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If a picture is worth a thousand words is video worth a million? Differences in affective and cognitive processing of video and text cases

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Abstract In this investigation we assessed whether different formats of media (video, text, and video + text) influenced participants' engagement, cognitive processing and recall of non-fiction cases of people diagnosed with HIV/AIDS. For each of the cases used in the study, we designed three informationally-equivalent versions: video, text, and video + text. Thirty participants experienced one version in each format, thought aloud as they read or viewed the case, discussed their reactions to the stories during an interview, and completed an affective and engagement survey. Participants were again interviewed 6 weeks later to assess their memory for the cases. Results from protocol analysis indicate that the video and video + text versions of the stories led to higher levels of both engagement and sympathy with the characters, and recall of particular information; however, interactions between medium and content were important. We argue the main benefit of video lies in engaging students emotionally in the content.

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Introduction

Evaluating the effectiveness of video as an instructional medium has proven to be complicated and somewhat contentious (e.g., see the debate by Clark 1983, 1994; Kozma 1994). In general, we concur with Mayer et al. (2009) that "media do not cause learning, methods cause learning" (p. 53), and a promising area of research is to examine the ways in which instructional technologies can be combined with instructional methods to produce cognitive and affective processing during learning (e.g., Mayer and Wittrock 2006). Early studies often showed no benefit for video, mixed results, or idiosyncratic findings, leading Clark (1983) to restate a similar claim that had been made by others that "media do not influence learning under any conditions" (p. 445). Researchers who disagree with Clark might concede, at the very least, that media benefits are not simple to identify, and that media effects interact with other educational factors (e.g., contexts, goals, social processes, etc.) in complicated ways. Kozma (1994), for example argues for this contextual stance by considering media to have affordances that "… interact with cognitive and social processes" (p. 11).

Cognitive theory of multimedia based on dual coding theory

Paivio's (1990) dual coding theory provides an initial framework for understanding how multimedia information is processed. Paivio's theory posits two separate symbolic systems—one system is attuned to verbal information including auditory processing and language and the other non-verbal system includes imagery, visual and spatial processing. Dual coding goes beyond making a distinction between separate processing of verbal and visual information, it suggests there is little competition for resources when presenting visual and auditory information together, so that multimedia representations have more powerful educational affordances (Paivio 1990). Additionally, dual coding theory conceptualizes affective and emotional reactions within the nonverbal system since affective responses, by definition, are nonverbal (Sadoski et al. 2000). Clark and Paivio (1991) asserted that pictures elicit higher emotional reaction than words.

Video with its visual and verbal codes might be a more effective and powerful medium for delivery of instructional material compared to a single representation of just verbal code. According to the cognitive theory of multimedia developed by Mayer et al. (2001), information is easier to process in multimedia environments with on-screen narration and images. Pictorial information and narration allows for the parallel processing of information via visual and verbal inputs (Moreno and Mayer 1999).

Affective processing of media

Visual imagery, such as pictures and video generally elicit more affective responses as compared to written words (Clark and Paivio 1991; Machula 1978). For example, Koehler et al. (2005) examined how equivalent text and video stories influenced participants' affective and emotional engagement. Results suggested that participants in the video condition found it to be more engaging and interesting than their peers in the text condition. Specifically, video showing emotional interactions led to participants' higher emotional engagement. The authors argued that one benefit of video lies in the affective realm to capture one's interest and engagement; however, there is a complex interaction between media format and the content it delivers. Specifically, Koehler and colleagues suggested that video is engaging for only certain types of stories, such as human-interest narrative, but not for artistic or informational presentations, such as a talking-head lecture. Machula also found that media and content interact to influence one's experience, with video producing affective responses in some stories and not others.

Video with its nonverbal cues has the potential to emotionally engage students. For example, Birdwhistell (1970) found that 55% of what one communicates to another is conveyed via nonverbal communication, such as body posture and movement, 30% using tone of voice, timber, tempo, and volume of speech, and only 7% via words. Mayer et al. (2001) also found that using video (with irrelevant information) to elicit emotional interest in an explanation primed students to pay attention to supplemental information rather than structurally relevant information.

Cognitive processing of media

A few notable attempts have been made to investigate media effects while controlling for equivalent content. For example, in a study by Baggett (1979), revisions to a text version of the dialogue-less movie *The Red Balloon* were made until participants could match episodes in the film with passages from the story and vice versa. The resulting structurally-equivalent forms of the story (the video and text versions) were used in a different study of memory. Using a cued recall approach, they found that immediately upon finishing the story, there was no effect for media—both forms of the story (text and video) led to similar patterns of recall. However, an analysis of delayed recall (7 days later) revealed much better performance for participants who had viewed the video version of the story. Interpretation of these findings is based upon the work of Kintsch and van Dijk (1975), who demonstrated that stories told in words invoke schemas for processing, storing, and organizing information to come later in the story. Baggett (1979) argued that a similar schema-driven process exists for stories told in video, however, these schemas differ from those used to process stories in text.

Presenting the same information in on-screen text and video may produce a redundancy effect because the cognitive load placed on the visual channel by the text and video have the potential to hinder processing of the information (Sweller and Chandler 1994). However, there is limited research that has utilized participant verbal reports to elicit their cognitive processing and affective responses to media.

In the present study, we were interested in studying students' level of engagement and affective impact of the cases with the different media formats (text, video, or video + text). We utilized verbal protocol analysis, which has led to important insights into how struggling and sophisticated readers process texts, reasoning that asking people to think aloud as they experienced different media might provide insight into students' cognitive processing strategies and affective responses (Lundeberg 1987; Pressley and Afflerbach 1995).

