Engagement in Multimedia Training Systems

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Abstract

Two studies examined user engagement in two types of multimedia training systems -- a more passive medium, videotape, and a less passive medium, interactive software. Each study compared engagement in three formats: the Text format contained text and still images, the Audio format contained audio and still images, and the Video format contained audio and video images. In both studies, engagement was lower in the Text condition than in the Video condition. However, there were no differences in engagement between Text and Audio in the videotape-based training, and no differences between Audio and Video in the computer-based training.

1. Introduction

For decades, researchers have been suggesting that certain types of business software be modeled on computer games [23, 26]. More recently, the popular press has included a cover story on the relationship between video games and learning [19], and a computer science visionary [5, p. 34] speculated:

> Is there a piece of game software that when played well will create a business plan for the player? Is there a game that trains a sales force on a newly released product? Are there games that can become the answer to declining scores and capabilities of the nation's school children? Goal-directed software (games) may have many uses that are just beginning to be understood and that may be the key to surviving in the explosive area of communication requirements in which an individual in an increasingly complex world is swimming in a sea of undigested information.

The reasoning for modeling software on games revolves around the engagement that users experience when interacting with game-like software, with the better learning and retention of material that should result [25, 27]. While the cognitive processes in learning have been well-researched, attention to motivational issues, such as engagement, has been lower [27]. Only recently has the notion of engagement begun to be formalized, so that the concept is rarely studied in the information systems literature [21, 22]. Related concepts (such as flow, described below) have, however, existed much longer.

Engagement represents one of the most critical indicators of product quality for multimedia courseware [3]. Multimedia courseware can contain game-like features, and thus can entice the learner to focus full attention on a task through the vividness of the presentation. Therefore, there have been calls to create systems for which users' interactions are pleasurably engaging, fun, and intrinsically motivating [25, 27], to design multimedia systems to be more lively, intriguing, or fascinating [18], and to recognize the achievement of engagement as an important goal in the design of systems [28].

The notion of engagement as used here also must be distinguished from other meanings found in the literature. For instance, Fisher, Blackwell, Garcia, and Greene [15] measured engagement solely on the basis of physical interactions, such as touching the keyboard and watching the screen. Further, "direct engagement", or the feeling of working directly on a task [30] or with a direct manipulation interface [20], focuses on virtual physical interactions. That is, during direct engagement, the user feels that s/he is operating directly on the conceptual objects underlying the on-screen representations.

The remainder of the paper is organized as follows. The following section describes engagement, and then develops hypotheses concerning multimedia training systems. The subsequent section reports on two studies comparing users' reactions to three different formats in each of two multimedia training systems. The paper concludes by discussing implications for research and practice.

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2. Theoretical approach

Engaging systems have been described as: enticing users [28]; drawing users into the activity [25]; seducing and spurring users on [40]; and catching, capturing, or captivating the interest and attention of users [22]. Jacques [22] queried computer users after they interacted with multimedia systems. When asked what engagement meant to them, they considered it to be a positive, interactive state, in which their attention was willingly given and held; they described their feelings when interacting with engaging software as "curiosity, interest, confidence, and surprise".

Engagement is similar to flow, a concept defined and studied by Csikszentmihalyi [8, 9]. Flow has received considerable research support in general (e.g., [10]) and in human-computer interactions in particular (e.g., [31, 43]). During flow, the individual experiences a sense of control, attention focus, curiosity, and intrinsic interest. These factors have been among those used in describing engagement, with the exception that individual control is necessary for flow, but not for engagement [42]. Therefore, in the present studies, engagement is measured by attention focus, curiosity, and intrinsic interest.

2.1. Comparing videotape and computer-based training systems

Based on cognitive psychology's classification of cognition as being either controlled or automatic (e.g., [16, 39]), we propose that a user's engagement in training systems may be more passive or less passive. When engagement is more controlled (similar to Norman's [30] "reflective" mode), the user's information processing includes conscious thought, comparisons, critical thinking, reasoning, abstraction, inference-making, and so on. More controlled engagement would be more likely to occur in exploration-based training (as compared with instruction-based training). Exploration-based training involves induction and more user control because the user sets the pace of the training [4]. Therefore, interacting with training software is more likely to involve a more controlled, or less passive, state of engagement.

