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Examining the Educational Benefits of and Attitudes toward Closed Captioning Among Undergraduate Students

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Abstract: Closed-captioning technology has been available for decades and is often used by individuals with disabilities to access video-based information. Videos are routinely used by educators in higher education settings throughout the United States. It is unknown, however, if closed captions are educationally beneficial for all students. The purpose of this study was to examine the educational benefits of closed captioning among college students without disabilities and their associated attitudes toward the technology. The use of closed captions adheres to the principles of Universal Design that encourage stakeholders to build environments and products that are accessible to all individuals. However, more evidence-based research is needed on the utility of this technology in college classrooms. Two separate video-based studies were conducted at one university, and groups were randomly assigned to "caption" or "no-caption" conditions. It was hypothesized that exposure to closed captions would increase students' recall and understanding of video-based information and improve attitudes toward the technology. Results suggested that participants who were exposed to closed captions scored significantly higher on the subsequent assessment. Participants who already used closed captions in their daily lives had significantly more positive attitudes toward the technology. Recommendations for college-level educators and further study are provided.

Keywords: closed captioning, universal design, video-based learning

Closed-captioning technology has been available for use with television, film, and videos in the United States (U.S.) since the 1970's (Taylor, 2005) and is often considered to be a reasonable accommodation for individuals with hearing impairments. When watching television, for example, closed-captions can be "turned on" to have a simultaneous visual text representation of what is being spoken on the screen. Typically, closed-captions will appear at the bottom of a viewing screen as one to three lines of white text on a black background. Closed-captioning is different from foreign language subtitles due to the inclusion of text that describes relevant non-speech sounds (e.g., falling rain, ominous music playing, dog barking) that sometimes take place off screen and are not visible to the viewer. The technology ensures that viewers with hearing impairments have a text representation of all relevant video-based information.

Research on the educational benefits of captioning began in the early 1980's (Taylor,

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2005), and since that time has mostly focused on benefits for children learning to read (Linebarger, 2001), students with disabilities (e.g., learning disability, deafness) (Kirkland, Byrom, MacDougall, & Corcoran, 1995), or those who are learning English as a second language (Chen, 2012; Garza, 1991). Among these specialty populations, closed captioning has proven to be a useful tool when viewing educational videos. In contrast, there is a paucity of research on the educational benefits of closed-captioning among a general student population at various grade levels.

Studies that did include a general student population were conducted decades ago and showed inconsistent results. In one example, Ruggiero (1986) found no statistically significant differences in test performance or attitudes toward closed captions among two groups of undergraduate students without disabilities ($N = 80$). In contrast, Lee and Meyer (1994) found that closed-captioned video was the "most effective instructional media for learning retention with students ($n = 25$) who do not have reading deficits" (p. 445). Lee and Meyer supported closed-captioning use among college students without disabilities but recommended further study with larger sample sizes.

The only recent study the authors could find took a longitudinal approach and looked at student grade trends ($N = 340$) over a two-year period in a college course on Native American history in the U.S. (Collins, 2013). The researcher noted that, over the course of four semesters, students who were exposed to educational videos with closed-captioning, on average, performed better on assessments compared to students not exposed to closed-captioning. Collins also opined that students who were exposed to closed-captioning were more engaged, took better notes (as evaluated on assessments), and were more responsive to questions posed in class.

Despite its potential value, anecdotal evidence indicates that captions are seldom used in college classrooms. It is hypothesized that one barrier may be attitudinal. If closed-captioning is viewed as a benefit for individuals with disabilities, it is possible that this may affect its acceptance among individuals without disabilities. Attitudinal research on closed captioning has also been limited among a general population of undergraduate students and warrants further study. Students with disabilities (Kirkland *et al*., 1995) or those learning a different language (Chung, 1996; Taylor, 2005; Weasenforth, 1994) have generally expressed a belief that the technology facilitates learning. In contrast, Ruggiero (1986) found no statistically significant differences in attitudes between two groups a (i.e., exposed to captions, no captions) of undergraduate students without disabilities. Sullivan and Jordan (2007) asked undergraduate students if closed captioning was an important and valuable service. Results indicated that students thought the technology was important for local news events but less important for entertainment style television such as sports programs and films. While Sullivan and Jordan did not explore attitudes toward closed captioning in an educational setting, they did point out attitudinal differences based on settings (e.g., news vs. entertainment). Therefore, the current study included attitudinal items that examined an expanded variety of settings where closed-captioning could be used.