Research questions

Our research questions were: (1) Does the media or case affect students' cognitive processing strategies? (2) Does the media or case affect students' emotional reactions? (3) Do either media or case affect students' 6-week recall? Emotional responses may motivate prosocial, moral behaviors (Pizarro and Salovey 2002), and if video cases of people diagnosed with HIV/AIDS elicit more emotion than equivalent text version, we would expect video cases to produce more engagement and delayed recall. We did not know what the effects of giving participants both text and video versions of the case simultaneously would produce.

Method

Participants

Thirty undergraduate students who were all education majors at a large Mid-western university took part in the study and were either paid for their time or received extra credit in their course work. Participants included seven males and 23 females who were freshmen ($n = 17$), sophomores ($n = 8$), juniors ($n = 4$), and one senior. The majority of the participants were Caucasian ($n = 24$), with three African Americans, one Asian, one Hispanic, and one Caribbean African. The average age of the participants was 19 years, ranging from 17 to 32 years of age.

Materials

We chose video that contained a number of personal narratives about HIV/AIDS. The stories are a mix of narration by a focal person and an unseen narrator. The cases were being developed for future use in biology courses, therefore we attempted to find cases that were ecologically valid and not contrived. The personal narratives were three individuals that had been diagnosed with HIV and were willing to share their experiences. The narratives used in the study were as follows:

- Lisa is a Caucasian, heterosexual female from an affluent background. Lisa was infected by her boyfriend and received immediate expert care and medications that controlled the spread of HIV in her body. She later married and had three HIV negative children by having unprotected sex when her viral load was low. She has not reported serious medical problems related to HIV.

- Doug is a Caucasian, homosexual male from a middle class background who grew up in Southern California. He "came out" when he was 20 and moved to San Francisco. While Doug was well aware of the risks of HIV, and knew how to protect himself, he had unprotected sex and contracted HIV. He found out he was HIV positive when he became seriously ill. Doug's case focuses on his poor decision-making and how that led to him contracting HIV. For example, Doug says, "[having unprotected sex] was stupid, you know, I mean I just can't believe that I did that". Doug closes his story by stating the importance of disclosing if one is HIV positive and that he is educating young people about HIV.
- Catrice is an African-American, heterosexual woman from a low socio-economic background. She grew up in a "Bible Belt" in the south. The risks of HIV were never discussed in her home or at school. She contracted HIV when she was 17 from a popular, promiscuous boy at school. After being diagnosed, Catrice reported going into a "deep denial" with her friends and family. She went untreated for 4 years. During that time Catrice became pregnant and she lost a lot of weight due to the virus. The case closes by stating that 3 months after she gave birth, preliminary tests showed that her daughter might have been exposed to the HIV virus.

Three different media versions—text, video, and video + text—were created for each of the three cases (i.e., Lisa, Doug, and Catrice). Text versions of the cases were created by transcribing the videos and making subtle changes to maintain the overall essence of the story. Any verbal patterns (e.g., uh's, like's, etc.) that led to unclear transcripts were removed and quotes from the focal person(s) in the videos were included. All three media types were presented in two segments on webpages (word length and readability statistics for the texts and time length for videos are summarized in Table 1 and an example of a screenshots are provided in Fig. 1).

All three formats (text, video, and video + text) were segmented at the same point in the case and participants had to click a button to continue watching/reading the remaining narrative. For the text version of the cases, the text was presented in paragraph form with a still picture of the individual from the personal narrative

Table 1 Length of video segments, number words from text, and Flesch reading ease for cases

	Length for video	Number of words from text	Flesch reading ease score
Lisa: Part 1	1 m. 14 s.	205	65.0
Lisa: Part 2	1 m. 08 s.	64	
Total	2 m. 22 s.	269	
Doug: Part 1	1 m. 54 s.	281	63.6
Doug: Part 2	0 m. 49 s.	136	
Total	2 m. 43 s.	417	
Catrice: Part 1	2 m. 26 s.	219	73.0
Catrice: Part 2	1 m. 40 s.	417	
Total	4 m. 06 s.	636	

Fig. 1 Screenshot examples

juxtaposed to the left of the text. For the video + text version of the cases, the video was juxtaposed to the left of the text narrative (i.e., the same text versions from the text only format) and included audio as well. Both the text and video + text versions were presented in a way that allowed participants to read the material at their own pace and were segmented into two sections. For the video + text versions, participants were given no direct instructions to use both media.

Procedure

All of the participants experienced three cases. We counterbalanced each combination of media (i.e., text, video, and video + text) and case (i.e., Lisa,

Doug, and Catrice) so that each media × case was presented in the first, second or third position, participants were then randomly assigned to one of the 36 potential sequences (e.g., $Lisa_{Video}$ $Catrice_{Video+Text}$, $Doug_{Text}$; $Catrice_{Text}$, $Doug_{Video}$, $Lisa_{Video+Text}$; and so forth). This was to assure that each media and case condition was equally likely to be presented first, second or third in the overall participant pool. Thus, each participant experienced every case and every media, but in different combinations and in a different order. The six sequences not used, based upon the random assignment of 30 participants to the 36 possible conditions, were: (1) $Doug_T$ $Lisa_{V+T}$ $Catrice_V$, (2) $Catrice_V$ $Doug_{V+T}$ $Lisa_T$, (3) $Lisa_T$ $Doug_V$ $Catrice_{V+T}$, (4) $Doug_{V+T}$ $Catrice_T$ $Lisa_V$, (5) $Doug_T$ $Catrice_V$ $Lisa_{V+T}$, and (6) $Doug_{V+T}$ $Catrice_V$ $Lisa_T$.