When engagement is more passive (similar to Norman's [30] "experiential" mode), the individual still has his/her attention captured by the situation but there are fewer responses to inputs. More passive engagement would be more likely to occur in instruction-based training. Instruction-based training involves deduction, structured learning, and less user control because the training is led by the instructor [4]. Passive engagement should be easier to achieve and maintain than controlled engagement, requiring less effort and motivation on the person's part to become involved. Passive engagement can attract and hold a person's attention, but is less useful in achieving learning goals that require higher-level cognition. For example, watching a videotape is more likely to involve a passive than a controlled state of engagement (although active cognitive involvement is still possible, for instance, when attempting to solve a mystery). Therefore, we propose that:

> **H1**: *Users will experience higher engagement with computer-based training systems than with videotape-based training systems.*

2.2. The effects of text, audio, and video formats in training systems

Current multimedia training systems often incorporate video, on the assumption that doing so will capture the user's attention, and thus result in improved learning. However, some debate exists over whether video adds anything beyond audio [46], and even whether users will be more passive during video than during text [45]. In the studies reported below, three formats of each of the two (videotape and computer-based) multimedia training systems are contrasted, which we label as Text (containing text and still images), Audio (containing audio and still images), and Video (containing audio and video images) conditions. We compare engagement and performance for the three formats.

We draw on past research from several theoretical perspectives to propose that engagement will be highest for the Video format and lowest for the Text format. The first theoretical perspective comes from Csikszentmihalyi's [8] research on flow, and relates to Video's higher feedback. Clear feedback from an activity enhances flow [8]. For instance, Malone [26] found that scoring in computer games related to students' preferences for games, Carroll [6] found that responsiveness of computer systems related to exploratory activities on computers, and Webster and Ho [42] found that users felt more engaged during multimedia presentations that were higher in feedback. The Video condition will be perceived as providing more feedback because it provides audio and video information, including tone and body language. When a video presents information in a multi-sensory way, it may reinforce the user's memory and contribute to the feedback. The second theoretical perspective comes from research on media richness [11]. A richer medium is able to: convey multiple verbal and nonverbal cues, allow for immediate feedback, use natural language, and have a personal focus. Past research has placed Video higher than Text on the richness hierarchy, and as Daily [12, p. 192] argued: "One of multimedia's strongest contributions to learning is increased visualization". Therefore, based on

the differences in the three formats with respect to feedback and media richness, we propose that:

> **H2**: *Users will experience the highest level of engagement with the video format and the lowest level of engagement with the text format.*

The relationship between format and performance is less clear than the relationship between format and engagement. Engagement should lead to greater performance because of increased concentration and motivation; however, this may not be the case for the following reasons. For example, adding animation to icons -- seen increasingly in Web pages -- could have one or more of the following effects: (1) adding variety and aesthetic value to the interface, (2) being distracting and overly complex, or (3) transmitting useful information and attracting attention when needed. Norman [30] warned against creating attractive presentations that promote much more experiential than reflective cognition. Such displays are flashy, entertaining, and even inspirational, but do not encourage the acquisition of much knowledge or understanding. A multimedia user may become passively engaged or engaged with the wrong aspects of the software, put little effort into their work, and be relatively unaware of this because of their absorption in the activity. As text may require more effort to interpret, it may be more obvious to a text user when s/he is skimming it and not giving it much thought. Salomon's work ([36, 37, 38]: reviewed in [45]) suggests that use of print (text on paper) will lead to greater learning performance than would use of television. By extension, it is possible that the same would apply when comparing on-screen text with video.

