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ABSTRACT

The educational and motivational benefits of captioning have been established for people who are deaf or hard-of-hearing as well as for students who have a learning disability or who have limited English proficiency. The primary goal of this study was to determine whether technological enhancements to captioning would benefit children with learning disabilities and the general population of students. An evaluation was conducted of the effects of the speed of captioning on comprehension and the secondary effects of advance organizers on comprehension and preference. Middle school students with learning disabilities were the focus of this study; 317 eighth grade students, 68 with learning disabilities or special education needs, were examined. Half of the classes were asked questions that served as advance organizers for videos on a science topic; the other half viewed videos without advance organizers. All classes were assigned three captioning levels: standard, edited, or highlighted. The use of videos enhanced by captioning and the use of advance organizers was shown to positively affect students' comprehension and attitudes. Irrespective of advance organizers and group identification (general or special education), students' comprehension dropped when captioning was withdrawn. Interest ratings did not correlate significantly to comprehension scores. (Contains 19 references.) (AEF)

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"The Effectiveness of Television Captioning on Comprehension and Preference"

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Introduction

The educational and motivational benefits of captioning have been established for people who are deaf or hard-of-hearing (Boyd & Vader, 1972; Koskinen, *et al*, 1986, 1987; Murphy-Berman & Jorgenson, 1980). Research also has shown benefits for students who have a learning disability (Koskinen, 1986) or who have limited English proficiency (Bean & Wilson, 1989; Garza, 1991; Goldman & Goldman, 1988; Neuman & Koskinen, 1992). The focus of this study was to research and illustrate the use of media and learning constructs in extended environments. Our research was guided by the following question: How is comprehension affected by the introduction of captioning and advance organizers for the general population and special education students over time? Additionally, affective measures were gathered and analyzed.

To this end, the National Captioning Institute and Macro International cooperated with the Howard County (Maryland) Public Schools to develop the research and provide

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technical assistance. The Virginia Computer Institute and a faculty member of the University of Virginia joined the team to provide statistical and conceptual analyses.

Technology has played a prominent role in learning since the printed page was introduced to the classroom and in the workplace. Kozma (1991) characterized media by its technology, symbol systems and processing capabilities; and the cognitive effects of the medium may rely more importantly on symbol systems and processing capabilities than on its technology. Salomon (1974, 1979) suggests that symbol systems should be used to define and describe media because they explain the way we learn.

Television may be defined as a medium capable of employing pictorial and audio-linguistic symbol systems. This medium can be enhanced by captioning, but symbol systems alone are not sufficient to describe its cognitive effects without process capabilities. Kozma (1991) cites numerous studies which confirm that simultaneous auditory and visual symbol systems produce learning, resulting in more recall than one or the other of the approaches alone.

Surprisingly, little research has been done on the effect of pace on comprehension. This is a potential critical variable when studying video and television presentations as distinct from print. Processing information using television or videos (transient) versus text (stable) becomes even more important when pace is considered in relationship with meaningful learning chunks (Wright *et al*, 1984; Simon, 1974).

The understanding of pace and knowledge transformations are subsumed under contemporary cognitive science. Central to Bereiter's (1990) synthesis of learning theories (to develop an educational theory at a higher level of thinking) is the idea of contextual models: to intelligently embed the learning process within the learner's cognitive structure and personal goals.

The practical needs of learning and learning theory were bridged by Ausubel (1968) in which he postulated a hierarchically organized cognitive structure. Ausubel's contention was that when the learner encounters new material, if subsuming concepts were already available in his cognitive matrix, the new material is subsumed and meaningfully learned.

Purpose

It was within this learning context and technical advances that we framed our research. Video, enhanced by captioning and advance organizers, define the symbol structure and information processing required of media learning. The primary goal of this study was to determine whether technological enhancements to captioning would benefit children with learning disabilities and the general population of students. In support of this goal, we evaluated the effects of speed of captioning on comprehension over time, and the secondary effects of advance organizers on comprehension and preference.