Participants completed a background survey designed to gather demographic information, specifically, participants' age, gender, ethnicity, and year in school. After participants completed the background survey, the experimenter introduced the media using a training video (i.e., a different HIV/AIDS story not used in the study) for the participants to familiarize themselves with how to stop the video to discuss what they were thinking or feeling while viewing the case. A training video was used to ensure participants were comfortable and knew how to stop the video in order to discuss their thoughts. We also trained students to think aloud when reading the text; specifically, we modeled how students could stop reading to share their thoughts with the researcher (students were not forced to do this and the discussion was driven by the participants).

Participants were then instructed to begin the first of the three cases and to think aloud as they experienced it. All think-aloud data were audiotaped and transcribed. With the narratives being segmented into two parts, the interviewer asked participants what they were thinking and feeling about the narrative and prompted for further clarification as needed between the segments and at the end of each case, even if the participant had stopped during the case or not. Participants experienced all three narratives using the same routine. These think-alouds were used to assess cognitive strategies used by participants to process the cases. Think aloud protocol has been used previously to assess cognitive strategies (Lewalter 2003). The researchers were trained in the think-aloud procedure regarding how to prompt participants to begin discussion, clarify their responses, and elaborate on their thoughts utilizing similar practice materials.

After each case, students also completed an affective/engagement questionnaire. The questionnaire consisted of 23 items using a semantic differential (Osgood et al. 1957) with opposing affective adjective pairs (see Table 2).

Fourteen of the items were in response to the prompt, "The stories made me feel …" (e.g., excited/bored, emotional/unemotional, informed/uninformed, interested/uninterested, etc.) and the other nine were in response to "The cases were …" (e.g., interesting/not interesting, realistic/unrealistic, sympathetic/unsympathetic, informative/not informative). The affective/engagement survey was adapted from Koehler et al. (2005) and was used as the basis to explore the macro-level questions of media and story interactions since this instrument was common to all stories.

Table 2 Adjective pairs and factor loadings

	Factor loadings						
	Positive affect	Engagement	Sympathy	Thought provoking	Knowledgeable	Realistic	Bias
Troubled–untroubled	.788						
Emotional–unemotional	.475						
Uncomfortable–comfortable	.613						
Not confused–confused	−.558						
Sad–happy	.610						
Optimistic–pessimistic	−.491						
Frustrated–not frustrated	.616						
Passive–active		.802					
Disengaged–engaged		.803					
Bored–interested		.774					
Interesting–not interesting		−.514					
Unsympathetic–sympathetic			−.791				
Convinced–unconvinced			.577				
Sympathetic–unsympathetic			.790				
Not informative–informative				−.728			
Unemotional–emotional				−.535			
Thought provoking–not thought provoking				.827			
Relevant–irrelevant				.490			
Informed–uninformed					.824		
Knowledgeable–not knowledgeable					.635		
Realistic–unrealistic						.741	
Clear–confusing						.720	
Biased–unbiased							−.825

Participants were interviewed again, by the same researcher, after 6 weeks to assess their recall of the three narratives experienced during the first session. Participants were asked what they could recall about the three narratives; specifically asking them what they remembered about each story and what stood out for them. Participants were also asked to recall how the person became infected. We utilized this free recall rather than a "standardized" recall, as it has been found that free recall allows participants to recall information as they have encoded it and not restrict their recall by imposing an external structure (Mandler 1967; Reffel 1997).

Data analysis

We analyzed participants' think-aloud protocols when they experienced the cases, their 6-week recall of the cases, and responses to the affective/engagement survey given after every case. Data from all 30 participants were used for the affective/engagement survey and the 6-week recall. Due to the amount of data generated by each individual during the think-aloud protocols, 15 participants were randomly selected for the protocol analysis from the 30 participants using a random number generator. The transcripts were not selected based on content or representativeness for any particular theme or participants' demographic information. Of the 15 students whose verbal protocols we analyzed, eight were female Caucasians, three were male Caucasians, three were African American females and one Caribbean-African male.

Think-aloud analysis

For the think-aloud protocols, we used Grounded Theory (Strauss and Corbin 1990) to develop a coding scheme. First we reviewed the 15 individual transcripts and identified appropriate categories. Upon completion of the first attempt for creating a coding scheme, we examined the transcripts a second time to see if any new categories could be identified. The first round of developing a coding scheme resulted in a very fine-grained analysis with two major categories, emotion and cognition, with 20 subcategories emerging for these themes. For the finalized coding scheme we collapsed many of the subcategories.

The finalized coding scheme resulted in the following six overarching categories: (1) *Cognitive Processing*; (2) *Cognitive Disconnect*; (3) *Positive Evaluations*; (4) *Judgments*; (5) *Prior Knowledge*; and (6) *Emotions*. See Table 3 for examples and descriptive statistics regarding the categories of comments.

With the final coding scheme, two researchers coded the 15 transcripts. The inter-rater reliability between two researchers was 79% agreement for all 15 protocols. When discrepancies in coding occurred, consensus was reached for the particular comment in question by consulting with a third researcher.

The six categories (*Cognitive Processing*, *Cognitive Disconnect*, *Positive Evaluation*, *Judgments*, *Prior Knowledge* and *Emotion*) were analyzed for differences using a multivariate analysis of variance (MANOVA) with two factors—media (text, video, video + text) and case type (Lisa, Doug and Catrice).