Several studies have compared performance with text, audio, and video. Pane, Corbett and John [33] observed students' understanding of declarative facts using multimedia educational software. They compared a training method with text, still graphics and a dynamic presentation to another method with only text and still graphics. They found no evidence that dynamic presentations enhance student understanding, and observed that there was limited exploration by students. Large, Beheshti, Breuleux and Renaud [24] conducted a study comparing text on screen to multimedia training. They found that the text on screen method lead to greater recall scores but multimedia led to greater inference scores. Moody, Blanton and Augustine [29] found that subjects who were shown an animated conceptual model performed better on comprehension tests than subjects who were shown a non-animated model. Similar results were found by Palmeter, Elkerton and Bagget [32]. They concluded that the effectiveness of multimedia depended on text level, text type, and media integration. Because of the mixed results from previous research, we therefore examine the following research question:

> **H3 (Research Question)**: *Will format (text, audio, video) relate to performance?*

3. Method

Two studies compared Text, Audio, and Video formats of multimedia training systems: the first study examined a more passive training system (videotape), and the second, a less passive training system (interactive software). As mentioned earlier, even the leanest format (Text) is considered multimedia as it contained still images in addition to text. Pilot studies were conducted for each of these studies.

3.1. Study 1

Study 1 compared users' reactions to one of three videotape formats, each of which contained the same content.

3.1.1. Conditions The videotapes were created using excerpts from a videotape entitled *Interview Skills - The Employer Viewpoint*.[1] This videotape addresses the topic of job search and interview skills by presenting employers' viewpoints. This topic was chosen for training because of its interest to the participants described below.

For the Video format of the training, the excerpts were presented untouched from the original videotape presentation. For the Audio format of the training, the same audio contained in the video version was included, but still pictures of speakers were substituted for the videos of employers' interviews. For the Text format of the training, still pictures again were substituted for the videos of employers and scrolled text of the speakers appeared below these pictures. Both the Video and Audio formats lasted 25 minutes while the Text format was 35 minutes in length (the length of the Text format was determined based on advice regarding reading speeds from our audio-visual department).

3.1.2. Participants Seventy-two introductory psychology students (22 males and 50 females) from the university participated in exchange for course credit. The participants were randomly assigned to one of the three training formats: overall, the Video method had 26 subjects, the Audio method had 21 subjects, and the Text method had 25 subjects.

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[1] © Career Services, 1991, Wilfrid Laurier University, Waterloo, Canada. Permission to modify and use the videotape given by Janice L. Basso, Director of Co-operative Education and Career Services, Wilfrid Laurier University.

3.1.3. Procedure Participants were randomly assigned to the Video, Audio or Text training formats. They participated in groups ranging from 2 to 8 students in a small conference room.

Four experimenters managed the training, using a script as a guide to deliver consistent information. The experimenters explained that participants would be watching a videotape on job search skills and would be "quizzed" on it after the experiment. After viewing the training, participants were given a questionnaire which assessed control variables, medium richness, engagement, and knowledge acquired. The questionnaires took participants 10 to 15 minutes to complete.

3.1.4. Measures The questionnaire was administered to participants immediately after the training session. Control variables included work experience and gender. Medium richness was measured using a four-item scale (adapted from [44]) with a 7-point response format ranging from "Not at all" to "To A Very Great Extent" (such as "To what extent would you characterize this presentation as having the ability to convey multiple types of information (verbal and nonverbal)?"); internal consistency reliability (Cronbach's alpha) was .74. A seven-item engagement measure, using a seven-point response format ranging from "Strongly Disagree" to "Strongly Agree" (such as "This presentation held my attention"), was based on [21] and [42]; Cronbach's alpha was .95. Finally, participants were tested on their knowledge of the training session by answering a 10-item multiple choice quiz.

3.2 Study 2

Study 2 compared users' reactions to one of three formats of a multimedia-based training software package, each of which contained the same content.

3.2.1. Conditions The participants used a commercially available, multimedia-based, educational software package called *The Manager's Workshop: Motivation*[2]. The software was designed to teach principles of managing and motivating people in a company. The software was modified to improve its suitability for a single tutorial session and to create the three format conditions.

