Using C-Print to Support Learning in Secondary and Postsecondary Settings

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C-Print™ is a real-time speech-to-text transcription system that was developed to meet the information access needs of students in mainstream classes while addressing constraints such as cost and availability of support services. Mainstreamed students often have diverse communication needs and may have difficulty fully comprehending information in class. Traditional support services of interpreting and note-taking serve many students adequately. However, alternative forms of support may provide the best access to communication for other students.

C-Print's development resulted from 10 years of research to create a new real-time speech-to-text system. It is a system which addresses the need for real-time and notetaking supports with more complete information than can usually be provided by a student notetaker while providing such information in a cost efficient way.

At present, over 250 people have been trained as C-Print captionists throughout the United States and the system is currently used as a support service in high schools and colleges across the nation. This paper addresses the following topics related to C-Print:

- The development and evaluation of the C-Print system.
- Ways in which C-Print supports individual learners within the mainstream classroom setting.
- How schools across the country are implementing the C-Print system.

Development and Evaluation of the C-Print System

The C-Print system involves a hearing captionist (transcriber) typing the words of the teacher and other students as they are being spoken. The system provides a real-time text display that the deaf student can read on a second laptop computer or a TV monitor to understand what is happening in the classroom. In addition, the text file is stored in the computer and can be edited, printed, and distributed to students, tutors, and instructors after class.

Due to the speed of speech normally used by college instructors (approximately 150 words per minute), the system cannot provide word-for-word transcription. Therefore, C-Print uses two strategies to achieve the goal of including as much of the relevant information as possible: (a) computerized abbreviation system to reduce keystrokes, and (b) text condensing strategies. The system employs ordinary word processing software which is augmented with a computerized abbreviation system to substantially reduce keystrokes. A set of phonetically-based rules for abbreviating words has been developed, as well as procedures for training captionists in using these rules. To deal with rapidly spoken lectures, the project developed text "condensing" or reduction

strategies. The goal of these strategies is to reduce the number of words and abbreviations typed while preserving meaning and keeping the message displayed as near verbatim as possible.

Where Have We Been?

Researchers at NTID have been working with Speech-to-Print transcription systems for almost 20 years. Much of the early research was conducted with stenographic systems (Real Time Graphic Display) by Ross Stuckless and Michael Stinson. That early work documented the value of such systems as a classroom support service and was a primary impetus for the development of a less expensive, more portable system with a shorter training time for the transcribers (or captionists as they are currently known) (Stinson, Eisenberg, Horn, Larson, Levitt, & Stuckless, 1999).

C-Print really began to "take off" when NTID received a three year federal grant to develop C-Print. Funding for the grant began in December of 1993 and allowed the department to hire a full-time research assistant and a full-time captionist trainer plus part-time captionists. The primary goal of that first grant was to develop the system. That goal has been accomplished.

A second grant began in 1996. The primary goal of the second grant was implementing the system in different environments. C-Print was piloted in several different settings (a) a large, centralized high school regional program; (b) a program which provides itinerant teachers and support services to deaf and hard of hearing students attending local high schools; (c) the college program at NTID which has a large number of students and extensive support services; and (d) a group of college programs with few deaf and hard of hearing students and limited support services.

Currently, C-Print is operating under its third grant, beginning in 1999. The primary goal for this third grant is to develop a national network of trainers and service providers for the system across the country. At this point, the project is making steady progress toward meeting that goal. Seven sites have provided or are in the process of providing 14 workshops to more than 100 individuals to become C-Print captionists. A database is being created on evaluations of all workshops that have been offered and a survey was developed and sent to 235 individuals who have completed C-Print captionist training. The development of certifications processes and procedures for C-Print captionists has been started.

What Have We Learned?

1. **We learned that students like the system and feel the completeness of the information is one of the major benefits**.

In a questionnaire/interview study conducted from winter, 1994 through spring of 1996 (Elliot, Stinson, McKee, Everhart, & Francis, in press), results indicated that students felt they were getting more complete information from C-Print than from other sources. According to responses from the in-depth interviews, students felt that they were getting complete information with C-Print and that this facilitated comprehension of the classroom discourse. The following comment shows how one student developed a new appreciation of the complexity and richness of the classroom dialogue with C-Print.