Table 3 Examples and descriptive statistics for think aloud categories

Response category	Example	M, SD and frequencies
Cognitive processing	*Prediction*: "When it said that this would be the last place that you would expect to find it, I knew she was probably going to have AIDS and it was probably from the guy she had slept with."	1.69, (1.35), 76
	Summary; "He knew the other partner and trusted him and basically he got infected."	
	Inference: He made his decision and I guess he realizes that now, and now he is just trying to make the best out of his situation."	
	Monitoring: "I don't know if they were married or just a boyfriend."	
Judgments	*Characters' actions and thoughts*: "They talked about condoms but just didn't use them, that was really stupid."	1.04, (.96), 47
	Society and education: "She should have been informed about it, like in school or something."	
Positive evaluation	"That's awesome that he loves her so much that he can get past that part that she was infected."	.84, (1.07), 38
	"Well for her she is lucky because it is covered by health insurance."	
Cognitive disconnect	*Disagreement*: "He says, 'especially the gay community,' how they should be aware of it. It's not just the gay community though. Everyone should be aware really, not just the gay people."	.69, (.87), 31
	Questioning: "When is back then in this story?"	
	Cognitive dissonance: "It just struck me as odd to see, when I read, that women, like Lisa, were not suppose to become infected by the AIDS virus."	
Prior knowledge	*Text-to-world*: "We can relate his story to someone, who is like Magic Johnson, who is 10 years ago, who came forward and said that he was infected."	.69, (.82), 31
	Text-to-self: "But my aunt who died, she had some type of infectious disease, like a viral that can only be transmitted through the blood."	
	Personal beliefs: "You can't count on everybody's parents to teach their kids about sex and everything."	
	Double coded with emotion: "It is just kinda stupid how some people are just in denial about when they are pregnant or they are just waiting for something to happen before they take care of themselves."	
Emotion	"I feel bad for her."	.53, (.89), 24
	"That's sad, that he wouldn't protect himself."	

Field (2009) recommended that the traditional approach is to complete a follow-up univariate analysis for each dependent variable of a MANOVA. Hence, we conducted a follow-up univariate analysis.

Recall analysis

The 6-week recall interview responses were transcribed, and analyzed for the facts participants could recall about each case. Two researchers independently coded

each transcript for the absence or presence of facts from the cases. Inter-rater reliability was 79% agreement, and disagreements were resolved by consensus.

The themes were collapsed into four overarching categories: *Description of the individual* (description of the individuals in the three cases); *Family of the individual* (description of the family of the individual); *Contraction* (recalling how the individual contracted HIV); and, *Medication* (recalling what the individual was doing for medication). These four categories were used as dependent variables in the final analysis using univariate analysis of variance (ANOVA) with two factors: media (text, video, video + text), and case type (Lisa, Doug and Catrice). However, we adjusted the probability level ($\propto = 0.05$) to guard for inflated experiment-wise (type-I) error rate. Since we used four ANOVAs, the Bonferroni adjustment resulted in the alpha value of 0.0125.

Survey analysis

The affective/engagement survey was analyzed using a principal components factor analysis with varimax rotation on ranked responses to the 23 items to identify patterns in the responses, and to reduce the number of dimensions of comparison in the analysis (for purposes of increasing interpretability and controlling overall experimental-wise error rate). To generate the factors, we used Kaiser's recommendation of Eigen value over one and also analyzed the scree plot, which suggested the same number of factors—seven. In order to interpret specific factors, we only assigned items with factor loadings above |0.40| and if an item had loadings on two factors greater than |0.40|, it was assigned to the factor with highest loading. The resulting factor scores were analyzed in a blocking design (using the participants repeated measures as blocks) in a three-way ANOVA with media (text, video, video + text), case (Catrice, Doug, Lisa), and participants as factors. Since we used seven ANOVAs, we adjusted the probability level for inflated experiment-wise (type-I) error rate, which resulted in the alpha value of 0.007.

Results

Affective/engagement survey

The principal component analysis with varimax rotation produced seven factors. The Kaiser–Meyer–Olkin measure suggested that the sample was adequate, KMO = 0.74, which is considered good (Field 2009). Bartlett's test of sphericity, $\chi^2(253) = 807.54$, $p < .0001$, indicated that correlations between items were sufficiently large for principal component analysis. These seven factors were produced, and can be easily interpreted based upon the adjective pairs most heavily loaded for each factor, as described in the Table 4 below.

Table 5 shows descriptive statistics and Table 6 shows ANOVA statistics for the survey factors.

Table 4 Results of factor analysis

Factor	% of variance	Adjectives most associated with this factor
Positive affect	23.9	I felt: *untroubled, comfortable, happy, optimistic*
Engagement	13.6	I felt: *active, engaged, interested*
		The stories were: *Interesting*
Sympathy	8.9	I felt: *sympathetic, optimistic, convinced*
		The stories were: *sympathetic*
Thought provoking	6.3	The stories were: *informative, thought provoking*
Knowledgeable	6.1	I felt: *informed, knowledgeable*
Realistic	5.3	The stories were: *clear, realistic*
Bias	4.5	The stories were: *biased*

Using three-way ANOVAs (Media × Case × Participant), a significant main effect was found for media on the engagement factor $F(2,52) = 10.396$, $p < .000$, $\eta_p^2 = 0.29$. A pairwise comparison analysis revealed that the text condition differed significantly in terms of engagement from the video ($p = 0.001$) and video + text conditions ($p = 0.001$). Participants felt more engaged in the video and video + text conditions than they did in the text only condition. A main effect was also found for case for the positive affect factor $F(2, 52) = 6.702$, $p = 0.003$, $\eta_p^2 = 0.21$. A pairwise comparison suggested that participants felt more positive affect towards Lisa ($p = 0.002$) and Doug's ($p = 0.005$) case as compared to Catrice's case.