Methods and Procedures

Middle school students (eighth grade) with learning disabilities were the focus of the study. Because these students are included in general education classes, data were collected on nondisabled students as well, thereby increasing the breadth and depth of the study. A total of 17 intact mainstream classes taught by nine teachers comprised the sampling units. After subject selection and assignment, classes were randomly assigned to treatments. The total sample comprised 317 students, including 68 with learning disabilities or other special educational needs.

Half of the classes were asked questions that served as Advance Organizers for the videos; the other half viewed videos without Advance Organizers. All of the classes, irrespective of whether they received advance organizers, were assigned one of three Captioning Levels: ***Standard***, ***Edited***, or ***Highlighted***. Standard captions present the near-verbatim dialogue at speeds of 150 to 180 words per minute (wpm). The Edited captions were derived from the Standard captions to achieve a maximum presentation rate of 120 wpm. Highlighted captions were created from the Edited captions by adding emphasis to key concepts by using UPPERCASE.

Fifteen videos were selected and lesson plans were prepared by a team of science and special education teachers. Each video presented a single science topic that was tied to the district's curriculum. All lesson plans had a common structure, including a Statement of Objectives, Key Concepts, Vocabulary, Cognitive and Affective Measures,

and an Advance Organizer. Content validation was conducted by a second team of teachers and administrators.

Design

The study utilized a repeated measures, split-plot design as the following table shows. The Between Ss Factors are the type of captioning (three levels) and the use of an advance organizer (two levels), resulting in six distinct treatment groups. The Within Ss Repeated Measures are lessons presented over time and the captioning or noncaptioning of the video.

Between Ss Factors		Within Ss/Repeated Measures Factor				Group
Captions	Advance Organizer	Baseline (No Captioning) Lessons 1-4	Introduction (Captioning) Lessons 5-8	Withdrawal (No Captioning Lessons 9-11	Reintroduction (Captioning) Lessons 12-15	
Standard Captions	Present					1
	Absent					2
Edited Captions	Present					3
	Absent					4
Highlighte d Captions	Present					5
	Absent					6

Data Analysis

Test data were pooled for each student for each treatment sequence. This resulted in four average scores for each student: one for lessons 1 to 4, one for lessons 5 to 8, one for lessons 9 to11, and one for lessons 12 to15. This pooling reflects the split-plot, repeated measures design; it also simplifies the analysis and minimizes the potential confounding effect of differential lesson difficulty.

Data analyses were conducted using SPSS/PC+ for the IBM PC. Multivariate analysis of variance (MANOVA) and various descriptive procedures were utilized.

Before undertaking the analysis of the cognitive and affective data, systematic differences between the groups were analyzed in terms of prior achievement. This was

accomplished by analyzing the students' performances on the Maryland Functional Reading Test (MFRT) and the Maryland Functional Math Test (MFMT), which were administered to all eighth grade students in the district. MANOVA analyses revealed a significant difference in prior mathematics achievement ($F = 2.534$, $p = .029$); therefore, the comprehension analyses utilized multivariate analysis of covariance (MANCOVA) with the MFMT scores as the covariate.

For the analysis of the data for the full sample, the design was extended to incorporate a categorical variable denoting educational status. This variable was assigned the value of 1 for general education students and 2 for special education students. This was consistent with the concerns related to covariance.