The idea of utilizing closed captions in educational settings is aligned with the principles of Universal Design (UD), which states that environments or products should be designed to be accessible to as many people as possible, regardless of ability (Center for Universal Design, 2008). Due to an emphasis on access, UD is commonly associated with individuals with disabilities. For example, speech recognition technology is commonly used by the general population with smartphones to create and send text messages. However, this same technology has been used for decades to help individuals with fine motor skill impairments access personal computers using voice commands. Although UD originated in the field of architecture, the principles have been

tailored for school-based settings (Scott, McGuire, & Shaw, 2003) and efforts have been made to encourage postsecondary faculty members to utilize more inclusive teaching methods (Lombardi, Murray, & Dallas, 2013; Murray, Lombardi, Seel, & Gerdes, 2014) due to the perceived benefits for all learners. For example, instructors who share their lecture notes online with students or provide an audio version of readings materials would be exercising UD *Principle 1: Equitable use* and *Principle 4: Perceptible information*. In addition to perceived educational benefits, the use of UD in college classrooms potentially decreases the need for students to request academic accommodations based on disabilities or other learning needs. Building from the previous examples, students with disabilities would rely less on human note-takers as an accommodation or would not have to wait for accessible audio-based reading materials. Additionally, students that could benefit from these types of accommodations might not request them due to perceived negative societal attitudes. Although UD principles suggest educational benefits for all diverse learners (e.g., international students, student with disabilities), more evidence-based UD research in educational environments, particularly college settings, is needed to support recommendations for broader implementation (Schelly, Davies, & Spooner, 2011).

Previous research has challenged the use of UD teaching methods, specifically related to the use of closed-captioning. The "redundancy principle" (Clark, 2002; Clark, 2007) or "split-attention affect" (Moreno & Mayer, 2002) theorizes that multiple stimuli (i.e., audio, graphics, text) provided at the same time overloads students' working memory and results in poorer outcomes on subsequent assessments. For example, Mayer and Moreno (1998) presented animated videos to students depicting how lightning forms and how brake systems work in vehicles. Students who saw the videos with audio narration only performed better on subsequent assessments compared to those who viewed the video with on-screen text. The researchers recommended only one visual stimuli for use with audio rather than two (i.e., graphics with on-screen text). Exceptions have been noted to the redundancy principle, however. Clark (2002) noted that individuals with poorer reading skills may benefit from multiple simultaneous stimuli (i.e., audio, graphics, text). Considering previous closed-captioning research findings, UD principles, and research on cognitive overload, it may be beneficial to examine the potential usefulness of closed-captioning for broader audiences more thoroughly.

In postsecondary institutions in the U.S., course-related videos are being shown more often than in the past (Burke, Snyder, & Rager, 2009; Moran, Seaman, & Tinti-Kane, 2011). This is most likely due to increased access to the Internet and classrooms that are equipped with computers, large screen projectors, and sound systems. The purpose of the current study was to examine the potential educational benefits of and attitudes towards closed-captioning technology among undergraduate students without disabilities. The authors were interested in adding to the knowledge base on this topic due to its potential impact on student learning. The following research questions were posed to help guide the study:

1) Does exposure to a video with closed captions influence performance on a subsequent assessment among undergraduate students?
2) Does exposure to a video with closed captions influence undergraduate students' attitudes toward the technology?
3) What is the relationship between undergraduate student demographics and attitudes toward closed captioning?
4) What is the relationship between undergraduate student grade point averages, demographics, and performance on an information recall based assessment?

Based on guidelines associated with UD, the researchers hypothesized that students who are

exposed to a video with closed captions will perform better on a subsequent assessment based on the content of the video. Furthermore, it was hypothesized that students who are exposed to captions would report more positive attitudes toward the technology, compared to students who viewed a video without. Finally, the authors were interested in examining how student grade point averages and other demographic variables influenced participants' performance on the assessment and attitudes toward closed captioning.