Overall, participants found that using video as a medium for presenting a case was more engaging than presenting the case using text. Presenting the cases in a video format seemed to make it easier for students to invest their attention and their emotions in the cases being presented. However, participants felt that Lisa's story was more realistic compared to Doug's or Catrice's story.

Think-aloud protocol analysis

A multivariate analysis of variance (MANOVA) was conducted to investigate potential differences between the independent variables (media and case type) on the six dependent variables (*Cognitive Processing*, *Cognitive Disconnect*, *Positive Evaluation*, *Judgments*, *Prior Knowledge* and *Emotion*), controlling for participants. We hypothesized that participants' media preference would have an influence on how they processed the content. With participants reporting a preference for either the video or video + text condition during the exit interviews during session one, we expected our hypothesis to be supported by the think-aloud data. Even though the overall omnibus MANOVA results were significant, the main effect for media type using Hotelling's trace was not, $F(12, 58) = .905$, $p = 0.547$, $\eta_p^2 = .158$ (See Table 7 for means and Table 8 for MANOVA statistics).

With all of the narratives from the same genre and about the same topic—people's stories about contracting HIV and their reaction to this disease—we did not

Table 5 Descriptive statistics for the survey factors

	Positive affect Mean (SD)	Engagement Mean (SD)	Sympathy Mean (SD)	Thought provoking Mean (SD)	Knowledgeable Mean (SD)	Realistic Mean (SD)	Bias Mean (SD)
Media							
Text	2.90 (0.43)	3.10 (0.51)	2.91 (0.38)	2.64 (0.43)	2.68 (0.73)	1.73 (0.66)	3.73 (0.98)
Video	2.77 (0.50)	3.43 (0.32)	2.77 (0.46)	2.56 (0.40)	2.38 (0.70)	1.63 (0.64)	3.50 (0.86)
Video + text	2.85 (0.44)	3.43 (0.34)	2.87 (0.45)	2.64 (0.42)	2.20 (0.58)	1.70 (0.68)	3.47 (0.90)
Case							
Lisa	2.94 (0.35)	3.29 (0.37)	2.89 (0.43)	2.66 (0.42)	2.49 (0.79)	1.82 (0.71)	3.70 (0.92)
Doug	2.92 (0.47)	3.24 (0.41)	2.91 (0.42)	2.64 (0.42)	2.45 (0.63)	1.58 (0.57)	3.50 (0.94)
Catrice	2.65 (0.48)	3.39 (0.50)	2.74 (0.43)	2.54 (0.42)	2.32 (0.66)	1.67 (0.67)	3.50 (0.90)

Table 6 ANOVA statistics for the survey factors

Dependent variable	Factor	*df*	*F* value	*p* value	Partial eta-squared
Positive affect	Media	2,52	0.86	0.43	0.03
	Case	2,52	6.70	0.003*	0.21
	Media × case	4, 52	1.17	0.34	0.08
Engagement	Media	2,52	10.40	0.00*	0.29
	Case	2,52	0.43	0.65	0.16
	Media × case	4, 52	0.80	0.53	0.06
Sympathy	Media	2,52	1.34	0.27	0.05
	Case	2,52	2.86	0.07	0.10
	Media × case	4, 52	0.71	0.60	0.05
Thought provoking	Media	2,52	0.72	0.49	0.03
	Case	2,52	0.60	0.55	0.02
	Media × case	4, 52	1.36	0.26	0.10
Knowledgeable	Media	2,52	3.24	0.04	0.11
	Case	2,52	0.55	0.58	0.02
	Media × case	4, 52	1.88	0.13	0.13
Realistic	Media	2,52	0.26	0.77	0.10
	Case	2,52	1.57	0.22	0.06
	Media × case	4, 52	0.57	0.68	0.04
Biased	Media	2,52	1.24	0.29	0.05
	Case	2,52	0.68	0.51	0.03
	Media × case	4, 52	0.15	0.96	0.01

* Indicates significant values

Table 7 Descriptive statistics for the verbal protocol categories

	Cognitive processing Mean (SD)	Cognitive disconnect Mean (SD)	Positive evaluation Mean (SD)	Judgment Mean (SD)	Prior knowledge Mean (SD)	Emotion Mean (SD)
Media						
Text	1.67 (1.91)	0.93 (1.10)	0.60 (0.83)	1.07 (0.80)	0.73 (0.80)	0.47 (0.83)
Video	1.47 (0.83)	0.73 (0.80)	1.00 (1.00)	1.27 (1.16)	0.67 (0.72)	0.67 (1.23)
Video + text	1.93 (1.00)	0.40 (0.63)	0.93 (1.33)	0.80 (0.86)	0.67 (0.97)	0.47 (0.52)
Case						
Lisa	1.40 (1.21)	0.93 (1.10)	1.73 (1.33)	0.73 (0.88)	0.73 (0.96)	0.33 (0.49)
Doug	1.33 (1.11)	0.40 (0.63)	0.67 (0.48)	0.87 (0.83)	0.73 (0.80)	0.33 (0.49)
Catrice	2.33 (1.59)	0.73 (0.80)	0.13 (0.35)	1.53 (1.00)	0.60 (0.74)	0.93 (1.33)

expect a difference to be found on the six dependent variables for case type. However, the results for the overall MANOVA revealed a main effect [$F(12, 58) = 4.074$, $p = .000$, $\eta_p^2 = .457$] for case type. Results for the overall MANOVA

