

LIBERATED LEARNING INITIATIVE

*Innovative Technology and Inclusion:
Current Issues and Future Directions for Liberated Learning Research*

David Leitch and Trish MacMillan

Supported by the J.W. McConnell Family Foundation,
IBM and Aliant Telecommunications

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Contributors

Willona Blanche, Durham College
Dale Caume, University College of Cape Breton
Carrie Richardson, Trent University
Dale Shain, Cambrian College
Michaela Wilkes, University of the Sunshine Coast, Murdoch University and
Central TAFE

David Leitch and Trish MacMillan

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*Great discoveries and improvements invariably involve the cooperation of many minds.
-Attributed to Alexander Graham Bell*

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Innovative Technology and Inclusion: Future Directions for Liberated Learning Research

INTRODUCTION

Creative uses for both mainstream and adaptive technologies are proliferating in higher education. Accordingly, there are continued opportunities to evaluate how technology may be used to enhance accessibility, facilitate inclusion, offer innovative learning alternatives, and ultimately promote academic success for students with disabilities (SWD). Historically, students with disabilities have experienced inadequate access to lecture material in the classroom, and insufficient access to the academic resources necessary to sustain their progress. In response to the need for increased inclusion and accessibility in university, the Liberated Learning Initiative (LLI) has been committed to understanding how speech recognition technology (SR) may contribute to creating a barrier-free learning environment for students.

The purpose of this report is twofold. First, we present the outcomes of the applied research on the responses of students with disabilities towards speech recognition technology, and address the core questions that have guided the research paradigm from its inception.

Our second objective is to build upon our existing knowledge to describe a framework for the expansion of the research lens. We identify several related areas of inquiry that warrant further consideration, and propose a way forward that will advance our goal of understanding the implications of innovative technologies for students and instructors.

The research described here is a continuation of an inquiry that began in 2000. This report focuses on outcomes pertaining to students with disabilities. Reports from previous years provide a comprehensive account of the impact of speech recognition on SWD, faculty members and non-disabled students.¹

Our research into the impact of speech recognition technology must feed into the broader issues that affect students with disabilities in the educational sphere, particularly as they pertain to academic success, support and inclusion.

¹ See Leitch and MacMillan (2001). “Improving Access for Persons with Disabilities in Higher Education Using Speech Recognition Technology: Year II Progress Report” and Leitch and MacMillan (2002). “How Students with Disabilities Respond to Speech Recognition Technology in the University Classroom: Final Research Report.”

To this end, the current and future research should strive towards three objectives: the first and most basic is to explore and describe the empirical evidence of the responses of SWD towards new technologies. Second is the philosophically-driven goal of understanding how new technologies may contribute to inclusion and accessibility for persons with disabilities. Finally, the ultimate goal of this work should be to effect policy changes in higher education which address the educational needs of students with disabilities.

SPEECH RECOGNITION TECHNOLOGY AND STUDENTS WITH DISABILITIES: RESEARCH OUTCOMES

The Liberated Learning research has been designed to explore the following core issues:

- Students' interactions with speech recognition and online notes as an indicator of their efficacy and an alternative learning tool
- The effectiveness of displayed text and software generated notes as a means of improving access to lecture material for SWD
- The effectiveness of the Liberated Learning concept² relative to students' specific learning needs and methods, levels of dependency on supports, and, in a limited capacity, the student's disability

The use of qualitative methods as the primary mode of inquiry has proven to be an appropriate and necessary approach in view of both the subject matter and the characteristics of the participants. The sample has comprised students from a wide range of ages, backgrounds, learning styles, disabilities, academic levels, academic proficiencies and life experiences. Moreover, students have been exposed to SR technology on different campuses, across numerous disciplines, and at several different course levels. The multiplicity of our sample (N=44) has been simultaneously advantageous and limiting. While the research is enriched by this diversity of experience and perspective, it is difficult to generalize from such a heterogeneous population. Current research outcomes provide a strong platform upon which to continue this work, but at heart of future endeavors is the need for much larger samples of students.³ Tables 1-3, Appendix A, provide demographic information on participants.

² This refers to the combination of displayed text and software-generated notes

³ See Recommendation #1 at end of report.