Interviewer:
tab *Do you have some opinions or faults or comments about C-Print that you would like to add?*
Informant: *Well, I would say that it helps a lot. And it surprised me, because I never realized how much information was provided in class. Before, I always thought that the teacher did not provide enough information and it was boring; but when I was using the C-*

Print, it seemed more interesting. It makes me feel like I have been missing something in the past. Like I missed the last few years.

From the questionnaire data, almost all students reported feeling that the summarization done by the C-Print captionist was acceptable and that they were getting the important points of the lecture compared to the one student who did not feel that the summarization was acceptable. A student responded to an interview question about the extent that the captionist summarized information as follows:

par *Yes, I accept that it is summarized. I can hardly tell if it is summarized. It looks like she is just typing every single word that the teacher is saying. I can hardly tell that she is summarizing. When I look at the interpreter, I can tell that they are summarizing. So I can see the difference.*

2. **We learned that we can capture two -thirds of all the information provided in a classroom and three-fourths of the important information**.

Information collected to date indicates that C-Print captionists record approximately 66% of the information spoken in class and 76% of the important information (Everhart, Stinson, McKee, Henderson, & Giles, 1995).

3. **We learned a lot about the skills and training required to become a C-Print captionist**.

We have now developed several screening tests for potential captionists. These tests include a typing test, general English language ability test and a phonetic test that assesses the ability to "hear the sounds in words--for example to hear that "C" in English is often pronounced "k"--so coffee sounds like "kfe." We have learned that it requires approximately four weeks of part-time training to bring a 60 word per minute typist with appropriate English and phonetic skills up to the level of what we have termed "apprentice" captionist. It then requires approximately one quarter (10 weeks) of in-class experience before an operator is ready to function without assistance.

4. **We have learned that it is often the "peripheral" issues that cause more problems than the actual implementation of the system**.

Previous informal feedback from captionists as well as data from the recent captionist training workshop survey (Elliot, McKee, & Stinson, 2001) suggest that issues such as equipment failure, finding backup for captionists who are ill, and finding appropriate places to sit in some classrooms are some of the difficulties that captionists encounter on the job.

5. **We have learned that providing C-Print services for the student provides the captionist with a sense of pride and satisfaction.**

In the recent captionist survey (Elliot et al., 2001), captionists were asked to identify positive aspects of their job. Among the top responses from 90 survey respondents were included: Support and appreciation of students (67%); opportunity to perform an important and needed task (58%); support from classroom instructors (50%); and, functioning as part of an educational team (49%). Consider the experience of one such captionist:

I will never forget a student (HoH) who resisted DSS for services. She did not know sign language. C-Print was introduced to her. After the first class she was overcome with emotion because she could understand both the professor and the students. I received an enormous hug. I also introduced C-Print at a recent Deaf Advisory Board Meeting. It is so cool to watch the deaf as the speaker is talking and they read the screen in awe. Many positive comments from deaf after the demo.

6. **We have learned that the demand for C-Print is great.**

To date, over 100 academic programs around the country use C-Print as a support service. Respondents to our recent survey (Elliot et al., 2001) report that they are using C-Print with students

in middle schools through graduate school. A few captionists are also using the service for adults through agencies such as Vocational Rehabilitation and the Social Security Administration.

Over the past five years, training for C-Print has taken place at more than 20 different sites in such places as Alabama, Arkansas, Arizona, California, Colorado, Connecticut, Florida, Illinois, Louisiana, Maryland, Massachusetts, Minnesota, Mississippi, New Hampshire, New Jersey, Oklahoma, Oregon, Pennsylvania, Texas, South Carolina, and Utah. Interest in the support service extends across international borders as well, with captionists being trained from such countries as Australia, Canada, and South Africa. The rate of inquiries about C-Print average 20 per month (Francis, personal communication, May 25, 2001).

7. **Finally, we have learned that we need to know more about integrating the C-Print system into existing support services programs and we still have a lot to learn about using the system in environments other than RIT**.