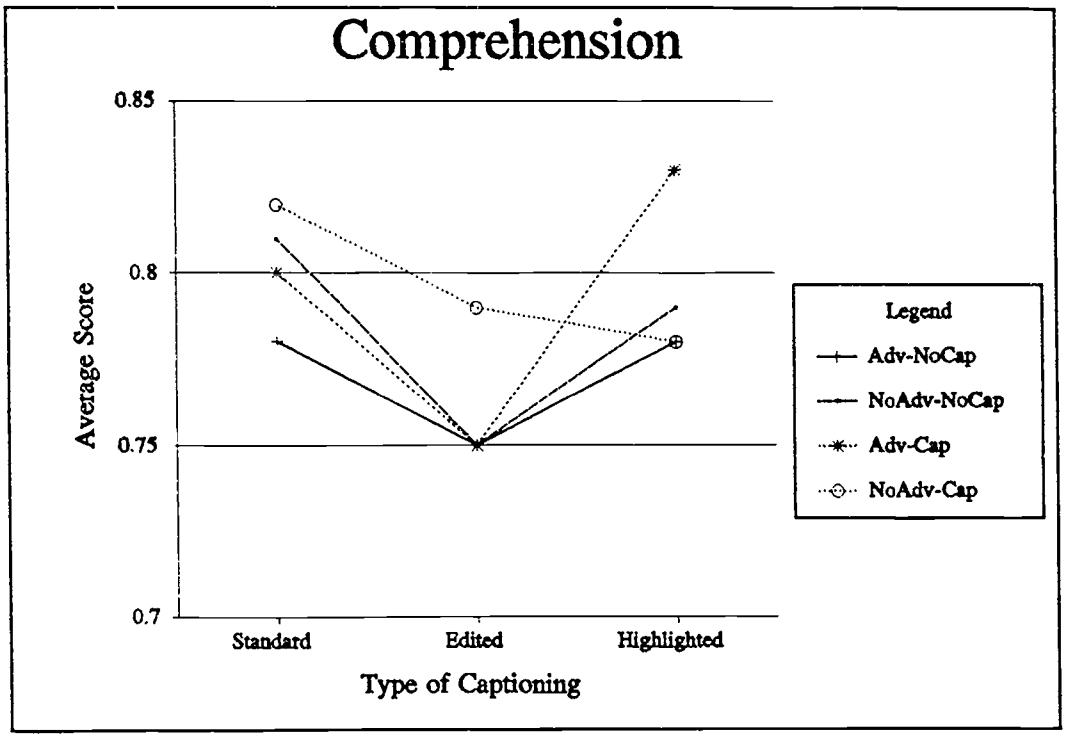
Results

Captioning improved comprehension.

There was a significant comprehension benefit over time when the videos were captioned ($F = 5.60$, $p = .019$). Also, captioning withdrawal resulted in significantly lower comprehension for all students; when captions were re-introduced, there was a rebound in comprehension.

Educational Status	Baseline	Caption Introduction	Caption Withdrawal	Caption Re-Introduction	Over Time
General	.8370	.8335	.7828	.8169	.8175
Special	.7207	.7143	.6419	.6902	.6918
Entire Sample	.8121	.8079	.7526	.7897	.7906

There also was a third-order interaction: type of captioning by advance organizer by whether the video was captioned or not ($F = 5.93$, $p = .003$).



Note that the above figure illustrates 12 aggregated average scores. The lines link similar combinations of treatments. For example, the line of the graph labelled "Adv-NoCap" represents the average of the baseline and withdrawal (*ie*, "no captions") for the groups that received advance organizers. The third line, labelled "Adv-Cap" shows the same groups' performances when the captions were presented (*ie*, during the introduction and re-introduction).

The overall highest performance for a single group was achieved when the video was captioned, the type of captioning was highlighting, and advance organizers were used. The second highest performance was when the video was captioned, the type of captioning was standard, and no advance organizer was used.

Standard and Highlighted Captioning were best.