Methods

Two studies were completed in Spring 2014 to examine the educational benefits of closed captioning and undergraduate student attitudes. The two-study design was used due to distinct differences in data collection methods. The researchers had an opportunity to recruit participants using two separate methods. Study 1 acted as a pilot study and took place in a computer lab using a computer-based assessment, while Study 2 took place in multiple classrooms using a paper-and-pen-based assessment. The researchers were interested in examining if results would vary dramatically or remain consistent when changing study environments (i.e., computer lab vs. actual classroom). The two-study design, versus one larger study, was also thought to increase the reliability of the results. Participants in both studies were undergraduate students enrolled at a research university located in the midwestern United States. Linear regression analyses were used to analyze the data. In addition to examining the relationship between closed captioning and assessment scores, the authors also examined student demographics.

Participants

Participants for Study 1 were recruited from the general population of undergraduate students at the university (N = 206). Study participants were predominately female (67.3%). Participants primarily identified as white (55.6%), followed by African American (15.1%), Hispanic (12.7%), Asian (6.3%), two or more races, (5.4%), Other (3.9%), Native Hawaiian or Other Pacific Islander (0.5%), and no response (0.5%).

Participants in Study 2 were enrolled in one of five introductory geology or geography courses (N = 257). The sample included 43.2% females. Participants identified as predominately white (67.7%), followed by African American (14.1%), two or more races, (7.7%), Hispanic (5.9%), Asian (2.7%), Other (1.4%), and American Indian/Alaskan Native (0.5%).

Based on institutional research, the total population of undergraduate students during the 2013-2014 academic year was 49.9% female, 60.2% white, 17.0% African American, 13.2% Hispanic, 4.9% Asian, 3.0% two or more races, and less than 1.0% American Indian/Alaskan Native or Native Hawaiian or Other Pacific Islander. Samples from Study 1 and Study 2 seem to closely resemble the total population of the university. Since previous closed-captioning research has already suggested benefits for students with disabilities or those learning the English language, the authors omitted participants who disclosed this information from the data analysis in both studies.

Materials

Materials for Study 1 and Study 2 included an educational video and a test packet that was created by the authors. The test packet was created using methods that were similar to previous studies involving captioning (Lee & Meyer, 1994; Garza, 1991; Ruggiero, 1986; Sullivan & Jordan, 2007; Taylor, 2005). The test packet consisted of short-answer, fill-in-the-blank, and multiple-choice items, as well as an attitudinal survey. Previous captioning research used similar items to measure understanding, information recall, and working memory. The 10-minute video used in the study discussed the issue of global warming (TED Talks, 2010) and could be shown with closed captions turned on or off. The test packet was created in consultation with experts in the field of assessment, geology, geography, and previous literature. All materials used in the study were subjected to pilot testing using undergraduate students.

Test packet. The test packet consisted of one short-answer item (i.e., *In complete sentences, please summarize the main ideas of the video.*) (score range 0-3), 12 fill-in-the-blank items (score range 0-12), and 16 multiple-choice items (score range 0-16); all related to information presented in the video. Test items were developed by the authors using a transcript of the video and in consultation with campus assessment experts and faculty in geology and geography disciplines. Based on Cronbach's alpha, the internal consistency for the fill-in-the-blank and multiple-choice items in Study 1 and Study 2 were 0.695 and 0.665 respectively, suggesting that the items had internal consistency. Scores on the short-answer, fill-in-the-blank, and multiple-choice items were combined to create a composite score (score range 0-31).

The short-answer item (i.e., *In complete sentences, please summarize the main ideas of the video.*), was scored by three trained graduate students. Using a rubric developed by the authors, evaluators independently reviewed each participant's answer and provided a rating of 0, 1, 2, or 3. A score of 3 indicated that participants had a working memory of the video content and detailed all the main ideas of the video. Agreement was obtained when two of the three evaluators provided an exact match. For Study 1 and Study 2, the inter-rater reliability among the three scorers of the short-answer responses was 0.84 and 0.87 respectively (Ebel, 1951). A second section measured participant attitudes toward the use of closed captioning and also included a demographic questionnaire. Attitudinal items were created by the authors using previous literature and in consultation with experts in deafness rehabilitation and instruction-based universal design.

