of class, the researcher invited the participants to sign-up for individual interviews. Although the participants were offered a small amount of extra credit for participation in the interview, the structure of the course allowed the students to earn course credit in a variety of ways throughout the semester. As they reported to the interview site, a research assistant explained the purpose of the interview and presented the participants with the questionnaire. Borg and Gall (1993) indicate that matching interviewers and respondents on variables such as social class, age, and gender may produce more valid responses; thus, like the majority of the respondents, the interviewer was an undergraduate student, female, and approximately 20 years old.

Using an interview guide, she conducted each interview in a consistent manner. The interviewer read the cover sheet aloud and waited for the respondents to complete the demographic questions. Then the interviewer read each question aloud. The students were asked to indicate their rating on the 5-point scale and to orally reflect on why they rated the medium as they did. These conversations were audiotaped and later transcribed.

Data Analysis and Results

Initial analysis focused on student's familiarity with the four media. One-hundred percent of the respondents indicated that they used books once a month or more, 97% indicated that they watched television once a month or more, and 92% indicated that they used computers once a month or more. However, 92% of the respondents indicated that they "hardly ever" used interactive video. Based on the infrequency of use, responses to questions addressing the perceived ease of learning from interactive video were eliminated from the data analysis. Subsequent analysis focused on learners' perceptions of the perceived ease of learning science content from books, television, and computers.

The interview responses were of primary importance in determining factors that contribute to learners' perceptions of the ease of learning from a particular medium. Responses to the questionnaire were analyzed quantitatively to provide guidance in interpreting the interview responses. Student ratings on the Likert scale were analyzed using a Repeated Measures Analysis of Variance to determine whether students preconceptions of the ease of learning science tasks varied by learning domain, by medium, or randomly depending on topic. Based on the findings of the statistical analysis, the interview data were analyzed to determine factors influencing learners' preconceptions of the ease of learning a skill in a given domain using a particular medium.

Analysis of Questionnaire Data

The Repeated Measures Analysis of Variance indicated several significant findings concerning learners' preconceptions of the ease of learning a given outcome using a given medium of presentation. (See Table 1.) Following the finding of a significant f, Tukey's Honestly significant Difference (HSD) test was used to determine significant differences among individual group means.

As expected, there was a significant interaction among learning domain and medium, $F(1,37) = 29.04$, $p < .001$. Learners perceived that it was significantly easier to learn psychomotor skills from television ($M = 2.10$) than from computers ($M = 2.75$) and books ($M = 3.28$), and significantly easier to learn psychomotor skills from computers than from books. For the learning of attitudes, learners also perceived it to be significantly easier to learn from television ($M = 1.48$) than from books ($M = 2.71$) and computers ($M = 2.93$). Learners perceived it to be significantly easier to learn intellectual skills from computers ($M = 2.27$) and television ($M = 2.63$) than from books ($M = 3.00$). Learners rated computers ($M = 1.70$) and books ($M = 1.84$) as significantly easier than television ($M = 2.29$) for learning verbal information. As expected, there was a significant difference among media, $F(1,37) = 18.98$, $p < .001$, and among learning domains, $F(1,37) = 47.01$, $p < .001$. Tukey's post-hoc analysis of the data revealed that television ($M = 2.13$) was perceived to be significantly easier than computers ($M = 2.42$) and books ($M = 2.71$), and computers were perceived to be significantly easier than books. Students perceived that it was significantly easier to learn verbal information ($M = 1.85$) than attitudes ($M = 2.15$), intellectual skills ($M = 2.42$) and psychomotor skills ($M = 2.44$), and significantly easier to learn attitudes than psychomotor skills.

Table 1: Means and standard deviations of ratings on preconceptions questionnaire.

		Computers	Television	Books	TOTAL BY DOMAIN
Psychomotor	Mean	2.75	2.10	3.28	2.44
	SD	1.04	1.03	1.12	1.16
Attitudes	Mean	2.93	1.48	2.71	2.15
	SD	1.09	.74	1.15	1.16
Verbal	Mean	1.70	2.29	1.84	1.85
	SD	.86	1.14	.95	.99
Intellectual	Mean	2.27	2.63	3.00	2.42
	SD	.99	1.57	1.21	1.15
TOTAL BY MEDIUM	Mean	2.42	2.13	2.71	
	SD	1.10	1.11	1.23	

Note: Higher scores mean greater perceived difficulty.
N=38.