How C-Print Supports Individual Learners

This section addresses three questions in regard to the support that C-Print provides to individual learners within the mainstream classroom setting: (a) How does the C-Print real-time text benefit learners? (b) How do the C-Print notes benefit learners? (c) Who are the learners and what are the classroom environments for which C-Print is more beneficial?

The C-Print Real-Time Text

The permanence of information on the C-Print real-time display is one way that C-Print may improve accessibility to classroom lectures and discussions so that students may more effectively comprehend the material and then remember the pertinent information. These processes are essential for performing well on tests and other course activities. Students view the C-Print real-time text display on either the monitor of a laptop computer that is on the students' desk or on a television monitor. Typically, each row of words remains on the screen for approximately one minute, providing students far more time to internalize the message than if they were using an interpreter or lipreading a speaker. In an interview study, one student contrasted C-Print with an interpreter:

> *...I go back and forth between the teacher and the C-Print. But if I understand with the C-Print it is clear. It doesn't mean the interpreter doesn't do a good job, but sometimes it is a lot, overwhelming all that information, trying to memorize everything. But if I can look at it on C-Print, then I can understand it. Looking back and forth I miss what is happening sometimes actually what is going on with the interpreter. But the information is wonderful on C-Print.* (Elliot et al., in press.)

Another benefit of the real-time display is that it captures exact technical information and specific vocabulary. One student commented, "I think I learn more big words." In addition, the C-Print text and notes provide students with more opportunity to strengthen their English skills. Some students felt that they were more confident about learning and that they could perform better when the C-Print service was provided. Thus, students generally thought that C-Print enhanced their educational experience. These findings were obtained in studies with college and high school students that have used C-Print (Elliot et. al., in press; Elliot, Foster, Stinson, & Colwell, 1997). In addition, several high school teachers remarked that their students were less anxious and more focused when they were using C-Print. This teacher captures their shared sentiment:

>*…I think that it gives them a security that once again they know they're going to get all that information so they don't need to worry about missing something because it's all there* (Elliot et al, 1997).

C-Print Notes

After a class session where the C-Print captionist provides the real-time display, the captionist saves the text produced in class in a computer file. The captionist then distributes this text, called "C-Print notes," to students in the form of either a paper hard-copy, a file on a floppy disc, a web-site posting, or as an e-mail attachment. Captionists vary in the extent that they edit these notes before distributing them. Some captionists distribute the C-Print notes without any editing. At the college level, captionists may edit the notes for misspellings, punctuation, and complete thoughts. At the high school level captionists may vary the editing in relation to the capabilities of the student. For example, a captionist may provide certain high school students C-Print notes similar to those that s/he would provide to college students and may provide other high school students notes that have been modified into an outline of the basic information. Regardless of the type of editing, these notes tend to be more detailed than those produced in handwriting by a notetaker, but briefer and easier to study than the verbatim transcripts produced by an educational stenographer (McKee, Stinson, Giles, Colwell, Hager, Nelson-Nasca, and MacDonald, 1999).

The C-Print notes provide additional access to class information for deaf and hard of hearing students. Legible, organized, complete notes are important study tools for mainstreamed students. If the student relies on interpreting services, speechreading the teacher, or a real-time text display, it is often difficult to simultaneously focus on this information and on taking good notes (Hastings, Brecklein, Cermack, Reynolds, Rosen, & Wilson, 1997). In view of this difficulty, educators such as Saur (1992) have stated that notetaking, where a designated person in the class takes notes, is an essential support for most deaf and hard-of-hearing students.

When students receive C-Print notes after class, they can further review the material in exactly the same wording and in greater detail than notes from a notetaker. With this improved accessibility, important cognitive and metacognitive processing skills for comprehension and learning may be enhanced. First, students may better relate the presented material to specific goals regarding the kind of information they must attend to and remember (Van Meter, Yokoi, & Pressley, 1994). Second, students may better summarize the information, which involves both comprehension of and attention to importance at the expense of trivia (Brown, Bransford, Ferraro, & Campione, 1983; Brown & Day, 1983).