The 15-item attitudinal section included statements such as "*Course-related videos that are viewed with closed-captioning support college student learning."* or "*It is not important for closed-captioning to be available for live television news broadcasts."* and were measured on a seven point Likert-type scale (i.e., *Strongly Disagree to Strongly Agree*) with a *Neutral* option included. One attitudinal item was negatively correlated with other attitudinal items in the survey and was omitted from further statistical analyses. Therefore, 14 attitudinal items were used to create an attitudinal composite score (score range 14-98). Higher scores on the survey indicated more positive attitudes toward the technology. For Study 1 and 2, Cronbach's alpha was .80 and .81 respectively, suggesting internal consistency among the 14 attitudinal items.

Items used for descriptive analyses were also included in the survey such as "*In your overall college experience, what percentage of your instructors have shown one or more videos in their courses*?" or "*What percentage of time were these course-related videos shown with closed captioning*?" The authors assume students are frequently exposed to course-related videos yet have less exposure to closed captioning. Demographic information was collected and served as additional variables for the regression analyses, for the descriptive analysis, or to omit certain participants from further analysis. Information included: year in school, college major, age, gender, race/ethnicity, grade point average, primary language, and disability status information.

Additionally, participants were asked the percentage of time they personally use closed captions (i.e., *1-25%, 26-50%, 51-75%, 76-100%*), if they knew someone with a hearing loss (i.e., *yes, no*), and if they had previously viewed the video (i.e., *yes, no*).

Study 1

Sample and Recruitment

The researchers utilized an undergraduate e-mail listserv to recruit participants. Undergraduate students were e-mailed once during the Spring 2014 semester and asked to participate in a study on video-based learning. The e-mail included a link which students could use to schedule one of eight times to participate in the study based on their availability. The eight scheduled times used were then randomly assigned "closed-captioning" or "no closed-captioning" conditions by the authors. An e-mail reminder was sent to participants the day before their scheduled participation date. A $10.00 incentive was also mentioned in the e-mail and was provided to participants who completed the entire study. The same classroom (i.e., a computer lab) was used for each of the eight data collection times and had a seating capacity of up to 50 participants.

Procedures

The authors greeted participants as they arrived at the classroom (i.e., computer lab). Once all participants were seated, the authors reviewed the informed consent form and gained participant signatures. Participants were informed that the study would examine how students learn using videos. Participants were then shown the video with the lights off. Captions were either turned on or off by the researchers, depending on the condition assigned. Immediately following the video, participants responded to an online "test packet." Participants were given five minutes (per section) to complete the entire packet, which was deemed ample during pilot testing. Sections were presented to the participants in the following order to minimize visual cues related to the content of the video: a) short-answer; b) fill-in-the-blank; c) multiple-choice; and d) attitudes, demographics. Prior to exiting the classroom, participants were debriefed and informed of the closed-captioning focus of the study.

Results

Composite information recall score. A linear regression analysis was used to analyze the data for Study 1. Three participants were omitted from the study because they categorized their year in school as "post-baccalaureate." Therefore, the total sample size for the statistical analysis was 203 participants.

Participant's grade point average (GPA), was significantly related to the participant's composite information recall score, $F(1, 196) = 13.59$, $p < .001$, $r = .25$. After controlling for the effect of GPA, there was also a significant effect of closed-captioning condition, $F(1, 196) = 5.61$, $p = .019$, $\eta_p^2 = .028$, gender, $F(1, 196) = 4.60$, $p = .033$, $\eta_p^2 = .023$, and undergraduate class, $F(3, 196) = 3.03$, $p = .031$, $\eta_p^2 = .031$. $R^2 = .147$, indicating that approximately 15% of the variance in composite information recall scores could be accounted for based on participant GPA, closed-captioning condition, gender, and undergraduate class. Table 1 provides a summary of the analysis.