Other than introductory and navigation screens, the modified software retained two components: an interactive management simulation, and a "theory section" of instructional material describing organizational behavior principles applicable to the simulation. The simulation was the core of the modified program. In it, the user played the role of a manager who must deal with a sales agent's performance problem. A total of 14 different situations could occur, depending on the user's decisions, until the situation was resolved in one of a few ways.

The three software formats varied in the nature of their primary medium (all versions included a small amount of text in titles, buttons, simulation decisions, etc.). In the Video condition, the user viewed videos with an audio track. In the Audio version, each video was replaced by a still image from the video, with the audio track retained. Stills were chosen to represent the essence of the video, showing a moderate degree of body language. In the Text version the same still image was accompanied by a box of text that was a transcription of the now absent audio track.

3.2.2. Participants A class of over 200 university students enrolled in an undergraduate Organizational Behavior course were available as participants in the study. As part of their course, the students had one tutorial period in which they worked through the software used for the experiment. However, completing the questionnaire and quiz was entirely voluntary. Between non-participation and equipment difficulties, 133 data sets became available for analysis: overall, the Video method had 49 subjects, the Audio method had 36 subjects, and the Text method had 48 subjects. Over 80% of participants were from schools of Engineering, Math, and Computer Science, with the remaining from Arts, Science, and Applied Health Sciences. About one third of the participants were female.

3.2.3. Procedure Given the large number of participants, multiple tutorial sessions (of 50 minutes each) took place. These were spread over three computer labs of differing sizes, at different times (mostly throughout one day). Only one software format was presented in each tutorial session to rule out students making comparisons. We randomly assigned students to sessions when multiple sessions occurred simultaneously.

Six lab assistants managed the tutorial sessions, usually in pairs, using a script as a guide to delivering consistent information and maintaining the schedule. Students were informed that the software had been modified so that it included only enough material for that day's tutorial, attempting to forestall disappointments in case expectations of extensive navigation freedom and content were not met.

Students were told that questionnaires would be handed out later in the lab, after they had had enough time to work and experiment with the software, but were not

[2] © Randall. B. Dunham, 1995, of the University of Wisconsin, through HarperCollins College Publishers, New York. The software, version 1.0, runs on Apple Macintosh computers, using the HyperCard multimedia environment. Permission to modify and use the software given by Randall. B. Dunham.

informed of the quiz portion of the questionnaire. Students worked individually, using headsets for the Audio and Video conditions; without these, the noise would have made concentration difficult.

After being told to stop using the software, students filled out the questionnaire. This questionnaire contained control variables, manipulation check measures used to compare formats (feedback and medium richness), engagement, and a quiz on the material contained in the software.

3.2.4. Measures Unless otherwise indicated, questionnaire items used seven-point scales ranging from "strongly disagree" to "strongly agree". Measures were similar to those used in study 1. Additionally, based on past research, we included several controls in our analyses: computer experience, gender, and school.

Manipulation checks on the three formats included feedback and medium richness. Three feedback items, such as "The software provided little feedback" (reverse scored), were taken from [42]; Cronbach's alpha was .85. Medium richness was measured on a seven-point scale ranging from "Not at All" to "To a Great Extent". Five items (four again adapted from [44]) measured medium richness; Cronbach's alpha was .80. Engagement contained nine items again adapted from [21] and [42], such as "When using the software, I was totally absorbed in what I was doing"; Cronbach's alpha was .89.

Performance was a straightforward test of recall and inference. It was calculated as the number of correct responses to a seven-item multiple choice quiz based on the instructional content of the software.

4. Results

Before testing the hypotheses, we compared the manipulation check variables for the three formats. For study 1, medium richness was significantly higher for Video than for Text (Video=4.13, Audio=3.82, Text=3.39). For study 2, medium richness was significantly higher for Video than for Text and for Audio than for Text (Video=4.99, Audio=4.77, Text=4.26); similarly, feedback was significantly higher for Video than for Text and for Audio than for Text (Video=5.74, Audio=5.81, Text=5.23). Tables 1 and 2 summarize the two studies' results. The control variables described above were not significant in either study, and thus were not included in the analyses which follow.