Interview analysis and results

Based on the results of the statistical analysis, the interview data was interpreted in terms of the media by domain interaction. Data from the interviews were entered into a database and coded as to the question number, medium, and domain addressed by each response. The data were sorted by medium and domain, resulting in a set of responses for books/verbal, books/ intellectual, books/ attitudes, books/ psychomotor, television/verbal, television/ intellectual, television/ attitudes, television/ psychomotor, computers/verbal, computers/ intellectual, computers/ attitudes, and computers/ psychomotor.

Two researchers independently read each statement associated with each medium/domain combination and tallied responses that were similar in meaning. For example "can go back", "can select what you want to study", and "could skip parts you knew" were all coded as "Learner Control".

Based on the categories that emerged during the previous exploratory study (Cennamo, 1993a), the list of responses was clustered into the following categories: symbol system, processing capabilities, task characteristics, personal preferences, and characteristics of the technology. For example "learner control", "practice and feedback", and "lack of interaction" all refer to the processing capabilities of the medium. After clustering the responses by category, the responses in each category were reviewed to verify the placement of each response.

Responses in each category were examined once again to determine if the responses could be further clustered within each category. This analysis revealed that responses addressing the *symbol systems* presented by the various media primarily were concerned with the pictures present, the way the verbal information was presented, the ability of the medium to present demonstrations, the examples and reasons provided, the ability to highlight important information, miscellaneous negative characteristics of the medium, and other miscellaneous responses. Responses that addressed the *processing capabilities* of the medium were primarily concerned with the ability of the medium to provide practice and feedback, learner control, the ability of the student to ask questions or clarify understandings, and other miscellaneous responses. Responses coded as *personal preferences* were mostly individualistic in nature; however, clusters that emerged were based on learners' past experiences or reflected their dislike for the media. *Task characteristics* clustered into those that addressed the ease or difficulty of the task, the suitability of the medium for the task, and other miscellaneous

responses. Responses that mentioned characteristics of the technology were rare, thus, the *technology* category was not subdivided further.

Typically, learning outcomes are determined prior to selecting media to deliver the content, thus, the results of this analysis will be discussed by learning domain of the intended outcome.

Attitude skills

Television was rated as significantly easier than computers and books for learning attitude skills (see Figure 1 and Appendix B). The ability of a medium to demonstrate the target skill using realistic pictures seemed to be the most prevalent characteristics influencing learners ratings of the ease of learning attitudes using the three media. In general, pictures were important for the learning of attitudes. The realistic nature of the pictures influenced learners' ratings of the ease of leaning an attitude skill. The presence of a variety of visual examples on television also was important to the participants of the study.

Figure 1. Mean ratings of the ease or difficulty of learning attitude skills.

Easiest			Most Difficult
Means	1.48 *a*	2.71 *b*	2.93 *b*
	Television	Books	Computers

Note: means with different subscripts are significantly different from one another.

The respondents felt that when using computers they would be primarily "just reading" "just facts" and that words would not be very valuable in changing their attitudes. Respondents also perceived that books tell you information and present facts, but mentioned that they were "just words" and indicated that some ideas could not be described well in words. They frequently mentioned that books did not present real situations and that you would not see the results of not changing your attitude. However, the respondents did acknowledge that books an computers could list the possible results of an action and the consequences or reasons why one should change an attitude. Participants acknowledged that television also would present verbal information with respondents mentioning the audio track as important for providing verbal descriptions.

The processing capabilities, characteristics of the task, personal preferences, and technology of a medium did not appear to be as influential as the symbol systems in learners' perceptions of the ease of learning an attitude skill. Personal preferences were stronger for books than the other two media; however, most ideas were mentioned only once, reflecting the individual nature of personal preferences. The perception that reading a book would not influence personal actions was the most frequently mentioned idea coded as a personal preference.

Intellectual Skills

Although computers were rated as slightly easier than television for the learning of intellectual skills, the difference was not significant; both media were rated as significantly easier than books in the learning of intellectual skills (see Figure 2 and Appendix C). Although television and computers were rated similarly for learning intellectual skills, the ratings were attributed to very different characteristics of the media.

Figure 2. Mean ratings of the ease or difficulty of learning intellectual skills.

Easiest			Most Difficult
Means	2.27 *a*	2.63 *a*	3.00 *b*
	Computers	Television	Books

Note: means with different subscripts are significantly different from one another

Participants perceived that demonstrations facilitated the ease of learning intellectual skills. Once again, the strength of television seemed to be in its ability to demonstrate the target skill in a step-by step manner. These characteristics were further enhanced by the audio capacities of television that allow the program to "tell", teach, and

explain information. The ability of computers to show how a tasks is performed and "take you through it, step-by-step" also was an important characteristic influencing participants' ratings of computers. These characteristics, coupled with the textual data and instructions contributed to the perceived ease of learning intellectual skills from computers. The perceived textual nature of computer demonstrations may have accounted for the fairly similar number of responses mentioning step-by-step explanations in books. The strength of books seemed to be the presence of examples that illustrate the target skill, which may reinforce the learners perceived need for demonstrations of the target skill.