Source	SS	df	*F*	Significance	η_p^2
Captions/No Captions	96.26	1	5.61	.019*	.028
Gender	78.99	1	4.60	.033*	.023
Year In School	156.02	3	3.03	.031*	.031
GPA	233.32	1	13.59	.000*	
Error		196			
Total		203			

Table 1. Study 1 Analysis of Covariance (ANCOVA) Summary Table
R^2 = .147
Note. Dependent Variable: Composite Information Recall Score
Note. * indicates statistical significance at .05 alpha level

For parameter estimates, groups that had the largest number of participants were identified as the comparison group. Planned contrasts revealed that participants (*n* = 92) exposed to closed captions had significantly higher composite information recall scores (*M* = 19.2, *SD* = 4.44) compared to participants (*n* = 111) not exposed to closed-captions (*M* = 17.73, *SD* = 4.34). Male participants' (*n* = 68) scores were significantly higher (*M* = 19.41, *SD* = 4.45) than female participants' (*n* = 135) (*M* = 18.04, *SD* 4.35), and participants who were sophomores (*n* = 48) had significantly lower scores (*M* = 17, *SD* = 4.93) compared to participants who were seniors (*n* = 89) (*M* = 19.48, *SD* = 4.20). Table 2 provides a summary of the individual group comparisons. Finally, a one unit increase in participant GPA (scale of 0 – 4) indicated an overall increase of 1.69 points in the composite information recall score.

Table 2. Study 1 Parameter Estimates Summary Table

Parameter	*B*	*t*	Significance	*r*
Exposed to Captions	1.389	2.369	.019*	.17
No Captions	0[a]	.	.	.
Male	1.337	2.146	.033*	.15
Female	0[a]	.	.	.
Freshman	-.421	-.412	.681	.02
Sophomore	-2.227	-2.982	.003*	.21
Junior	-.610	-.784	.434	.05
Senior	0[a]	.	.	.
GPA	1.696	3.687	.000*	

Note. Dependent Variable: Composite Information Recall Score
Note. 0[a] indicates comparison group
Note. * indicates statistical significance at .05 alpha level

Composite attitudinal score. A linear regression analysis was used to analyze the data. Participants were omitted from this portion of data analysis if they disclosed that they were post-baccalaureate, they had a disability or hearing loss, English was their second language, or they had viewed the video previously. Participants were also omitted if they did not complete all of the attitudinal items. The total number of participants omitted from this portion of the study was 67; therefore , the total sample size for the statistical analysis was 139 participants. Scores on the fourteen attitudinal items were combined to create a composite attitudinal score, and all items had relatively high internal consistency (α = .800). The covariate of participant age was not significantly related to the participants' composite attitudinal score. After controlling for the effects of the covariate of age, there was a significant effect of personal use of captions, $F(4, 115) = 3.57$, $p = .009$, $\eta_p^2 = .111$. No significant effects were found related to closed-captioning condition, undergraduate class, college in which participant major is housed, gender, race/ethnicity, or relationships with individuals with hearing impairments. $R^2 = .229$, indicating that approximately 23% of the variance in composite attitudinal scores can be accounted for based on the independent variables.

For parameter estimates, groups that had the largest number of participants were identified as the comparison group. Planned contrasts revealed that participants (n = 7) who personally use closed-captioning an estimated 51-75% of the time reported significantly higher scores (M = 88.1, SD = 12.6) compared to participants (n = 74) who personally use captions 1-25% of the time (M = 77.81, SD = 22.61). Table 3 provides attitudinal group comparisons based on the amount of time for personal use of captions.

Table 3. Study 1 Parameter Estimates Summary Table

Parameter	*B*	*t*	Significance	*r*
Never Use Captions	-2.284	-1.04	.299	.09
Use Captions 76-100% of the Time	10.749	1.92	.056	.17
Use Captions 26-50% of the Time	4.782	1.64	.103	.15
Use Captions 51-75% of the Time	10.286	2.35	.020*	.21
Use Captions 1-25% of the Time	0[a]	.	.	.

Note. Dependent Variable: Composite Attitudinal Score
Note. 0[a] indicates comparison group
Note. * indicates statistical significance at .05 alpha level

Study 2

Procedures in Study 2 were similar to procedures in Study 1; however, participants in Study 2 were recruited through courses they were enrolled in, the test packet was completed on paper, and no monetary incentive was provided. All other procedures were the same, and the major variables were consistent across both studies.