Table 8 MANOVA results from verbal protocol analysis

Factor	*df*	*F* value	*p* value	Partial eta-squared
Media	12, 58	0.905	0.547	0.158
Case	12, 58	4.074	0.00*	0.457
Cognitive processing	2, 35	3.074	0.059	0.149
Cognitive disconnect	2, 35	2.465	0.100	0.123
Positive evaluation	2, 35	13.672	0.000*	0.439
Judgment	2, 35	3.382	0.045*	0.162
Prior knowledge	2, 35	0.162	0.851	0.009
Emotion	2, 35	2.385	0.107	0.120
Media × case	24, 114	2.546	0.001*	0.349
Cognitive processing	2, 35	1.399	0.254	0.138
Cognitive disconnect	2, 35	7.295	0.000*	0.455
Positive evaluation	2, 35	0.423	0.791	0.046
Judgment	2, 35	0.687	0.606	0.073
Prior knowledge	2, 35	4.520	0.005*	0.341
Emotion	2, 35	1.128	0.359	0.114

* Indicates significant values

also revealed a significant main interaction effect between media and case [$F(24, 114) = 2.55$, $p < .001$, $\eta_p^2 = .349$].

On a follow-up investigation of the case type main effect, we found that two factors were significant for case type—*Positive Evaluation* [$F(2, 35) = 13.672$, $p < 0.001$, $\eta_p^2 = .439$] and *Judgments* [$F(2, 35) = 3.382$, $p < 0.05$, $\eta_p^2 = 0.162$]. In addition, a non-significant trend for *Cognitive Processing* was found [$F(2, 35) = 3.074$, $p = .059$, $\eta_p^2 = .149$]. Post hoc t-tests were conducted for the two factors, *Positive Evaluation* and *Judgments*, to evaluate where the differences occurred between the three cases—Lisa, Doug, and Catrice.

The post hoc t-tests for *Positive Evaluation* by case type revealed significant differences between all of the cases (Lisa > Doug > Catrice; Lisa > Doug, $t(28) = 2.907$, $p = .007$; Lisa > Catrice, $t(28) = 4.490$, $p < .000$; Doug > Catrice, $t(28) = 3.434$, $p = .002$). In other words, students made more positive evaluations when experiencing Lisa's case than they did with Doug's case, who in turn experienced more positive evaluations than did Catrice. Students seem to identify with Lisa's case and reported being happy that her treatment was working and that she experienced successful outcomes. Typical *Positive Evaluations* for Lisa included, "it's good that she went on with her life", and "I'm happy her kids are HIV negative". Doug represented more of a neutral case; however, several students made *Positive Evaluations* regarding his decision to educate people about HIV infection. For instance one student stated, "I think it is nice that he is helping people. It's a pretty noble cause to undertake".

Perhaps understandably then, the results of the post-hoc t-tests for *Judgment* by case type (No significant difference between Lisa and Doug; Lisa < Catrice,

$t(28) = 2.334$, $p = .027$; Doug < Catrice but not at a significant level, $t(28) = 1.994$, $p = .056$) indicated that students were much more likely to evaluate Catrice negatively over the other two characters, Lisa and Doug, due to her perceived poor decision-making. This contrast can be seen in the following response, "It is just kinda stupid how some people are just in denial about when they are pregnant or they are just waiting for something to happen before they take care of themselves."

However, with Catrice's case we also observed a tendency for participants to remark on the lack of education that high school students receive regarding proactive behaviors against HIV. On average students made almost double the negative judgments when experiencing Catrice's case over the other two cases (1.53 comments on average compared to 0.73 for Lisa and 0.87 for Doug). Whereas, many of the judgments made during Lisa's case had to do with the ability to purchase medication due to inequality of socio-economic status among HIV patients. Thus, we found that the individual cases mediated the effects of video. Even though the cases were all the same genre, they affected students' emotions differently.

Recall analysis

Tables 9 and 10 show detailed descriptive and inferential statistics for the recall data.

The ANOVA results suggested no significant media differences on the four categories, *Description of the individual*, $F(2, 38) = 1.768$, $p = .184$, $\eta_p^2 = 0.085$; *Family of the individual,* $F(2, 18) = 2.661$, $p = .097$, $\eta_p^2 = .228$; *Contraction*, $F(2, 38) = 0.288$, $p = .561$, $\eta_p^2 = .030$; *Medication*, $F(2, 38) = 3.350$, $p = .046$, $\eta_p^2 = .150$. For case type, results suggested that two of the four recall categories were significant: *Family of individual in the case*, $F(1, 18) = 39.806$, $p < .000$, $\eta_p^2 = .689$; and *Medication*, $F(2, 38) = 5.507$, $p = .008$, $\eta_p^2 = .255$.

