

Relationships Between Benefit and Use of a Speech-to-Text Service,
Perceptions of Courses, and Course Performance

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Abstract

This study examined relationships between benefit and use of support services by deaf/hard of hearing students and their perceptions of and performance in mainstream college courses. Data for speech-to-text supported courses were compared with data for courses with interpreting and note taking support. Students rated comprehension with the real-time display of the speech-to-text service as greater than comprehension of an interpreter. They also reported that the saved text of the speech-to-text service was more helpful than note taker notes, used the text more often than notes, and, used more study strategies with the text than with notes. A similarity in results for the two courses was that, for both, perceived ease and clarity of course information was associated, at a statistically significant level, with ratings of percent of the lecture understood. A key difference in relations among students' perceptions for the two courses was that, for the speech-to-text course, students who assigned higher ratings for course motivation also assigned higher ratings for helpfulness of the text, reported using more strategies with the text, and rated use of the text as more frequent. In contrast, for the interpreting/note taking supported course, none of these correlations were statistically significant.

Relationships Between Use of a Speech-to-Text Service,
Perceptions of Courses, and Course Performance Among
Deaf/Hard-of-Hearing College Students

Currently, more than 26,000 students who are deaf/hh are enrolled in postsecondary programs (Marschark, Lang, & Albertini, 2002). A substantial majority of these students receive their education in mainstream classes alongside hearing classmates (Lang, 2002; NCES, 2000). A key issue for these students is the extent to which they have access to lecture and discussion in the classroom. One way that access is provided is through a sign language interpreter, and a second is through a real-time speech-to-text support service. Use of speech-to-text services has grown considerably in recent years (Stinson et al., 1999).

Another important means for learning is through notes that record information during the class session. Hearing students are able to take notes for themselves. In contrast, deaf/hh students often rely on notes *taken by others*. Often peer or professional note takers handwrite the notes that are provided to mainstreamed students after class (Hastings et al., 1997). Speech-to-text services provide deaf/hh students a means to remember material by making available the saved text that is produced during class. This stored text, in either electronic or paper form, is likely to be considerably more detailed than hand written notes.

This paper reports on one of a series of investigations that have examined the C-Print® speech-to-text support service (e.g. Elliot, Foster, & Stinson, 2002).

These investigations have been studying the service's benefits to mainstreamed deaf/hh students, the manner in which they use the service, and the relation between this use and student characteristics. The technology for this speech-to-text service has been under continuous evolution (Elliot, Stinson, Francis, Coyne, & Easton, 2003). For this study, the speech-to-text system consisted of a hearing transcriber who, using a computerized abbreviation system, typed the words of the teacher as they were being spoken. These typed words provide a real-time display that students usually read on a laptop computer. The text file for the real-time display was available for student use after class.

Goals

It is not a reasonable expectation that all mainstreamed students would benefit equally from speech-to-text support services. Thus, there is a need to examine the differential benefits of speech-to-text utilization that occurs for these students who bring different perceptions and academic proficiency to their coursework. In addition, variation in how individual students utilize speech-to-text support services as part of their learning and study strategies is important in determining the educational benefits of this technology. In addressing these issues, this study focused on the following questions:

1. How do students describe the benefits and use of the speech-to-text service?
2. How does students' use of the speech-to-text service relate to their perceptions of the course regarding motivation to learn and succeed in the

course, and ease in learning course concepts and clarity of the teacher's presentation?

3. How does students' use of speech-to-text services and their perceptions of the course relate to course performance?

Design

To address these questions, all students in the study took one course during a term in which they received speech-to-text services. In addition they took in the same term a comparable course without the speech-to-text service, but which had interpreter and note taker support. Courses were matched as well as possible for content demands on learning, such as both courses being liberal arts, etc. This design permitted both comparative and correlational data analyses.

Method

Participants

Participants were 53 women and 35 men who were deaf/hh students in mainstream classes who received speech-to-text services at one of 5 postsecondary programs. 74 attended RIT, 5 attended Louisiana State University, 6 attended a community college in Connecticut, and 3 attended a community college in the Rochester NY area. Their mean pure-tone average in the speech range for the better ear was 89.9 dB ($SD = 22.1$). Students were evenly distributed among the 4 years of college. 24, 23, 15, and 25 were enrolled in Years 1,2,3, and 4 (or more), respectively.

Courses. Students were enrolled in 41 different courses with speech-to-text services, and in 79 different courses with only interpreting and note taking services.