Sample and Recruitment

During the spring 2014 semester, undergraduate geology and geography faculty teaching introductory courses were contacted and asked if they would be willing to allow the authors to facilitate the study as part of their courses. Faculty members viewed the global warming video and decided if it was appropriate for their courses. Five faculty members agreed to allow the authors to come to class on a specific date during the semester, show the video to students, and then administer the test packet. Students were notified ahead of time about the specific date when the study would be conducted and that their participation was voluntary. A total of 257 undergraduate students participated in the study. Five classes were used in the study, and the classes were randomly assigned "closed-captioning" or "no closed-captioning" conditions by the authors. Three of the classes took place in the same location (i.e., classroom). The other two classes took place at two different classrooms on campus.

Results

Composite information recall score. A linear regression analysis was used to analyze the data. Participants were omitted from this portion of data analysis if they disclosed they were post-baccalaureate, had a disability or hearing loss, English was a second language, they had viewed the video previously, or they did not provide a GPA estimate. Therefore, the total sample size for the statistical analysis was 216 participants. The covariate, participant's grade point average (GPA), was significantly related to the participant's composite information recall score, $F(1, 195) = 7.386$, $p = .007$, $r = .19$. The covariate of participant age was not significantly related to the composite information recall score. After controlling for the effects of the covariates GPA and age, there was also a significant effect of closed-captioning condition, $F(1, 195) = 4.15$, $p = .043$, $\eta_p^2 = .021$, gender, $F(1, 195) = 7.75$, $p = .006$, $\eta_p^2 = .038$, and race/ethnicity, $F(6, 195) = 7.43$, $p = .000$, $\eta_p^2 = .186$. No significant effects were found related to participants' undergraduate class or college (e.g., business, education). $R^2 = .346$, indicating that approximately 35% of the variance in composite information recall scores can be accounted for based on the independent variables. Table 4 provides a summary of the analysis.

Source	SS	df	*F*	Significance	η_p^2
Captions/No Captions	54.91	1	4.15	.043*	.021
Year In School	93	3	2.34	.074	.034
College/Major	168.48	7	1.82	.085	.061
Gender	102.5	1	7.75	.006*	.038
Race/Ethnicity	589.66	6	7.43	.000*	.186
GPA	97.61	1	7.38	.007*	
Age	11.57	1	.87	.350	
Error		195			
Total		216			

Table 4. Study 2 Analysis of Covariance (ANCOVA) Summary Table

$R^2 = .346$
Note. Dependent Variable: Composite Information Recall Score

Note. * indicates statistical significance at .05 alpha level

For parameter estimates, groups that had the largest number of participants were identified as the comparison group. Planned contrasts revealed that seeing closed captions (n = 90) significantly increased composite information recall scores (M = 20.5, SD = 8.85) compared to not seeing closed captions (n = 126) (M = 19.43, SD = 9.79). Male participants' (n = 124) scores (M = 20.71, SD = 9.81) were significantly higher than female (n = 92) participants' (M = 19.22, SD = 8.9), and African American participants (n = 30) had significantly lower scores (M = 15.25, SD = 4.62) compared to Caucasian participants (n = 147) (M = 20.37, SD = 7.27). Finally, a one-unit increase in participant GPA (scale 0 – 4) predicted an increase of 1.61 points in the composite information recall score. Table 5 provides a summary of the individual group comparisons.

Table 5. Study 2 Parameter Estimates Summary Table

Parameter	*B*	*t*	Significance	*r*
Exposed to Captions	1.072	2.03	.043*	.14
No Captions	0[a]	.	.	.
Females	-1.493	-2.78	.006*	.2
Males	0[a]	.	.	.
American Indian/Alaskan Native	4.460	1.14	.254	.08
Asian	-.091	-.059	.953	.004
African American	-5.119	-6.43	.000*	.42
Other	-1.164	-.524	.601	.03
Hispanic/Latino	-.355	-.313	.755	.02
Multiple Races	-.556	-.584	.560	.04
Caucasian	0[a]	.	.	.