Table 9 Mean for all the four recall categories

	Description of individual Mean (SD)	Family of individual Mean (SD)	Contraction Mean (SD)	Medication Mean (SD)
Media				
Text	2.13 (1.42)	1.50 (1.4)	1.43 (1.72)	0.17 (0.49)
Video	2.91 (2.42)	1.93 (1.94)	1.74 (1.51)	0.48 (0.89)
Video + text	2.26 (1.51)	1.18 (1.77)	1.30 (1.25)	0.83 (1.11)
Case				
Lisa	1.78 (0.95)	2.57 (1.72)*	1.04 (1.18)	0.87 (1.18)*
Doug[a]	2.61 (1.40)		1.78 (1.27)	0.09 (0.28)
Catrice	2.91 (2.64)	0.48 (0.89)	1.65 (1.89)	0.52 (0.84)

* Indicates significant values

[a] Participants did not recall any items for Doug's family

Table 10 ANOVA results for the four recall categories

Dependent variable	Factor	*df*	*F* value	*p* value	Partial eta-squared
Description about the individual	Media	2, 38	1.768	0.184	0.085
	Case	2, 38	4.292	0.021	0.184
	Media*Case	4, 38	1.233	0.313	0.115
Family of the individual	Media	2, 18	2.661	0.097	0.228
	Case	1, 18	39.806	<0.00*	0.689
	Media*Case	2, 18	2.516	0.109	0.218
Contraction	Media	2, 38	0.288	0.561	0.030
	Case	2, 38	2.281	0.116	0.107
	Media*Case	4, 38	1.460	0.233	0.133
Medication	Media	2, 38	3.350	0.046	0.150
	Case	2, 38	5.507	0.008*	0.225
	Media*Case	4, 38	1.432	0.242	0.131

* Indicates significant values at $p < 0.00125$

It was not a surprise that case was a significant factor for participants being able to recall about *Family of the individual in the case*. Participants recalled the most information about Lisa and her family ($M = 2.57$, SD $= 1.72$) as compared to Catrice ($M = 0.48$, SD $= 0.89$). Lisa's case was unique with regards to family as she met her husband after she had contracted HIV and they got married. The case further describes how they had three HIV negative kids in spite of Lisa being HIV positive. The case also described that Lisa's dad was a doctor and hence was able to provide her with the best care possible. These aspects of the case about Lisa and her family helped students recall more details about her family. This is highlighted by one participant's comments when recalling Lisa's case, "And then she [Lisa] met another guy, who, they wanted to get married and they wanted to have kids but, she was uh concerned about her kids getting HIV. So anyways, they got married [and had] three kids who didn't get the virus [were not HIV positive]."

Similar to the findings for media type, case type was also a significant factor for the *Medication* category. Results indicated that participants recalled more things about Lisa's medication/treatment ($M = 0.87$, SD $= 1.18$) as compared to Doug ($M = 0.09$, SD $= 0.28$) and Catrice ($M = 0.52$, SD $= 0.84$). This was again not surprising as Lisa's case depicted her as being from a wealthy family and her dad as a doctor; hence, she was able to afford the best medication available. Another hypothesis for why participants recalled more about Lisa's medication is that even though she was HIV positive, she had three kids who were not. In addition, her husband remained HIV negative even after having unprotected sex with Lisa in order to conceive their three children. This is highlighted by one participant's comments, "the second one [Lisa] I think she was a married, she was married woman and had kids and her kids didn't have HIV, her dad was a doctor… she was like better off, she was pretty wealthy and her dad got her lots of good treatment and everything, and she was really able to get it under control". Similarly another participant said, "So anyways, they got married [and had] three kids who didn't get

the virus. I just remember her… [talking about] taking medicine to control the virus to increase her T-cells in fighting the infection." Thus, students recalled different kinds of information from the three cases and these differences appeared connected to the differences in emotional reactions produced by these cases. Video contexts strengthened the information recalled, depending on the context of the case.

Discussion

Results from this study suggest that video is more powerful than text in engaging students; both mediums have similar cognitive affects in terms of cognitive processing and recall; finally, the interaction between medium and the content it delivers is important. Participants in this study were more engaged when experiencing the cases in the video or video + text condition as compared to the text condition. Participants also felt more sympathetic and thought the video cases were more realistic than the text cases. We also found that media did not significantly influence participants' cognitive processing and cognitive disconnect or recall of the description of individual and family in the cases.

Video more powerful than text

Results from this study suggest that video (or video + text) cases were more powerful than the text cases in the affective realm. Specifically, the engagement questionnaire suggested that participants felt video was more engaging than text, and video also elicited more emotional feelings towards the focal person in the cases presented. The data also suggested that participants found video to be a more powerful medium as it "brought to life" the cases and made them more "realistic" as compared to the text cases, which were "like reading a newspaper". This finding has important implications for influence on students' lives and promoting prosocial behaviors. Previous research by Cody and Lee (1990) has suggested that when students watch an emotional video, they are less likely to engage in risky behaviors. They examined the influence of viewing an emotional video about skin cancer on students' beliefs, knowledge, and skin protection behavior as compared to informational video and a control video. Data was collected in a pretest–posttest format; a second posttest was also conducted 10 weeks later using questionnaires that assessed students' health beliefs and behaviors. Cody and Lee found that students who watched the emotional video were motivated to use higher skin protection behaviors as compared to the control video. Even though we did not directly examine students' subsequent intentions about protection from HIV/AIDS, our finding in conjunction with Cody and Lee's findings that an emotional video can captivate students' attention is important given the nature of the disease and the worldwide attention it receives. Emotions, too, have an impact on conceptual change in science, and we are just beginning to appreciate the role of "hot cognition" in learning as Sinatra and colleagues have illustrated (Sinatra et al. 2009).