The processing capabilities of computers were viewed as important factors contributing to the perceived ease of learning intellectual skills. The presence of practice and feedback was the characteristic most responsible for the higher rating of computers than of books and television. Learner control was also perceived as critical in learning intellectual skills. The most frequently mentioned feature of learner control was the ability to review and repeat information.

Task characteristics, personal preferences, and the technology had little influence on the perceived ease of learning intellectual skills. The most frequently mentioned task characteristic was the appropriateness of the medium for teaching the task. Once again, personal preferences influenced students' ratings of books more frequently than the other media. The frequency of responses mentioning characteristics of the technology as influential in their ratings was similar across media.

Psychomotor skills

Television was rated as the easiest medium from which to learn psychomotor skills (see Figure 3 and Appendix D). The presence of demonstrations was especially influential in the learners' rating of the media. The ability of a medium to present directions and "tell how" in a step-by-step manner also was considered in the learners' ratings of the ease of learning psychomotor skills from the three media.

Figure 3. Mean ratings of the ease or difficulty of learning psychomotor skills.

Easiest			Most Difficult
Means	2.10 *a*	2.75 *b*	3.28 *c*
	Television	Computers	Books

Note: means with different subscripts are significantly different from one another

Lack of practice opportunities was perceived as a disadvantage when learning psychomotor skills from television and books, while respondents did not perceive the processing capabilities of computers as particularly relevant to learning psychomotor skills. Students mentioned that they would not be "actually doing it" when learning psychomotor skills on the computer.

The perceived ease or difficulty of the task accounted for the majority of the "task related" responses. However, the suitability of the task for presentation via computer was the most frequently mentioned "task variable" influencing students' ratings of computers.

Personal preferences and the technology were not particularly influential in students' ratings of the ease of learning psychomotor skills

Verbal information

Students perceived it to be easier to learn verbal information from computers and books than from television. (See Figure 4 and Appendix E.) Surprisingly, the presence of pictures illustrations, and diagrams were perceived as important features influencing the ease of learning verbal information from all three media. Students continued to value the demonstrations provided by television. Also surprisingly, students perceived the three media as being fairly equal in their ability to present verbal information.

Figure 4. Mean ratings of the ease or difficulty of learning verbal information.

Easiest			Most Difficult
Means	1.70 *a*	1.84 *a*	2.29 *b*
	Computers	books	Television

Note: means with different subscripts are significantly different from one another

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The processing capabilities of the media were important to the learners' ratings of the ease of learning verbal information from books, computers, and television. Participants mentioned the ability to review and refer back to information presented through books and computers. This ability to refer back to information with ease, coupled with the participants perceptions that the task required memorization and rehearsal of the information may have accounted for the perceived ease of learning verbal information from computers and books. The ability of the computer to provide drill and practice with feedback also contributed to the perceived ease of learning verbal information from computers.

Participants felt that the ease or difficulty of the task was more relevant to learning from books than other media. In addition, students perceived books to be more appropriate for learning verbal information than computers or television.

Neither personal preference or the technology seemed to be particularly important to the perceived ease of learning verbal information from the three media.

Summary and Discussion

Discussion

This study was conducted as an initial step in determining factors that contribute to learners' preconceptions of the ease or difficulty of learning science tasks in the attitude, psychomotor, intellectual, and verbal information domains using computers, television, and books.

Consistent with the results of a previous study (Cennamo, 1993a), the students' ratings of the ease of learning various tasks using computers, television, and books seemed to reflect some awareness of the external conditions needed for optimal learning in each domain (Gagné, 1985; Gagné, Briggs, & Wagner, 1992). Opportunities for rehearsal can enhance the learning of verbal information, and books and computers, the two media where the pacing is under the control of the learner, were rated as the easiest from which to learn verbal information. Likewise, the learners' ratings of the ease of learning intellectual skills from computers reflected an awareness that opportunities for practice and feedback with a variety or examples can enhance the learning of intellectual skills.