Note. Dependent Variable: Composite Information Recall Score
Note. 0[a] indicates comparison group
Note. * indicates statistical significance at .05 alpha level

Composite attitudinal score. A linear regression analysis was used to analyze the data. Participants were omitted from this portion of data analysis if they disclosed they were post-baccalaureate, had a disability or hearing loss, English was a second language, they had viewed the video previously, they did not complete all of the attitudinal items, or they did not provide their age. Therefore, the total sample size for the statistical analysis was 220 participants. Scores on the fourteen attitudinal items were combined to create a composite attitudinal score, and all items had relatively high internal consistency (α = .810). The covariate of participant age was not significantly related to the participants' composite attitudinal score. After controlling for the effects of the covariate of age, there was a significant effect of closed-captioning condition, $F(1, 195) = 5.54$, $p = .02$, $\eta_p^2 = .028$, personal use of captions, $F(4, 195) = 5.59$, $p = .000$, $\eta_p^2 = .103$, and gender $F(1, 195) = 8.44$, $p = .004$, $\eta_p^2 = .042$. No significant effects were found related to undergraduate class, participant college, race/ethnicity, or relationships with individuals with hearing

impairments. R^2 = .244, indicating that approximately 25% of the variance in composite attitudinal scores can be accounted for based on the independent variables. Table 6 provides a summary of the analysis.

Table 6. Study 2 Analysis of Covariance (ANCOVA) Summary Table

Source	SS	df	*F*	Significance	η_p^2
Captions/No Captions	577.2	1	5.54	.020*	.028
Personal Use of Captions	2328.74	4	5.59	.000*	.103
Year in School	308.06	3	.98	.4	.014
College Major	692.31	7	.95	.469	.032
Gender	879.11	1	8.44	.004*	.042
Race/Ethnicity	1209.58	6	1.93	.077	.056
Contact/Individuals with Hearing Impairments	186.05	1	1.78	.183	.009
Age	8.94	1	.086	.77	
Error		195			
Total		220			

R^2 = .244
Note. Dependent Variable: Composite Attitudinal Score
Note. * indicates statistical significance at .05 alpha level

For parameter estimates, groups that had the largest number of participants were identified as the comparison group. Planned contrasts revealed participants (n = 89) who saw closed captions reported significantly higher scores (M = 81.15, SD = 27.10) compared to participants (n = 131) who did not see closed-captions (M = 77.62, SD = 29.53). Participants (n = 78) who never personally use closed captioning reported significantly lower scores (M = 71.52, SD = 24.32) compared to participants (n = 100) who personally use captions 1-25% of the time (M = 75.48, SD = 25.68). Participants (n = 6) who personally use closed captioning an estimated 51-75% of the time reported significantly higher scores (M = 85.06, SD = 12.06), as well as participants (n = 6) who personally use closed captioning an estimated 76-100% of the time (M = 85.56, SD = 12.24) compared to participants who personally use captions 1-25% of the time. Female participants' (n = 95) scores were significantly higher (M = 81.56, SD = 27.09) than male (n = 125) participants' (M = 77.21, SD = 29.96). Table 7 provides a summary of the individual group comparisons.

Table 7. Study 2 Parameter Estimates Summary Table

Parameter	*B*	*t*	Significance	*r*
Exposed to Captions	3.534	2.35	.020*	.17
No Captions	0[a]	.	.	.
Never Use Captions	-3.958	-2.392	.018*	.17
Use Captions 76-100% of the Time	10.085	2.15	.032*	.15
Use Captions 26-50% of the Time	3.821	1.737	.084	.12
Use Captions 51-75% of the Time	9.588	2.07	.039*	.15
Use Captions 1-25% of the Time	0[a]	.	.	.
Female	4.353	2.9	.004*	.2
Male	0[a]	.	.	.

Note. Dependent Variable: Composite Attitudinal Score
Note. 0[a] indicates comparison group
Note. * indicates statistical significance at .05 alpha level

Discussion and Conclusions

The results of the current research support the use of closed captions among a general college student population. Results suggested that participants who were exposed to closed captions performed better on the information recall assessment compared to participants in the no-captioning condition. Although different procedures were used in the current studies, the results were consistent with Lee and Meyer (1994) and Collins (2013) suggesting that closed captioning may help all students learn video-based information. There was no evidence that closed captions hindered information recall scores when comparing participants. This finding suggests that turning on closed captioning when showing a video to undergraduate students may be warranted.

Higher participant GPA's were also associated with higher information recall scores. Interestingly, in both studies, male participants scored significantly higher compared to female participants. Differences in recall performance among male and female students are something that should be examined further. The average GPA among males and females in both studies was not significantly different. It may be possible that male participants were more interested in the subject matter and, therefore, paid more attention to the video used in the research project.