As Table 1 shows, across each format, engagement was higher for the interactive computer-based training in Study 2 than the videotape-based training in study 1 (supporting Hypothesis 1). Interestingly, the level of engagement in the "leanest" format in study 2 (the Text format in the computer-based training) was at the same level as the "richest" format in study 1 (the Video format in the videotape-based training).

Table 1. Comparision of engagement levels in study 1 and study 2

	Means		
	Text	Audio	Video
Study 1:			
Engagement	3.41	3.13	4.65
Study 2:			
Engagement	4.68	5.49	5.28
T-test of differences[a]	3.85***	7.38***	2.52*

[a]: T-test for two independent groups of unequal size [41]
* $p < .05$
** $p < .01$
*** $p < .001$

As proposed in Hypothesis 2, format related positively to engagement (see Analysis of Variance (ANOVA) results in Table 2). For study 1, Scheffé comparisons indicate that Video was higher than both Audio and Text, but that Audio and Text did not differ between themselves. For study 2, Scheffé comparisons indicate that Video and Audio were higher than Text, but that Video and Audio did not differ between themselves.

The research question, H3, examined the relation between format and performance (see Table 2). For study 1, Scheffé comparisons indicate that participants performed higher in the Video format than in the Audio or Text formats. For study 2, there was no relationship between format and performance, although those in the Text condition received (non-significantly) higher scores.

Table 2. Software conditions: *F*-tests, means, and Scheffé comparisons for ANOVAs

	F-ratio	Means			Scheffé Comparisons[a]
		Text	Audio	Video	
Study 1:					
Engagement	8.73***	3.41	3.13	4.65	VT VA
Performance	2.92+	5.72	6.33	6.88	VT VA
Study 2:					
Engagement	9.10***	4.68	5.49	5.28	VT AT
Performance	0.18	3.54	3.36	3.33	- -

[a]: Scheffé tests are at the $p = .05$ level. Letters indicate pairs of conditions that are significantly different, where V = Video, A = Audio, T = Text.
+ $p < .10$
* $p < .05$
** $p < .01$
*** $p < .001$

5. Discussion and Conclusions

Interactive computer-based training resulted in higher engagement than videotape-based training across each of the three formats (Text, Audio, and Video). Figure 1 contrasts these findings with results from an earlier study [42] investigating two formats of an instructor-led computer-based multimedia training presentation. Webster and Ho contrasted a Text format with an Audio plus Animation format and found that participants were more engaged in the Audio plus Animation format. Across these three studies, engagement was low for text. As this finding persisted across different tasks, participants, and training systems, this suggests that text will be a less engaging training format.

Results from the three studies also suggest that for more passive training systems (such as videotape-based and instructor-led presentations), users may require the increased richness that video and animations provide for higher engagement. In contrast, for less passive training systems (such as interactive computer-based systems), it appears that the interactive nature of the medium may help to overcome the leaner formats. Further, it seems that Video does not increase user engagement over Audio for less passive training systems. This is consistent with past research comparing audio and videoconferencing [46] in which users perceived no significant differences between the Audio and Video conditions. If designers of interactive computer-based training systems can induce the same levels of engagement with audio and stills as with full-motion videos, significant savings in terms of computer memory and processing load could result for multimedia systems.