From the responses to the interview questions, it appears that for these non-science majors, visual imagery is important in learning science content. Learners in a prior study (Cennamo, 1993a) who responded to questions about the ease of learning a variety of skills in several content areas indicated that demonstrations were important in learning psychomotor skills and attitudes; the learners who responded to questions specifically addressing science content indicated that demonstrations enhanced learning for all domains but verbal information. However, these learners indicated that pictures and illustrations increase the ease of learning verbal information. Kozma (1991) indicates that visual images are particularly important when learning new content, suggesting that pictures provide learners with a mental model onto which they can then map the information provided by the text. It is likely that the undergraduate students majoring in education and child and family development may have lacked confidence in their understanding of the science content, thus, they may have felt the need for a concrete visual image.

Kozma (1991) suggested that "whether or not a medium's capabilities make a difference in learning depends on how they correspond to the particular learning situation- the tasks and learners involved- and the way the medium's capabilities are used by the instructional design." (p. 182). From the responses to this study, it seems that students' perceptions of the ease of learning a particular skill using a particular medium was influenced by their perceptions of the way a medium's characteristics are used by the instructional design. They perceive television to include demonstrations and realistic pictures. They perceive computers to include graphics and practice with feedback. As students have more experience with computer programs capable of presenting visual and verbal information with the realism currently associated with television, students' perceptions of computers will likely change to reflect a broader definition of computer assisted instruction. In addition, they indicated that "the task and learners involved" did influence their ratings of the ease of learning science skills from the three media. Personal preferences and characteristics of the task such as the domain of the target skill, the perceived ease or difficulty of the target task, and the perceived appropriateness of the media for teaching the task were important to the participants.

These results reinforce that it is important to consider the target skill in selecting media for instruction. Given the results of this study, it is surprising that the majority of college level instruction uses books as the primary method of relaying science content. Most college level instruction focus on teaching intellectual skills such as concepts, rules, and problem solving rather than attitudes, psychomotor skills, or verbal information. However, books were rated as the most difficult medium from which to learn intellectual skills. Although science majors may have different perceptions of the ease of learning from books, this study suggests that perhaps computers should be used to teach intellectual skills and

verbal information to novice learners. Perhaps television or videotapes should be used to teach attitudes and psychomotor skills. Perhaps it will be even better if designers of computer-based lessons for teaching science content incorporate "television like" sequences and images in multimedia programs designed to teach intellectual, attitude, or psychomotor skills. However, the inclusion of realistic, moving images and sound in computer-based instruction requires large amounts of computer memory and storage. Thus, an awareness of situations where learners perceive realistic images and sound as important for the ease of learning remains important.

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Appendix A. Cover sheet for preconceptions questionnaire.

Preconceptions Questionnaire **NUMBER** _____

This questionnaire is designed to examine your preconceptions of four forms of media. Specifically, it is designed to determine your perceptions of the ease or difficulty of learning from books, television, computers and interactive video.

As you know, instruction can be presented in a variety of media formats. Throughout your education, you have probably read many books and seen quite a few videotapes. You may or may not have had experience in computer assisted learning or interactive video based instruction. Since this questionnaire is about your preconceptions of books, television, computers, and interactive video, the terms will be operationally defined as explained below:

For the purposes of this questionnaire, when you see...

Books: Please imagine that you are reading text materials supplemented with photographs and illustrations.

Television: Please imagine that you are watching a series of moving video images, supplemented with narration, music and other sound effects. Appropriate illustrations, still pictures, or text screens may also be presented.

Computers: Please imagine that you are using a computer program that contains text screens and graphic illustrations. Animation may be used to create moving images. There is no sound. At certain points in the program, it will be necessary to make a selection from a menu or to respond to a prompt or question before the program will continue.

Interactive video: Please imagine that you are using a program that combines computer generated screens with video images. The video display may include moving and still images, narration, music and sound effects. The computer display may include text screens, graphic illustrations, and animation. At certain points in the program, it will be necessary to make a selection from a menu or to respond to a prompt or question before the program will continue.

Please indicate your gender ..... ( ) male ( ) female

Please indicate how frequently you use

Books ( ) almost never ( ) once a year ( )once a month ( ) once a week or more

Television ( ) almost never ( ) once a year ( )once a month ( ) once a week or more

Computers ( ) almost never ( ) once a year ( )once a month ( ) once a week or more

Interactive Video ( ) almost never ( ) once a year ( )once a month ( ) once a week or more

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Appendix B. Factors influencing participants' ratings of the ease or difficulty of learning attitude skills from computers, books and television.