*Data analysis*⁴

At the outset, four primary analytic categories, derived from the core research questions, were applied to the data⁵:

Attitude: Students' attitudes towards the LLI concept (displayed text and online notes) were generally categorized as "Favourable", "Indifferent", "Conditional" and "Unfavourable". Since the data is based on qualitative, semi-structured interviews, careful judgment and continuous evaluation and review of the data was necessary in determining the applicability of an attitudinal category to a particular response. A "favorable" or "unfavorable" attitude was evinced by a preponderance of positive statements or negative statements and consistency in this position throughout the interview and within any follow-up contacts. "Conditional" responses were evinced by responses in which a student's views on the viability of the LLI was accompanied by a condition – an assertion, for example, that changes were needed to the technology before it could be considered viable (e.g., "If the text was more accurate, I'd be able to use it more."). The category "Indifferent" was applied to responses that suggested a lack of need for, or interest in, the technology (responses were generally neither positive nor negative).

Source of responses: The analysis included a consideration of the sources of students' responses to the LLI concept. For example, was an "indifferent" response to SR based on a reaction to particular shortcoming in the technology, or grounded in a student's sense that his or her existing learning methods precluded the need for any new interventions? Codes were created around several possible sources of responses, including but not limited to: a student's exclusive dependency on existing supports, a student's preference for his or her existing supports, the technology being incompatible with the student's needs, a deficiency in the technology itself (be it real or perceived), and a lack of interest or initiative on the student's part to engage the technology.

⁴ The recruitment methods have remained unchanged since Year One of the project and will not be reiterated here. For details on recruitment, please consult Leitch, David & MacMillan, Trish (2002) "How Students with Disabilities Respond to Speech Recognition Technology in the University Classroom: Final Research Report." (p. 4)

⁵ Several descriptive and interpretive codes were applied to the data - they are too numerous to describe here.

Interaction: In interviews, students were asked: 1) how often they watched the digitized lecture; and 2) how often they obtained online notes. This was defined as “interaction” with the LLI concept. Categories of interaction included "frequent", "intermittent", "infrequent", and "no interaction". Determining levels of interaction required careful scrutiny of how students described their uses of SR in the classroom, as well as their uses of online notes. Similar to “attitude”, the category “interaction” was often difficult to ascertain since responses could be subject to multiple interpretations. For example, the statement "I watch the screen in class all of the time and find it very useful " suggests at the outset a "frequent" interaction with the LLI concept. However, a subsequent discovery that the student has only attended 3 classes out of the semester weakens the potency of the statement and challenges the original assumptions made in the analysis. Hence, it was important to mind these details when making determinations about the extent of a student’s engagement with the technology.

Function of LLI concept: One of the fundamental questions being pursued in this project concerns how speech recognition technology actually functions as an alternative to conventional note-taking in the classroom. What is its central role in the classroom? Does the technology do what it was intended to do? Were there any spin-offs not originally anticipated? In view of these questions the analysis considered students' uses of SR (beyond simply "watching” the screen) as indicative of how the technology functions most effectively for them.

Cross-comparisons: In view of the fact that this research has extended to test sites around the world, it is important that data is compared and contrasted among test sites from which it is collected. As noted previously, the Liberated Learning concept was tested within an array of settings by instructors with diverse levels of experience and varying levels of success with maintaining high accuracy. Accordingly, the analysis was mindful of the need to continually consider disparate settings as a possible influence on students' responses.⁶

An equally important consideration involves the evolving nature of the LLI technology itself since the implementation of the formal research model in 2000. Many changes have been made to the technology, and as a result students have been responding to slightly modified versions of the LLI concept over the course of three years. This was also considered in the analysis.

⁶ See recommendation # 2 at the end of this report

The analysis also involved arranging the data in a case-ordered descriptive matrix, a method by which the main variables of interest, their values and outcomes are displayed in a case-by-case arrangement. This method, modeled after a study contained in Miles and Huberman (1994), was most appropriate in the context of this research.⁷ It allowed for a classification of responses (e.g., "positive", "negative") by case, illuminated general patterns, themes, and relationships within and across cases, and highlighted any contradictions or extreme cases. Finally, this method allowed for a cross-site and cross-discipline comparison.

The Liberated Learning Concept and Composition

The components of the Liberated Learning Concept include displayed text and software generated online notes. Displayed text was projected onto a screen in real time in the classroom. Professors wore wireless microphones “connected” to a computer system running speech recognition software. The digitized lectures were then edited for word accuracy and posted online on the Liberated Learning website. Ideally, the turnaround time for posting was 48 hours, though occasionally turnaround time could vary due to time constraints or technical difficulties.

Research Outcomes

The following outcomes are based on three years of research at 6 university and 2 college test sites.⁸ In total, 44 students with various types of disabilities participated in the research. Nearly three years of research into students’ responses to speech recognition has yielded many common and persistent themes in the data. The following is a description of the most prevalent themes that have materialized in the data analysis, beginning with students’ responses to digitized lectures, and following with a discussion of students’ uses of software generated online notes.