Inconsistencies also existed between results of the two studies in relation to the information recall scores. In Study 1, sophomores had significantly lower information recall scores compared to seniors. In Study two, African-American participants had significantly lower information recall scores compared to Caucasian participants. Studies utilizing multiple videos that highlight different subject matter and associated assessments are needed to further examine differences among the year in school of participants, gender, and race/ethnic backgrounds.

Results of both studies suggested that participants who use closed captions more often in their daily lives have more positive attitudes toward the technology compared to participants who

use closed captions less often. Only in Study 2 did results suggest more positive attitudes among female participants compared to male participants. Although inconsistencies occurred, other attitudinal research has suggested females typically have more positive attitudes toward UD and disability-related issues (Hergenrather & Rhodes, 2007; Lombardi & Murray, 2011; Lombardi, Murray, & Gerdes, 2011; Rice, 2009; Upton, 2002). Additionally, in Study 2, those who were exposed to closed captions during the study reported more positive attitudes toward the technology compared to participants who did not see closed captions. These inconsistencies warrant further study across a larger population of undergraduate students at multiple postsecondary institutions.

Results of both studies suggested that closed captions may be beneficial for learning video-based information. Results also suggested that those who use the technology in their daily lives tend to report more positive attitudes toward broader use of closed captioning. Additionally, descriptive statistics in both studies revealed the average attitudinal response fell within the *somewhat agree* category. This suggests that, on average, participants had ambivalent to somewhat positive attitudes toward closed-captioning technology. Therefore, in a college classroom setting, it seems most students would not be opposed to viewing closed captions when viewing a course-related video.

Descriptive statistics in both Studies 1 and 2 indicated approximately 10% of participants reported *never* being exposed to course videos during college. Therefore, the majority of participants had experienced course-related videos at some point during their college careers. Approximately half reported being exposed to closed-captioning less than 25% of the time course-related videos were shown. An additional 33% (n = 48) and 27.7% (n = 61) respectively, reported *never* being exposed to the technology when course-related videos were shown. These descriptive statistics support the authors' assertion that closed captions are not routinely shown with course-related videos.

Based on the results of this study, faculty members are encouraged to "turn on" closed captions when showing course-related videos in class or for online courses. Another option is to allow students repeated viewing of a video on their own time and inform them that closed captions are available. Doing so may enhance learning opportunities for students taking courses and improve student attitudes toward the technology. The authors realize that it may be difficult, without administrative support or other institutional resources, for faculty members to ensure that all course-related videos have closed-captioning capability. For example, adding closed captions to a video may take significant time or cost money if other professionals add the closed captions. Therefore, more research on the educational impact of closed captioning for all students is needed in order to advocate for more widespread institutional support.

Limitations

The study took place at one university; therefore, the results are not generalizable to a whole population of postsecondary undergraduate students. Participants were not individually randomly assigned to a condition; rather, whole groups of participants were assigned to either closed-captioning or no closed-captioning conditions. Multiple classrooms were utilized during Study 2, and, therefore, room size varied. In both studies, data collection took place during different times of the day. Finally, only one video-based topic (e.g., global warming) was used for the studies. Ideally, multiple videos and corresponding assessments should be utilized.

Future Research

Almost no previous research exists on the use of captioning in college classrooms. Previous research that sampled from a general population has been limited in scope. The current study expanded upon previous research by completing multiple studies in different settings (e.g., classroom vs. computer lab), securing larger sample sizes, and group randomization. Results suggested that closed-captioning may be useful for learning in college courses when videos are shown. Therefore, the use of closed captioning in postsecondary settings using participants from a general student population warrants further study. Closed captioning benefits specific populations; however, measuring the broader educational impact of this technology is a worthwhile endeavor. Assessing educational technology for effectiveness is important prior to making recommendations for widespread use. Replication of the current study could be done by randomly assigning individual participants to a "caption" or "no-caption" condition. Future studies could collect data on an individual participant or group basis and should control for the influences of room size, video volume, and background noise. These factors may affect how participants learn via video-based information and perform on subsequent assessments. Furthermore, a large variety of videos and assessments should be utilized that cover different topics.

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