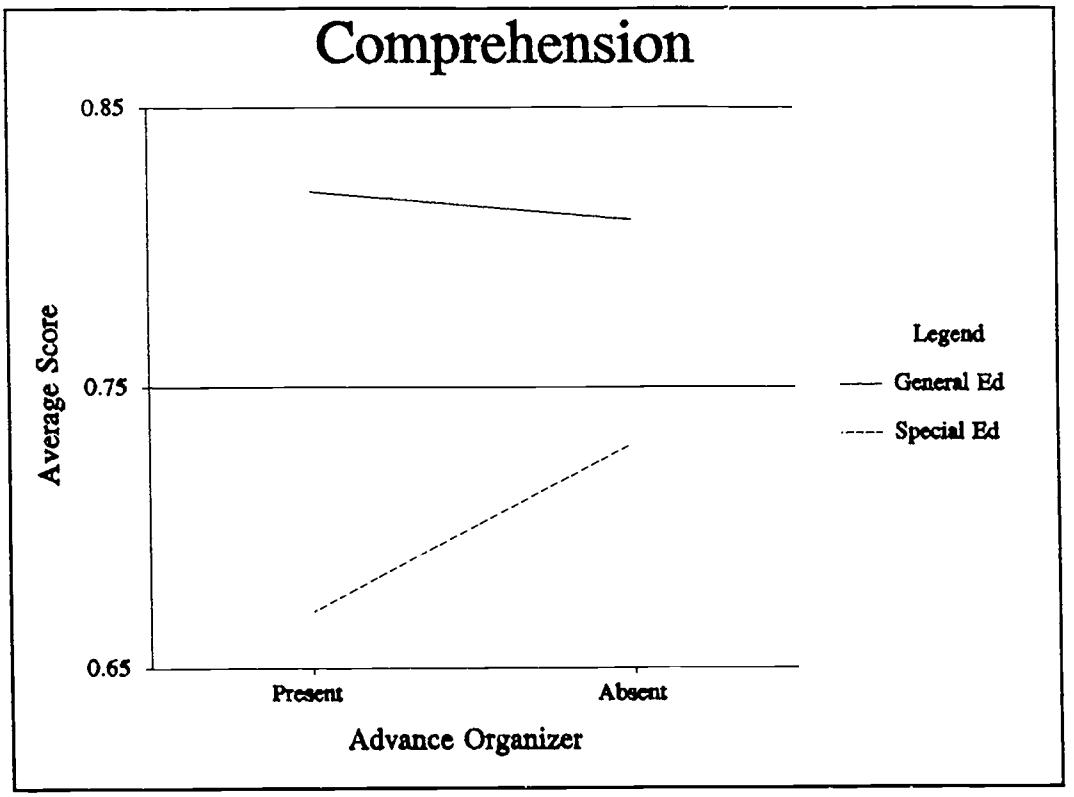
The three types of captioning resulted in significantly different comprehension scores ($F = 4.23$, $p = .015$). Performance was best for Standard captions and worst for Edited captions. Students receiving Highlighted captions achieved nearly the same scores as those receiving Standard captions. This is particularly noteworthy in that the

Highlighted captions were identical to Edited Captions with respect to content, placement, and pace; they differed only with respect to identifying key concepts.

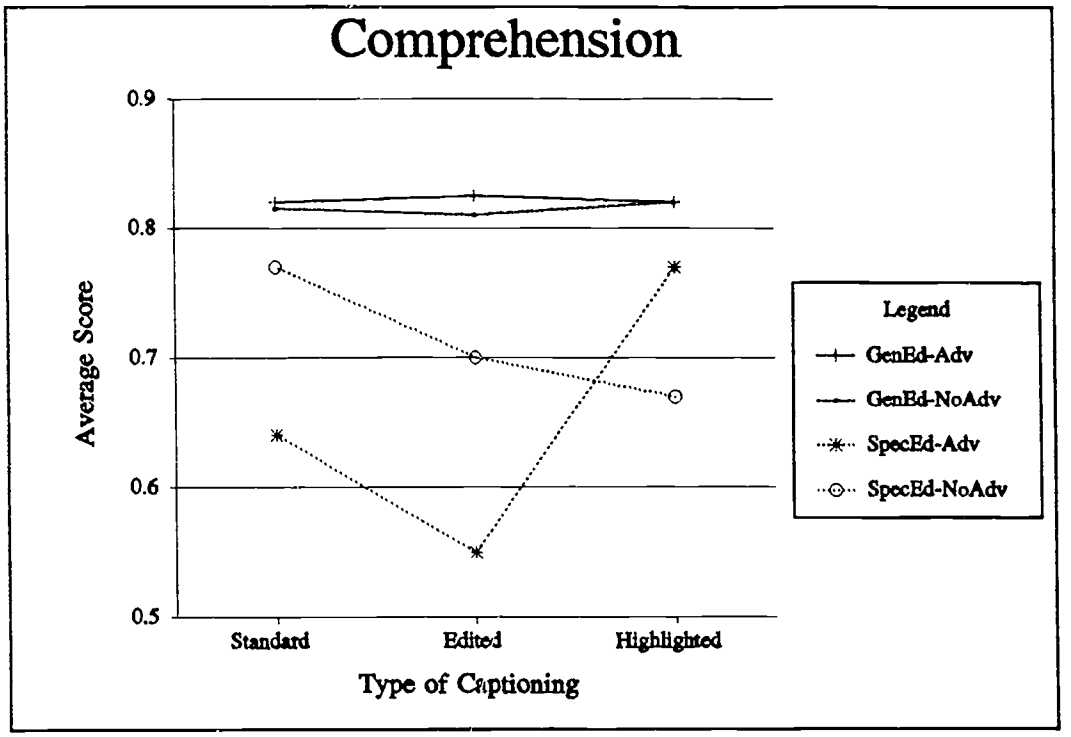
Type of Captioning	Baseline	Caption Introduction	Caption Withdrawal	Caption Re-Introduction	Over Time
Standard	.8162	.8251	.7725	.7892	.8008
Edited	.7947	.7837	.7059	.7659	.7626
Highlighted	.8174	.8034	.7579	.8036	.7956
Entire Sample	.8121	.8079	.7526	.7897	.7860