Fourteen students expressed very favorable views towards digitized lectures and used the technology in the following ways:

⁷ Miles, Matthew B. and Huberman, A. Michael. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*. California: Sage Publications.

⁸ See Appendix A, Table 1 for a breakdown of participants by university test site.

Compensating for missed information: The principle way in which students took advantage of digitized lectures was as a means of compensating for information they missed or overlooked during the spoken lecture (“missing” parts of the lecture is typically defined as failing to hear it, or losing focus). This response has emerged continually over the course of this research and strongly suggests that the digitized text operates first and foremost, and is currently most successful, as a supplementary information resource in the classroom. As shown in the following examples, the majority of students reported focusing primarily on the professor and using the screen if they fell behind in their note-taking or lost track of parts of the spoken lecture. Recent interviews with students strongly parallel the observations made in this regard by past research participants.⁹ :

...if I miss something from what he says, I don't hear it properly or I don't understand his wording, I look at the screen and take it directly from the screen...because it does make it easier. You know, you don't miss everything you would before. Um, having two sources to draw from instead of just the one, it doubles your chances of getting everything you need.. [“Aaron¹⁰”, Saint Mary's student with a learning disability, Year III]

...because like if I miss something then it's there and I just you know write it somewhere else in my notes...[Joanne, Saint Mary's student, with a learning disability, Year III]

It drew my attention. And also when I listened and I missed something, it was good to read. [Silke, USC student with a medical disability, Year III]

...sometimes I'd get a little behind, so it would be up on the top of the screen. So if I missed something, something I'm noting down and I couldn't remember what it was, I could just look up and quickly jot it down. [Gill, Cambrian College student with a disability, Year III]

Related functions of SR: Many students who watched the screen in class reported that the digitized text functioned as a means of comparing the spoken lecture with the text in order to verify and clarify information. As well, some

⁹ See Leitch and MacMillan (2002) p. 11

¹⁰ All names are fictional

students felt they were able to keep up with the flow of the spoken lecture while taking notes when they could use SR as a reference. As these students observed:

Yeah, I'm finding that I can catch up with what he's talking about better this way. I'm not missing notes. Complete and total sections of notes. [Aaron, Saint Mary's, Year III]

It helps you reinforce the ideas. I think, "okay, why not?"... It just, if you see it and hear it at the same time you'll be more likely to retain it. [Buffy, Durham College student with a learning disability, Year II]

It brings it all together into a whole. You get the visual, you get the auditory, and also, if I'm writing notes at the same time, you get everything into a whole and it just makes it more concrete I would say.. [Cathleen, Cambrian College student with a learning disability, Year III]

In one case, the digitized text was used to verify the spelling of words. Chianne, a Saint Mary's student with a learning disability, commented:

If I need to spell something it'll be there. And, um, if I just was to [see] what he just said. I, I want to read what he just said (Chianne, Saint Mary's student with a learning disability, Year III)

These outcomes are extremely encouraging. They suggest that many students are able to adapt to new mediums in the classroom provided the medium is compatible with their learning strategies. Cathleen's observation that the digitized text "brings it all together into a whole" is particularly poignant. It illustrates the potential for SR to carry out its intended role – bridging the information gap that students often face in the classroom. It further suggests the potential for SR to enrich the learning environment of students who are able to put it to good use.

Indifferent responses: As noted in previous reports, some students expressed neither overtly negative nor positive views of SR. Fifteen students were best categorized as "indifferent" towards the digitized text in the classroom. Typically these students relied very strongly on their own supports systems such as sign language interpreters, note-takers, tutors, etc. Other students preferred their own learning strategies, preferred to focus on other mediums in the classroom, or were simply more comfortable with their own note-taking.

Similarly, some of these students noted that visual mediums conflicted with their learning styles.¹¹ For example, these students commented:

I found that in the beginning, I was looking at [the digitized text], but I found it very very distracting – it’s not conducive to the way I learn... if I’m listening to a tape and reading the book I can do that... if I’m looking at the lecturer and I take my eyes off the lecturer, it’s almost like I turn my ears off, if it makes any sense. I don’t pick up the, what is it, the little innuendos and nuances of what he’s talking about [Bob, Murdoch University student with a learning disability, Year III]

No, I didn’t use the screen because I have trouble seeing colors and some things from a distance... but I think the screen and the notes are a great idea... really helpful for students with disabilities [Elenor, Murdoch University student with a medical disability, Year III].