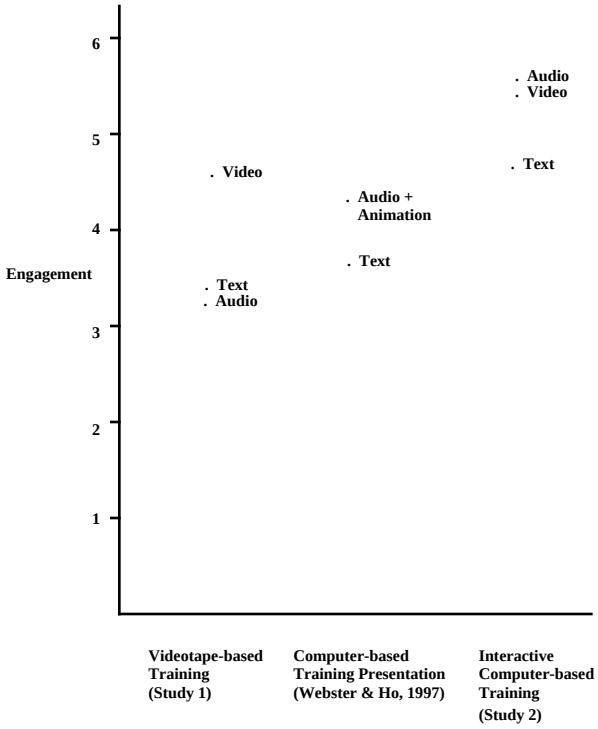

Figure 1: A comparison of engagement across multimedia training modes

Some stereotypes about interactive multimedia are strongly positive. That is, multimedia developers may believe that sound, video, and animations offer much potential for learning. However, Salomon's work (e.g., [36]) suggests that the Text format could result in greater effort expended and increased performance compared to the Video format. Interestingly, performance was highest in study 2 with Text (but not significantly so), giving some support to this argument. In contrast, performance was higher for the Video format for study 1, supporting other research (e.g., [32]). These mixed results suggest that if increased performance is the goal, attempting to engage the user should not be done without considering how cognitively involved the use is in the content of the training. Therefore, future research needs to carefully

examine the relationship between engagement, cognitive effort expended, and performance.

5.1. Limitations and strengths

The study designs contained limitations that may have affected the results. First, the training topics differed between the two training studies -- topics were chosen based on publically-available training materials and on participants' interest in these topics. However, the differences in topics may have affected participants' levels of engagement. Second, both studies used university students as participants. Third, the time available for each participant to actually use the training systems was short, which left little time for experimentation and learning. This could help to explain the results for performance. Such short experimental times are not uncommon in computer-based instructional research, but certainly can be criticized [35].

Notwithstanding these limitations, these studies have several strengths. First, this research responds to calls for more studies on engagement in computer-based learning, and in multimedia in particular (e.g., [1,13,14,22]). Second, as Clark and Craig [7, p. 27] argued, "the main obstacle to multi-media and learning studies is that they are conducted without the benefit of any theory about *why* one would expect differences in the first place"; this study provides a start toward the development of such a theory. Third, this research represents some of the first controlled studies of engagement in human-computer interactions (in which the three conditions were made as similar as possible). Finally, study results have implications for multimedia designers in the growing market for training systems in organizations [34].

5.2. Implications for research and practice

Future research should continue to conduct controlled studies of multimedia training systems, but should extend users' interactions to longer time periods. Further, future research needs to examine the effects of engagement on transfer of training to other coursework, and to the workplace in general [17].

Designing multimedia systems for engagement offers to make interactions with computers enjoyable and rewarding to the user. Although it is not difficult to be in favor of systems that users enjoy, some warn that "preference does not equal performance": the system that users prefer may not actually be the one most conducive to performance [2]. For instance, our study results suggest that designers of computer-based multimedia training systems can expect the same levels of engagement for systems with audio tracks and stills as compared with those with videos.

Engagement should be integrated into software so that the user is engaged by the appropriate aspects of the software. Consider courseware in which a video accompanies textual information. The user may well become engaged mainly by the video and pay less attention to the text. If the text is designed to contribute much more than the video to the learning goals, then the focus of the engagement has been misplaced. Elements such as videos may distract from a learning task -- or, they may maintain attention on the task. The outcome may depend on the way in which the elements relate to the learning material. This represents an area for further exploration.

More generally, researchers need to build from this study to develop a fuller theory of engagement in multimedia systems. Such studies will help to extent research on the motivational aspects of human-computer interactions.

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