Differential learning takes place in the mainstream environment.

Even though previous achievement was partialled out by the use of MANCOVA, educational status remained a highly significant factor ($F = 23.44$, $p = .000$), illustrating a fundamental difference between general education and special education students under these treatment conditions. Interestingly, Advance Organizers were associated with a significantly lower performance by special education students ($F = 5.76$, $p = .017$) :



There was a third-order interaction of type of captioning by advance organizer by educational status ($F = 3.56$, $p = .030$). The figure illustrates that the comprehension of the video content by general education students was not affected appreciably by the advance organizer or by the type of captioning. Special education students, in contrast, were adversely affected by the advance organizers and by editing of the captions. The critical exception to this is the case of highlighted captions with advance organizers, which resulted in performance comparable to standard captions without the organizer.



Underlying learning structures were supported by affective measures.

Significant intercorrelations were observed between Interest (Q1), Ease of Understanding (Q2), and Prior Knowledge (Q3) for both general and special education students. To improve validity estimates, the following correlations were based on the average of the 15 lessons.

		Comprehension Score	Q1	Q2	Q3
General Education Students (n = 249)	Comprehension	1.000	.0531	.3210**	.3398**
	Q1	.0531	1.000	.1900*	-.0214
	Q2	.3210**	.1900*	1.000	.5189**
	Q3	.3398**	-.0214	.5189**	1.000
Special Education Students (n = 68)	Comprehension	1.000	.0537	.4005**	.3415*
	Q1	.0537	1.000	.1713	.1741
	Q2	.4005**	.1713	1.000	.6846**
	Q3	.3415*	.1741	.6846**	1.000

* - .01 ** - .001

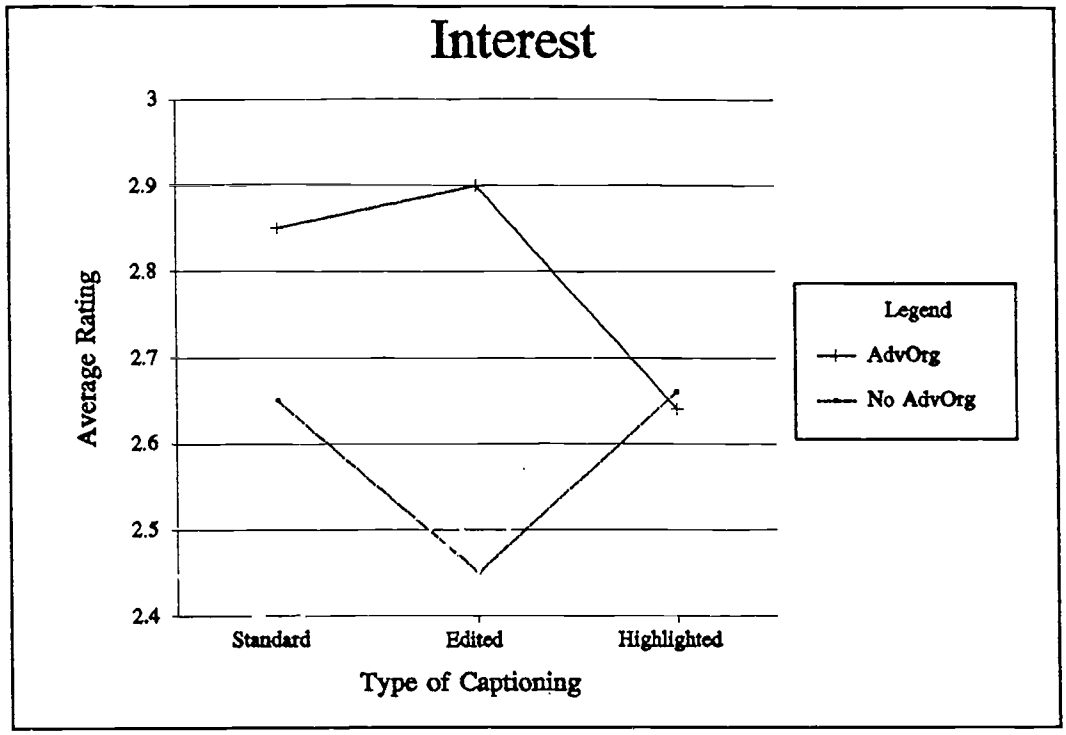
It may be seen that Interest in the specific video contents was not associated with Comprehension scores. Ratings for Ease of Understanding and Prior Knowledge were significantly associated with comprehension scores for all students. For General Education students, Interest ratings were related to Ease of Understanding but not to Prior Knowledge; neither of these ratings was significantly related for Special Education students. Finally, the two groups were consistent in showing a significant relationship between Ease of Understanding and Prior Knowledge.