Video and text have similar cognitive effects

The mediums, however, did not differ in terms of their influence on cognitive factors. Specifically, the verbal protocol analysis exhibited no difference on participants' cognitive processing and cognitive dissonance. Also, the recall differences between the mediums were not found to be significant. These recall results were surprising as it was hypothesized that there would be differences between the mediums for recall of information, since video—with its two separate symbolic systems—provides little competition for resources (Paivio 1990). A possible conjecture for this finding might have been that the information presented via both text and video was concrete, as opposed to abstract, and was easily encoded twice, "once in terms of verbal attributes and once in terms of imaginal attributes" (Ashcraft 1989, p. 219). For example, the category description of individual consisted of themes like Caucasian, African American, Woman, etc., which could be "recorded twice in memory, once as a word and once as a visual image, there were two different ways it could have been retrieved from memory, one way for each code" (Ashcraft, p. 219). Hence, we did not find significant difference between video and text for recall of concrete information presented in the cases.

Content matters

One of the crucial findings of this study is that differences between stories did occur and there was significant interaction effect between media and case for the verbal protocol analysis. Specifically, the story significantly influenced participants' positive evaluation and judgment of the individuals portrayed in the story. These results were not particularly surprising as each case presented a unique story about the focal person and showcased different situations depending on the individual. For example, participants made more positive evaluation statements for Lisa, while making more negative judgment statements for Catrice. These two cases were quite different as Lisa's case showcased her as being "responsible" where she took medication when she found out she was HIV positive. Lisa met her husband and told him about her illness and they had three children who were all HIV negative. Catrice, on the other hand, remained in denial for 4 years after she found out she was HIV positive, got pregnant, and her child might have been exposed to HIV. Hence, it was not a surprise that case was a significant factor in participants' positive evaluation and judgment of the individuals portrayed in these cases.

Case was also a significant factor for recall of an individual's family and medication they took. In recalling about the family of the individual in the case, participants recalled most about Lisa's family; specifically, recalling how Lisa was married and had kids, who were all HIV negative. Participants were surprised at this, as one participant reported, "the thing I remember about that is that they were um, they were doing unprotected sex and the dad didn't get infected. He was negative, and then he didn't get infected, which was shocking to me". It is possible that this information presented in the case stood out for the participants and they were more likely to recall it as it was something they did not know about previously.

Finally, participants' recall regarding individuals receiving medication/treatment was greatest for Lisa. This could be because participants were able to recall that Lisa's dad was a doctor and she received the best care, which allowed her to get pregnant without having her husband and kids being infected with HIV. Furthermore, the majority of the participants were able to recall that taking medication helped Lisa increase her T-cell count to fight the infection. These two facts could have potentially supported or challenged participants' already known information (or misinformation), they were able to recall it more easily.

Conclusion

Our purpose in this study was to examine both cognitive and affective differences between text, video, and video + text by using verbal protocol analysis, interviews, and survey. There are three main findings from this study as discussed above: video is more powerful than text in the affective/engagement realm; video and text have similar cognitive effects as indicated by the cognitive processing, cognitive dissonance, and recall of information; finally, content matters as stories significantly influenced participants' evaluation, judgment, and recall. Results also suggest that the interaction between medium and story was more complex and it was not simply a matter of whether video is better than text. Our findings support recent research on differences between video and text (see Koehler et al. 2005). Particularly, we support Koehler and colleagues view that even though video as a medium does not influence learning, it influences viewers in terms of engagement and affective change "in ways that reading a text does not" (p. 269).

The lack of relevance is one of the greatest barriers for learning and is the reason why some students are not interested and lack motivation in learning (Aikenhead 2006; Brophy 1999, 2004). Interest plays an important role in learning as Dewey (1916) stated citing an American humorist, "It makes no difference what you teach a boy so long as he doesn't like it" (p. 134). Piaget (1981, as citied in Hidi 1990) also argued that both affective and cognitive components are equally important for intellectual functioning. Hence, one main benefit of video lies in engaging students in the content and making it interesting. However, more research needs to be conducted to examine the impact of video in a classroom setting. A second benefit of video may occur in instructional contexts when students are encouraged to make judgments. In this study, participants recalled more under both, negative judgments (i.e., with Catrice's case) and positive judgments (i.e., with Lisa's case). Given that HIV/AIDS has become a global problem, it is imperative to increase students' awareness and literacy of this infectious disease. HIV infections have been increasing dramatically worldwide; HIV infections have increased by 3.5 million between 2001 and 2007, and in the U.S. it has risen by 200,000 over the same period of time, with the bulk of the increase in the 15–49 age groups (UNAIDS 2008). Media, such as presenting emotional and informational video has the potential to increase awareness of HIV/AIDS and promote positive behaviors among the target age groups 15–49, which has seen the most dramatic increase of this disease.

Limitations and future research

One limitation of this study is that it was not conducted in a classroom context, and thus we were unable to examine the effects of media combined with instructional method. Another limitation of this study was the overrepresentation of Caucasian females, however, this demographic is representative of the population we sampled—education majors (Jennings 2007). Because this was conducted as a lab study with a large number of Caucasian females, our results are limited in terms of external validity.

The current research did not examine how participants' background influenced their affective response to the cases as well as the medium. Future research needs to investigate how participants' background, such as preference for medium, experience with content of the story itself, etc. might impact their emotional and cognitive responses. Additionally, future research also needs to investigate whether order-of-media changes participants' engagement with the content and the medium. Because the cases were being developed for future use in biology courses, we attempted to find cases that were not contrived and had a feeling of authenticity. However, in this process there were many details across cases that were not consistent. Future research should explore whether or not there are differences between media when content is held consistent across cases.

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