Findings from interview and questionnaire studies indicate that students have responded favorably to the C-Print notes. Furthermore, students' responses suggested that they engaged in metacognitive processes, such as the extraction of important information, with these notes. Many commented on the clarity and detail of the notes. This detail was especially helpful in providing clarification of what was not understood during the lecture. Students recognized the benefits of the notes to themselves and to others in class. C-Print notes appear to be a versatile study tool. Students read, highlighted, and wrote on these notes. C-Print notes helped students to recall class proceedings and students used them to study for tests and to write papers. In addition, students generally reported that the C-Print notes were more helpful than handwritten notes from a notetaker (Elliot et. al., 1997; Elliot et. al., in press).

Individual and Classroom Differences

Some deaf and hard-of-hearing students benefit more from C-Print than others. Extent of benefit relates to individual differences in characteristics of the students. Also, C-Print is more appropriate for some class situations than for others. Students in mainstream settings vary considerably in the degree of hearing loss, proficiency in sign communication, comfort in communication with hearing teachers and peers, and concerns about access. It is difficult for support services for these students to adapt to these variations, especially when it is not unusual for these variations to occur in the same classroom (Kluwin & Stinson, 1993; Stinson, Liu, Saur, & Long, 1996). C-Print is one of several services, or options, that can provide the support that best matches an individual student's needs, within constraints of cost and availability. These options include interpreting, notetaking, and stenographic real-time transcription (Saur, 1992).

An obvious consideration in providing C-Print services is that for students to benefit, they must have sufficient reading skills to understand the C-Print text. The minimum recommended reading level is the fourth grade. Furthermore, research indicates that, beyond the fourth grade level, the greater the reading proficiency, the more likely the student will benefit from C-Print (Elliot et al., in press).

Another characteristic of students who are likely to benefit from C-Print can be that they have expressed a preference for the service or that they have had a favorable past experience with a speech-to-text service. Students also need to have the maturity to work with a laptop computer and generally need to be able to use the C-Print notes. In addition, students who are able to use speech in question asking and discussion in class are likely to benefit. C-Print provides the option of the student typing their response or question and having the captionist read it aloud in class. It is generally easier, however, for students to speak, rather than type. Research has found that students with greater proficiency in speech respond more favorably to C-Print (Elliot et al., in press).

Students less likely to benefit from C-Print include those for whom sign language is their first language. These students often better profit from an interpreter.

Due to the interactive constraints of C-Print services, it is usually more effective in courses with a lecture mode as opposed to those that are highly discussion oriented. This may not apply when the student has intelligible speech. In general, C-Print seems more effective for certain subject matters, such as liberal arts courses, than for others, such as mathematics courses. However, it is not unusual for students to request C-Print services for mathematically based technical courses (Stinson, Eisenberg, Horn, Larson, Levitt, & Stuckless, 1999).

How Schools Across the Country are Implementing C-Print

There are over 100 academic programs around the country, both secondary and postsecondary, using C-Print as a support service for their students who are deaf and hard of hearing. Many of these programs have received training as a result of grant funds from the United States Department of Education, through both the C-Print National Network Training Grant and the Postsecondary Education Programs Network (PEPNet). In addition, the National Technical Institute for the Deaf has provided funding annually for training in Rochester, New York since 1996.

If a program determines that C-Print is the appropriate accommodation for one of their students, a variety of configurations can be used to serve students with different needs. For example, a student with very little workspace may choose to sit next to C-Print captionists rather than have a laptop on his or her desk. The captionist can increase the font size to allow the student to comfortably read the text. Also, since there would be only one laptop, the student would need to

feel comfortable with using her or his own voice, as there would not be a second laptop to use for two-way communication.

The C-Print system can be used for both real-time access and notes. Depending on the student's needs, the system can be set up in different ways. For example, the real time text can be displayed using two laptops--one for the student and one for the captionist, allowing for two-way communication. Or, for classes with several students who would be watching the display, only one laptop might be used for the captionist with the display shown on an external monitor (television or computer). The C-Print notes are also distributed in different formats including hard copy, disk copy, e-mail, and Internet. Again, the decision about the arrangements for real-time and notes is made based on the student's needs. Also taken into consideration are the program's resources.