Interest was higher when Advance Organizers were used.

This first affective question addressed the issue of how interesting the student felt the video was. A significant Between Ss main effect was obtained for the advance organizers ($F = 9.13$, $p = .003$).

	Baseline	Introduction	Withdrawal	Re-Introduction
Advance Organizer				
Standard	2.8801	2.8363	2.8450	2.7953
Edited	2.8494	2.7436	2.9295	2.8974
Highlighted	2.8664	2.5714	2.5026	2.6177
No Advance Organizer				
Standard	2.7676	2.7077	2.5047	2.5892
Edited	2.4603	2.4702	2.5040	2.3988
Highlighted	2.9267	2.6940	2.5632	2.5805
Entire Sample	2.8026	2.7627	2.6109	2.6304

There was a significant, Between Ss, second-order interaction of type of captioning by advance organizer ($F = 4.02$, $p = .019$).



Videos were judged easier to understand without captions.

This question requested each student's perception of how easy or difficult it was to understand each video. There was a significant Between Ss main effect based on the students' educational classification ($F = 8.41$, $p = .004$). This reflects the consistently lower ratings given the videos by students with special educational needs. Similar to Q1, there was a significant effect based on whether the video was captioned or not ($F = 35.01$, $p = .000$). In general, students rated videos that were not captioned to be easier to understand than videos that were captioned; however, both of these average ratings were quite high.

Prior knowledge was judged greater for videos that were not captioned.

The third question requested the students' perceptions of their prior knowledge of the video content. There were no significant Between Ss main effects. There was a significant third-order interaction of type of captioning by advance organizer by educational status ($F=3.43$, $p=.034$). Two Within Ss effects were significant: Time ($F=4.84$, $p=.029$) and whether or not the video was captioned ($F=25.26$, $p=.000$). These data are summarized in the table below.

	Baseline	Caption Introduction	Caption Withdrawal	Caption Re-Introduction
Type of Captioning				
Standard	2.8815	2.7148	2.8516	2.6706
Edited	2.9387	2.8321	2.8922	2.6287
Highlighted	2.9208	2.8168	2.7851	2.7266
Entire Sample	2.9088	2.7789	2.8349	2.6830

Students rated their prior knowledge higher for videos that were not captioned than for videos that were captioned.

Standard captions were preferred to Edited captions.

A fourth question was included only for videos that were shown with captions. It addressed whether the captions helped the students understand the video or not. Significant Between Ss effects were obtained for type of captioning ($F=4.46$, $p=.006$) and for educational classification ($F=7.78$, $p=.006$). Standard captions were judged to help the students more than edited or highlighted captions. These data are summarized in the following table.