(Some courses enrolled more than one participant in this study.) 53 of the students that received speech-to-text services were enrolled in liberal arts, 27 in applied science/technology, and 8 in business courses. 38 of the students that received interpreter/note taking services were in liberal arts courses, 17 in applied science/technology, 16 in science, 9 in imaging arts and sciences, and 6 in business courses. Examples of courses were “Introduction to Philosophy” and “Social Psychology” in liberal arts, “Computer-Human Interface” and “Introduction to Visual Programming” in applied science/technology, and “Calculus for Technology,” and “College Algebra and Trigonometry” in science. Speech-to-text service providers identified 54 of the students that they supported as being in courses that were primarily lecture oriented and 7 in courses that were half lecture and half discussion oriented. Equivalent information was not available for the classes with only interpreting/note taking services.

For the speech-to-text courses, 77 of the 88 students also had interpreting services and 74 had note taking services. For the interpreting/note taking supported courses, 85 of these students had interpreters, and 86 had note taking support. Thus, the interpreting/note taking supported courses included a few instances in which one of these services was not provided.

Materials and Procedures

The materials and procedures used for data collection included: questionnaire items (a) about the course that included speech-to-text services, (b) about the course with only interpreting and note taking services, and (c) about participants’

communication preferences. In addition, data were collected with a student log form and from student records.

The speech-to-text and interpreting/note taking items were in separate sections of the questionnaire. At the beginning of the section about the speech-to-text supported course, the questionnaire listed the name of the course at the top of the page, followed by the statement, “Questions about C-Print (the speech-to-text service) for this course.” To introduce the section pertaining to the course with interpreting/note taking services, there was the statement, “Notice! These questions are about a different course”, and the statement, “Name of the course without C-Print _____ (name supplied) _____”.

The speech-to-text and interpreting/note taking sections of the questionnaire included 3 pairs of single item ratings: (a) student rated understanding of the speech-to-text real-time display (or of the interpreter), (b) rated help provided by the saved text for the speech-to-text services (or note taker’s notes) after class; and (c) rated number of times students used the text (or notes) for study in past week. In addition, the questionnaire included 3 pairs of multi-item scales. (d) For a pair of 6-item scales, students reported the number of strategies for using the text (or notes; e.g. “prepared for test,” “highlighted/underlined,” etc.; maximum scores, 6; saved text internal-consistency reliability, $\alpha = .40$, notes $\alpha = .71$). (e) For a pair of 3-item scales, students rated motivation for the course with speech-to-text services (and with interpreting/note taking; maximum scores, 5, averaged for the 3 items; speech-to-text $\alpha = .78$; interpreting/note taking $\alpha = .85$). (f) For a pair of 2-item scales, students rated perceived ease in learning concepts and clarity of teacher for

the course with speech-to-text services (and with interpreting/note taking; maximum score, 5, averaged; speech-to-text $\alpha = .68$; interpreting/note taking $\alpha = .81$).

A student log form contained a question about the rated number of times that students used the text (or note taker notes) for study in the past week, identical to that in the questionnaire. Rated time on the log and questionnaire items were averaged separately for the speech-to-text and interpreting/note taking items.

A separate section of the questionnaire asked students 7 questions about communication preference. 6 items asked about preference for expressive and receptive communication in class. (e.g. "How do you like to communicate with deaf students?") For these items, the student response was scored a "1," if the student selected the alternative of preferring sign alone or an interpreter, and his/her response was scored a "0" if the student selected the alternative of preferring speech along, or speech and sign. For the 7th item, "How often does your family use sign language," responses of "never" and "sometimes" were scored as "0" and "often" and "all the time" were scored as "1." (Maximum score, 7: $\alpha = .87$.) The questionnaire and log items used in the study are presented in Appendix 1.

C-Print speech-to-text and interpreting/note taking services were provided to students for the entire term, 10-17 weeks, depending on the college. As noted, courses with the speech-to-text service typically also had interpreting and note taking services.

Speech-to-text service providers distributed the log form to students during a class session in the middle of the term near the end of the term in the course with

that service, and distributed the questionnaire near the end of the term. Students completed the questionnaire independently, returned it to a designated office at the college, and received \$5.