Books/ Attitudes	
Symbol systems	98
Still Pictures	28
Words, tell, facts	27
Negatives	19
List results	17
Examples	6
Miscellaneous	1
Processing	10
Lack of Interaction	8
Learner control	2
Task	8
Easy task	6
Miscellaneous	2
Personal Preferences	24
Won't affect actions	6
Miscellaneous	18
Technology	3

Computers/ Attitudes	
Symbol systems	138
Lack of real images	29
Not seeing task or outcome	25
Graphics, pictures	20
Words, tell, facts	32
Reasons	15
Shows you	5
Miscellaneous	12
Processing	4
Miscellaneous	4
Task	7
Miscellaneous	7
Personal Preferences	6
Miscellaneous	6
Technology	0

TV/Attitudes	
Symbol systems	146
Demonstration	86
Realistic pictures	22
Variety of examples	14
Audio	14
Miscellaneous	10
Processing	1
Miscellaneous	1
Task	6
Miscellaneous	6
Personal Preferences	5
Miscellaneous	5
Technology	0

Appendix C. Factors influencing participants' ratings of the ease or difficulty of learning intellectual skills from computers, books and television.

Books/Intellectual skills	
Symbol systems	68
Examples	23
Explains, step-by-step	21
Words & equations printed	12
No demonstration	5
Miscellaneous	7
Processing	34
Lack of practice	25
Learner control	9
Task	28
Ease or difficulty of task	10
Not appropriate for medium	12
Miscellaneous	6
Personal Preferences	15
Past experience	10
Takes much time	5
Technology	3
Miscellaneous	3

Computers/ Intellectual	
Symbol systems	76
See, step-by step	32
Examples	14
Tells	16
Pictures/ graphics	7
Miscellaneous	7
Processing	73
Practice and feedback	55
Learner control	18
Task	9
Miscellaneous	9
Personal Preferences	9
Media difficult	4
Miscellaneous	5
Technology	3
Miscellaneous	3

TV/Intellectual	
Symbol systems	128
Demonstrate, step-by step	72
Tell you	32
Realistic pictures	8
Examples	6
Written text	7
Miscellaneous	3
Processing	27
Practice and feedback	13
Learner control	9
Unable to clarify	5
Task	14
Not appropriate for medium	5
Miscellaneous	9
Personal Preferences	7
Miscellaneous	7
Technology	0

Appendix D. Factors influencing participants' ratings of the ease or difficulty of learning psychomotor skills from computers, books and television.

Books/ Psychomotor	
Symbol systems	76
Pictures, illustrations	24
No demonstration	22
Tells how	17
Examples	4
Miscellaneous	9
Processing	42
Lack of practice & feedback	36
Learner control	4
Miscellaneous	2
Task	26
Ease or difficulty of task	17
Not appropriate for medium	9
Personal Preferences	4
Miscellaneous	4
Technology	2
Miscellaneous	2

Computers/ Psychomotor	
Symbol systems	109
Graphics, visuals	56
Show how	21
Tell how	25
Miscellaneous	7
Processing	20
Practice and feedback	18
Miscellaneous	2
Task	19
Not appropriate for medium	17
Miscellaneous	2
Personal Preferences	3
Miscellaneous	3
Technology	0

TV /Psychomotor	
Symbol systems	143
See how	108
Realistic, clear pictures	18
Tells you	12
Miscellaneous	5
Processing	22
Lack of practice	22
Task	10
Ease or difficulty of task	6
Miscellaneous	4
Personal Preferences	6
Miscellaneous	6
Technology	0

Appendix E. Factors influencing participants' ratings of the ease or difficulty of learning verbal information from computers, books and television.

Books/ Verbal	
Symbol systems	79
Pictures	35
State facts, describe	29
Important information evident	11
Miscellaneous	4
Processing	18
Learner control	18
Task	63
Ease or difficulty of task	21
Task requires memorization	42
Personal Preferences	6
Miscellaneous	6
Technology	0

Computers/Verbal	
Symbol systems	83
Graphics, visuals	40
Important information evident	11
Words, tells	25
Miscellaneous	7
Processing	56
Practice and feedback	32
Learner control	21
Miscellaneous	3
Task	23
Task requires memorization	9
Ease or difficulty	6
Not appropriate for medium	8
Personal Preferences	10
Miscellaneous	10
Technology	3
Miscellaneous	3

TV /Verbal	
Symbol systems	122
Shows you	36
Realistic pictures	29
Tells you	20
Text	20
Examples	6
Audio	5
Miscellaneous	6
Processing	25
Learner control	24
Miscellaneous	1
Task	21
Not appropriate for medium	9
Ease or difficulty of task	4
Task requires memorization	4
Miscellaneous	4
Personal Preferences	11
Miscellaneous	11
Technology	1
Miscellaneous	1