Establishing C-Print as a service involves designating personnel to assist with implementing and facilitating the service, purchasing and setting up equipment, identifying and training a captionist, and educating students and teachers in how to effectively use the system. Those interested in the C-Print support service have obtained information from written materials distributed by the C-Print central office or by visiting a program that already uses C-Print. Visiting a nearby program helps provide an understanding of how the system works and also provides an opportunity to discuss implementation strategies with experienced personnel.

School administrator support has been vital to successful implementation of the C-Print service. Often it is the administrators who resolve any financial or personnel issues. Facilitators (e.g., a special education teacher or support service coordinator) who are familiar with the student's needs act as liaisons between faculty, students, parents, and captionists. Also, because C-Print is a computer-based system, technical support has been necessary for assistance with purchasing and setting up equipment and resolving hardware and software concerns that arise.

rd   Although development of the system has taken several years, providing C-Print as a support service is relatively new. A principal challenge faced by many programs is recruiting, selecting, and training captionists. Generally, captionists are hired to work either in staff or contract positions where the equipment is provided by the program. Some trained individuals offer C-Print services on a freelance basis, but that is currently a small percentage of the overall group of C-Print captionists. Programs have found that it is advantageous to hire the captionist as a staff member because often the individual will have more of a commitment to the school, which serves as a motivator in the training process. Conversely, freelance providers are motivated to become proficient in order to establish a clientele and a steady income.

Regardless of how programs decide to hire captionists, it is most important to remember that the quality of service is largely dependent on the skills of the captionists. If an individual is not given adequate training time or is not motivated to be a captionist, service to the student will be adversely affected. C-Print captionists should have good skills in typing, English, listening, computers and word processing. It is equally important that the captionist has confidence working in educational settings and enthusiasm about providing C-Print as a support service.

The cost of the C-Print system has been a concern for many programs. Costs to be considered are equipment, software, training, and the captionist's salary. Equipment costs include a computer (laptop recommended), a display device for the student user (e.g., another laptop or an external monitor), and linking cables or network cards to connect the captionist and student display when using two laptops. The abbreviation software that includes the C-Print dictionary is available for $150. When linking two computers, communication software is necessary. There are free communication software programs available, however, they are limited in capabilities and technical support.

Because using C-Print as a support service is a method of providing real-time access, it can also be used in accordance with the Americans with Disabilities Act and the Individuals with Disabilities in Education Act. However, emphasis is again placed on whether C-Print services are the appropriate choice to meet the unique needs of the individual with a disability.

Discussion

The C-Print speech-to-text support service has evolved over the course of 15 years of research aimed at providing a cost effective support service alternative for students who do not benefit from other support services.

Extensive evaluation of the service has demonstrated that students like the system and feel that they receive very complete information. The C-Print captionist relies on both summary skills and a phonetically-based abbreviation system to capture information. We have learned a great deal about the process of training C-Print captionists. C-Print appears to have mutual benefit--students appreciate the information and captionists feel pride in delivering this service to students.

C-Print supports individual learners in several ways. First, the real-time display remains on the screen for about one minute, allowing for the student to internalize the message. Second, the display provides exact technical information and specific vocabulary, which allows students to strengthen their English skills. Third, C-Print provides hard copy notes after class, which students find useful for a number of purposes.

Some students and some classroom situations are more appropriate than others for C-Print. Reading skill, preference for a speech-to-text service, and maturity to work with computers all influence the benefit to the student. Past experience has shown that C-Print works best in lecture-based courses and courses that rely more on words as opposed to formulas or graphics.

C-Print is currently in use at over 100 secondary and post secondary programs throughout North America. The service can be delivered in a variety of ways involving laptop computers and TV monitors, depending upon the needs of the students. Notes are also adapted and distributed according to student needs and preferences.

In addition to the appropriate student, the success of C-Print depends upon hiring persons who have the skills to become successful captionists. As well, knowledgeable technical support is necessary as is a supportive administrator.

C-Print is not a panacea for the communication difficulties of all students who are deaf or hard of hearing. But, C-Print does provide one more cost effective alternative support service that is being used by more and more educational programs.

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