Student Records

Students gave the researchers permission to access their records at their college's program. Data were collected regarding grade-level reading proficiency, year in college, and grades for the course in which students used the speech-to-text service and for the one in which they answered questions about using interpreting and note taking services. Reading test data were available from the following: (a) reading comprehension section of the California Achievement Test, $M = 9.6$, $SD = 1.5$, $N = 44$, (b) the Michigan Test of English Proficiency, $M = 78.2$, $SD = 10.4$, $N = 40$, (c) the verbal section of the Scholastic Aptitude Test (SAT), $M = 416.3$, $SD = 87.7$, $N = 30$, and (d) the reading section of the American College Testing (ACT) exam, $M = 21.7$, $SD = 5.7$, $N = 20$. In order to use the reading scores together in the analyses, we applied a z -score transformation to the reading scores, separately for each of the four tests, using all sample data for that test. One z -transformed score for each student was included in a z -reading variable. 40 z -reading scores were based on a California score, 1 on a Michigan score, 15 on an SAT score, and 12 on an ACT one. (There were no reading data for 16 participants.) The California Achievement Test is now called the Terra Nova CAT and is distributed by TB McGraw-Hill (2000)). The Michigan Test of English Proficiency is a retired component of the Michigan English Proficiency Battery distributed by the English Language Institute of the University of Michigan (2000).

Technology. Students in the study used the C-Print speech-to-text support service. The technology for the C-Print service has been under continuous evolution (Elliot, Stinson, Francis, Coyne, & Easton, 2003). For this study C-Print used standard laptop computers and word-processing software. In addition, it included computerized word-abbreviation software and training that allows service providers to more closely capture the essence of the lecture. The phonetics-based abbreviation software allows for the transformation of an abbreviation into a full word on the computer screen. In addition providers learn strategies for identifying important points, and for condensing and organizing information (Stinson & McKee, 2000). The provider, using the computerized abbreviations types the words of the teacher and students as they are being spoken. The system provides a real-time display that the student can read on a laptop computer or television monitor. The text display for the message appears approximately 3 s after the words are spoken and remains on the screen for approximately 1 min. This provides students far more time to consider these words than if they were using an interpreter or lip reading. In addition, the text files are saved and may be edited after class. Students can use these edited texts after class by reading them on a monitor or as printed text. The system cannot provide word-for-word transcription because it cannot keep up with the speed of speech (approximately 150 words per minute). However, the system does provide for capturing almost all of the meaning of the lecture (Elliot, Stinson, McKee, Everhart, & Francis, 2001; Stinson, McKee, & Elliot, 2000). C-Print texts contain the important information in a more condensed format than verbatim transcription.

Results

Comparison of Ratings for Speech-to-Text and Interpreting/Note taking Supported Courses

In the first set of analyses, we compared students' reports on the questionnaire of benefit and use of the speech-to-text service with reports regarding interpreting/note taking support. Table 1 presents mean questionnaire ratings regarding benefit and use for speech-to-text and interpreting/note taking services. Students were asked to rate their comprehension of class lectures with the speech-to-text service, as compared to with an interpreter. In examining these data, we compared ratings for 27 students who reported that they had the speech-to-text laptop available for viewing in at least 50% of classes and had interpreter support for at least 50% of their classes. Students assigned higher ratings for percentage of lecture understood with the speech-to-text service than with interpreting, paired *t*-test, $t(26) = 2.44, p < .025$, effect size, $\epsilon^2 = .19$. (These data were not included in the following multivariate analysis of variance [MANOVA] because there were substantially fewer data for this measure than for the measures included in the MANOVA.)

Insert Table 1 about here

Next, students' ratings of the saved text generated by the speech-to-text service and note taker's notes were compared. The first step in these analyses was to perform a MANOVA upon the dependent variables of rated helpfulness of the

saved text/notes, times text/notes was used, and number of strategies used with the text-notes. This analysis yielded a significant effect for the type of service provided, $F(3, 68) = 13.54, p < .001$. The three follow-up univariate analyses of variance (ANOVA) yielded noteworthy results. Students rated the saved text as more helpful than the notes, $F(1, 70) = 36.34, p < .001, \epsilon^2 = .34$. Also, students reported that they used the text more than the notes during a one-week period, $F(1, 70) = 5.95, p < .01, \epsilon^2 = .08$; and students reported that they used more study strategies with the text than with the notes, $F(1, 70) = 12.71, p < .001, \epsilon^2 = .15$.

Relations Between Students' Perceptions of Courses and of Support Services

The next set of analyses examined relations between students' perceptions of courses regarding motivation and ease/clarity of course information and their rated benefit and use of the speech-to-text and interpreter/note taking support. A first step was, for each of these two student perception variables, to compare means for speech-to-text and interpreting/note taking supported courses with each other. The MANOVA with the two course perception measures as the dependent variables was not statistically significant. The means for course motivation were 4.2 ($SD = .6$) for the speech-to-text supported and 4.1 ($SD = .8$) for the interpreting/note taking supported courses. The respective means for ease/clarity of course information were 3.9 ($SD = .8$) and 3.7 ($SD = 1.1$).