		Caption Introduction	Caption Re-Introduction
Type of Captioning	Standard	2.1960	2.0983
	Edited	1.8946	1.9547
	Highlighted	1.7810	1.6687
Educational Status	General	1.9277	1.8394
	Special	2.1385	2.1385
Entire Sample		1.9729	1.9035

Special education students gave higher ratings for the captioning benefit than did general education students. There also was an interaction of type of captioning by advance organizers ($F=3.44$, $p=.033$).

Preference ratings for captioning itself were mixed.

A fifth affective item was included for videos that were shown with captions. It asked students if they liked the captions or not. Significant Between Ss effects were obtained for type of captioning ($F=6.84$, $p=.001$) and educational classification ($F=4.13$, $p=.043$). A significant Within Ss effect was obtained for advance organizers over time ($F=4.31$, $p=.039$). The means for these effects are listed in the following table.

		Caption Introduction	Caption Re-Introduction
Type of Captioning	Standard	2.0651	1.9857
	Edited	1.7770	1.8027
	Highlighted	1.6157	1.4993
Advance Organizer	Present	1.8630	1.8619
	Absent	1.8051	1.6745
Educational Status	General	1.7895	1.7363
	Special	1.9865	1.8505
Entire Sample		1.8318	1.7608

Discussion

Videos, enhanced by types of captioning and by the use of advance organizers, define the symbol structure and information processing required of media learning. This use of videos were shown to positively affect students' comprehension and attitudes. Irrespective of advance organizers and group identification (*ie*, general or special education), students' comprehension dropped when captioning was withdrawn.

It also was apparent that the mainstream classroom is filled with complex and differential learning effects as media interacts with classroom context and learning for general and special education students. The combination of Highlighted captions with Advance Organizers resulted in highest single-group performance. However, Standard

captions without Advance Organizers ranked next highest in terms of comprehension; and Advance Organizers were associated with lower comprehension for special education students overall. These paradoxical results suggest that verbal overload might have resulted initially from the combination of video captions and advance organizers. With experience with the highlighted captions and the classroom context of pre-viewing discussions, the students came to use the caption information effectively.

These results also point to the larger issue that with the introduction of media, we must analyze carefully the relationship of the media (and prior experience with the given media) with classroom context, motivation, and learning constructs. Our results lend partial support to the research summarized by Pintrich (*et al*, 1993) which has shown the role of motivation and classroom contextual factors are related to the process of conceptual change. Goals, values, self-efficacy, and control beliefs (as discussed in Pintrich's review) are directly and indirectly related to our Preference scales: Interest, Prior Knowledge, and Ease of Understanding. Correlations indicated stability and construct validity, supporting the contention that affective measures are viable indicators of learning and that video caption comprehension is affected by prior knowledge and by ease of understanding. This is consistent with the research summarized by Tobias (1994) that concluded that there was a substantial relationship between interest and prior knowledge.

Interest ratings, however, did not correlate significantly to comprehension scores. This is in contrast to the research summarized by Tobias (1994) which holds that peop.e learn more when working on tasks that interest them; that interest (motivation) invokes deeper comprehension processes, leads to greater use of imagery, and may stimulate a more emotional, personal, and extensive network of relevant associations. Perhaps the individual student's topic or enduring interests in the content did not stimulate the situational interest (Hidi, 1990) that may have benefited comprehension.

As a final consideration, the pacing of the video and the captioning may be crucial to the learning process. Unlike the words on a printed page, each caption appears on the television screen for only a few seconds and then disappears, being replaced by a new caption. There is little if any opportunity to re-read or otherwise strive to comprehend the textual information. Students (and others) may well benefit

from being able to control the pace of the captions and to learn at their own rate how to relate word meanings to concepts presented on the video.

In summary, by showing that the use of captioning can improve general and special education students' comprehension of academic concepts, these results take research in the use of technology and media a step further. The study suggests new areas of research by raising questions about the popular instructional practice of teachers introducing videos with advance organizers. The study also raises questions regarding the nature of the video content in combination with captions. Because science videos may be more content rich than those of other disciplines (*ie*, they present more concepts in a shorter amount of time), research on the use of captions in other subject areas is needed.

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