Next, the four benefit/use of support services measures, the course motivation measure, and the ease/clarity measure were correlated with each other. Table 2 displays the separate set of correlations for the courses with speech-to-text (below the diagonal) and with interpreting/note taking support (above the diagonal).

Examination of the pattern of correlations for these courses revealed some similarities in results for the two courses. For both, perceived ease and clarity of course information was associated, at a statistically significant level, with ratings of percent of the lecture understood. In addition, for both courses, helpfulness of the saved text (notes), times used, and number of strategies had positive, significant correlations with each other. Also, for both, course motivation and ease/clarity of information were associated with each other.

Insert Table 2 about here

A key difference in the patterns of correlations for the two courses was that, for the speech-to-text course, students who assigned higher ratings for course motivation also assigned higher ratings for helpfulness of the text, reported using more strategies with the text, and rated use of the text as more frequent. For the interpreting/note taking supported course, none of these correlations were statistically significant. In addition, for the interpreting/note taking course, ease/clarity was associated with helpfulness of the notes, but for the speech-to-text course, the correlation between the equivalent variables was not statistically significant.

Separately for each course, sets of correlations were also computed between the measure of communication preference and the 4 ratings regarding benefit and use of the support service. None of these correlations were statistically significant.

Relations Between Course Grades, Students' Ratings, and Reading

A final set of analyses examined relations between course grades and (a) students' ratings regarding benefit and use of the two support services, (b) students' perceptions regarding course motivation and ease/clarity, and (c) reading proficiency. For both the speech-to-text and interpreting/note taking supported courses, none of the 4 measures regarding benefit and use of the services correlated with grades at a statistically significant level. (The mean grades for the two courses were not significantly different from each other—speech-to-text, $M = 3.2$, $SD = 1.3$; interpreting/note taking, $M = 3.5$, $SD = 1.3$.) For the class with speech-to-text support, higher grades were associated with greater ease/clarity of the class, $r = .29$, $p < .01$, and with greater reading proficiency, $r = .42$, $p < .001$. For the class with the interpreting/note taking support only, higher grades were associated with greater ease/clarity, $r = .33$, $p < .01$, and with motivation, $r = .45$, $p < .001$.

Importance of Study

In regard to the question of perceived benefit and use of speech-to-text compared to interpreting/note taking services, students rated understanding of the teacher as higher with speech-to-text than with interpreter support. This result indicates that students who used the display viewed it as beneficial and is consistent with results of four previous studies involving speech-to-text support services (Elliot et al., 2002; Elliot, Stinson, McKee, Everhart, & Francis, 2001; Stinson et al, 2000; Stinson, Stuckless, Henderson, & Miller, 1988).

Turning to the saved text, students indicated that the text was more helpful than notes from the note taker, they studied with the text more often, and they used

more strategies with it. Students may have used the text to understand and remember what happened in class and to do homework and prepare for tests. These results are key findings that point to the benefit of the text and are consistent with findings of a qualitative study on use of this text (Elliot et al., 2002). Additionally, findings that pertained to relationships between use of support services and perceptions of courses suggested that one way that students expressed their motivation to do well and the effort they put into the course was by actively working with the text. This interpretation is provided some support by three statistically significant, albeit weak to moderate, correlations between course motivation and use of the text.

To the extent that students viewed ease and clarity of the course as being mediated by the support services, the positive correlations between perceptions regarding the support service and those regarding ease/clarity suggest that students perceived both speech-to-text and interpreting/note taking support as facilitating ease in understanding of the course. On the other hand, perceptions of ease/clarity could also have reflected thoughts about the courses' content and characteristics of the instructors. One of the items specifically stated, "The *teacher presented* the course material clearly (italics added)."

Findings pertaining to relations between grades, perceptions of support services, perceptions of the courses, and English proficiency indicated that there were no relations between perceptions of support services and grades. These results may have reflected the multiplicity of factors that determine attainment of a

particular course grade. With numerous determinants, impact of a support service upon attainment of a grade may be limited.

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Table 1. Mean Questionnaire Ratings Regarding Benefit and Use of Speech-to-Text and Interpreting/Notetaking Services.

<u>Rating</u>	<u>N</u>	<u>Type of Support</u>			
		<u>Speech-to-Text</u>		<u>Interpreting/Notetaking</u>	
		<u>M</u>	<u>SD</u>	<u>M</u>	<u>SD</u>
1. Percent Lecture Understood	27	90.4	19.9	74.6	25.6
2. Text/Notes Helpful	71	4.4	.7	3.5	1.1
3. Times Used Text/Notes Per Week	71	2.6	1.4	2.1	1.6
4. Strategies Used with Text/Notes	71	3.0	1.3	2.2	1.7

Table 2. Correlations Among Four Ratings of Benefit and Use of Speech-to-Text (and Interpreting/Notetaking) Services, Motivation, and Ease/Clarity of Class Information.^a

Measures	1	2	3	4	5	6
1. Percent of Lecture Understood		.47**	.09	.19	.20	.52**
2. Helpfulness of Text/Notes	.47**		.54**	.56**	.18	.40**
3. Times Used Text/Notes	-.04	.33**		.61**	-.20	-.08
4. Strategies Used with Text/Notes	.17	.48**	.43		-.06	-.11
5. Motivation	.15	.31**	.25*	.26		.53**
6. Ease/Clarity of Information	.37*	.19	.03	.07	.37**	

*p<.05. **p<.01.

N ranged from 41-88 depending on data available.

^a Correlations below diagonal are for class with speech-to-text service. Correlations above the diagonal are for interpreting/notetaking services.

APPENDIX 1

Questions Specific to Course with Speech-to-Text (C-Print) Support*TO THE STUDENT:*

This questionnaire is not part of your school work. It will not be graded. If you decide you do not want to finish the questionnaire, you can stop at any time. We need your honest answers. Please read each question carefully. Thank you for your help.

NAME OF THE COURSE *with C-PRINT*: (course title written in) .

QUESTIONS ABOUT *C-PRINT* FOR THIS COURSE. Circle one answer for each question.

a. What percent of your classes was the laptop set up for you?

1	2	3	4	5
None of the classes	25% of the classes	50% of the classes	75% of the classes	All of the classes

b. How much of the class did you understand using C-Print on the laptop computer?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

c. The C-Print notes were very helpful.

1	2	3	4	5
strongly disagree	disagree	not sure	agree	strongly agree

d. How did you use the C-Print notes? (you may check more than one)

did not use
 to do homework
 to prepare for a test
 to remember what happened in class
 wrote an outline or summary from the C-Print notes
 highlighted or underlined information in the C-Print notes
 used the notes with your tutor or TOD

e. In the past week, *how many times* did you use the C-Print notes to do your homework or study for a test? (Also on log form.)

never 1 2 3 4 5 more than 5 times

Questions Specific to Course with Interpreting/Note taking Support

NOTICE! THESE QUESTIONS ARE ABOUT A DIFFERENT COURSE.

NAME OF THE COURSE *without* C-PRINT service: : (course title written in) .
 QUESTIONS FOR THIS COURSE. Circle one answer for each question.

a. How often was the interpreter in this class?

1	2	3	4	5
None of the classes	25% of the classes	50% of the classes	75% of the classes	All of the classes

b. How much of the class did you understand with the interpreter?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

c. The notetaker's notes were very helpful.

1	2	3	4	5
strongly disagree	disagree	not sure	agree	strongly agree

d. How did you use the notetaker's notes (you may check more than one)?

did not use
 to do homework
 to prepare for a test
 to remember what happened in class
 wrote an outline or summary from the notes
 highlighted or underlined information in the notes
 used the notes with your tutor or TOD

e. In the past week, *how many times* did you use the notetaker's notes to do homework or study for a test? (Also on log form.)

never 1 2 3 4 5 more than 5 times

Questions Repeated for Each Course

a. This course was very important to me.

1	2	3	4	5
strongly disagree	disagree	not sure	agree	strongly agree

b. I was very interested in this course

1	2	3	4	5
strongly disagree	disagree	not sure	agree	strongly agree

c. I made a great effort to do the work for this course

1	2	3	4	5
strongly disagree	disagree	not sure	agree	strongly agree

d. It was easy for me to learn the concepts in this course

1	2	3	4	5
strongly disagree	disagree	not sure	agree	strongly agree

e. The teacher presented the course material clearly

1	2	3	4	5
strongly disagree	disagree	not sure	agree	strongly agree

**Questions Asked Once
(Used in Analyses with Both Courses)**

COMMUNICATION PREFERENCE IN SCHOOL Circle one answer for each question

	Interpreter	Sign	Speech	Speech & Sign
a. How do you like best to communicate with hearing students?	1	2	3	4
b. How do you like best for hearing students to communicate with you?	1	2	3	4
c. How do you like best to communicate with other deaf students?	1	2	3	4
d. How do you like best for other deaf students to communicate with you?	1	2	3	4
e. How do you like best to communicate with teachers?	1	2	3	4
f. How do you like best for teachers to communicate with you?	1	2	3	4

HOME COMMUNICATION

g. How often does your family use sign language?

1 Never	2 Sometimes	3 Often	4 All the time
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