It’s worth noting that “indifferent” responses did not necessarily preclude some intermittent use of the displayed text. Often students reported watching the screen on occasion to supplement their notes, but generally preferred to focus on the professor. Another important point should be made here with respect to why students may have expressed indifferent responses to the LLI concept. At present, the project is developing a written guide for students that comprises strategies on how to best incorporate speech recognition and online notes into their classroom and study activities. The strategies are intended to facilitate students’ engagement with the technology. It is possible that in the absence of clear directions regarding how to make use of speech recognition, students may have been unsure about how to best engage the technology, and therefore opted to continue with their existing learning methods. Research into the impact of the learning strategies on students’ uses and attitudes towards SR and online notes would be worthwhile.

Conditional and negative responses: Eleven students in the sample were categorized as unfavorable towards the digitized text. The source of these students’ views had primarily to do with levels of accuracy and difficulty reading and overcoming errors in the text. Four students conditioned their responses to SR by noting that the digitized text would be significantly more useful with higher and more consistent accuracy rates. While the issue of

¹¹ See Recommendation # 5

accuracy emerged in most interviews, these students regarded poor accuracy as particularly problematic. One student from a university in Australia noted:

Yes, initially I made an attempt to monitor the screen... I would look at it several times each lecture but then the level of accuracy seemed to get less...maybe only 60 to 70 percent accuracy. The inaccuracies were so huge that you could easily misinterpret a word... [Nicholas, Murdoch University student with a medical disability].

If I missed what the lecturer was saying I would look at the screen... but 50% of the time it wasn't what she said... it was a bit off putting. Sometimes when I looked at it, it did make sense...if there was extra information, I mean more than was on the Power Point slides it was helpful (Collete, Murdoch University student with a medical disability)

“Karen”, a student from Saint Mary’s who participated in Year II, was asked what it was in particular that she found troublesome about the errors in the text:

... you're, you're trying to think, “well what was she saying there?” Because the errors are like, bad. They're not like, like it's not as bad now but when there is an error it's the complete opposite word. You wouldn't even be able to figure out what her word was. [Karen, Saint Mary's student with a learning disability]

A student at the Cambrian College test site makes a similar observation:

...sometimes what she says, I guess the machine thinks it's different words or, and it doesn't make sense. So you're like, “what is she saying?” And you can't get it down. [Melly, Cambrian College student with a physical disability, Year III]

Other concerns students expressed included being distracted by the screen, the fear of recording erroneous information in their notes, and the occasional disruptions in the classroom. The challenge to resolve problems with accuracy is ever present and will be discussed in more detail later in this report (see Table 5 at the end of this report for accuracy scores).

Coping with poor accuracy: It is interesting to note that accuracy rates had differing impacts on students’ comprehension of the digitized text, as well as

their perceptions of the gravity of errors. For some students, poor accuracy rendered the text unusable. Other students tried to decode errors as they appeared. For example, some students suggested that errors in the text could be understood so long as they stayed focused on the lecture or placed the words on the screen in context. For example:

***As long as you're paying attention to what he's saying, you can figure it out."* [Joanne, Saint Mary's student with a learning disability, Year III]**

...if you're reading along and there's a couple of words that make no sense for why they're there...you can kind of fit them back up to where they were supposed to be. [Molly, Saint Mary's student with Tourettes, Year III]

...you also don't notice the mistakes as much anymore either. I mean you sort of get used to mistakes being there like it's just part and parcel [Bob, Murdoch University student with ADD/ADHD, Year III]

Many students reported that despite errors in the screen they were still able to extract a basic understanding of the text. This notion was typically expressed as “getting the gist” of the lecture. For example:

...I mean you can obviously understand the gist of what he's saying. It's not, I mean it's not rocket science. But you know for some other people they may be going “what?”. It may be hard for them. But it wasn't, it's not hard for me [Buffy, Durham College student with a learning disability, Year II]¹²

...like it doesn't go exactly with what he says all the time, but you get the main gist of it. [Molly, Saint Mary's student with Tourettes]

Like if you were listening to her, then you should have got the gist of what was being said in the sentence [Gill, Cambrian College student with a disability, Year III]

While the aforementioned students appeared satisfied with their ability to “decode” errors in the text, one student suggested that “getting the gist” is not sufficient. Chianne observed:

¹² Emphasis added.

...though it's, some of it's accurate, it's not accurate enough to read while he's doing his lectures. To that point. It's accurate enough to get the gist but not like to study from. Like you would be just reading it off. It's not accurate enough to read. Like people, let's say deaf. You wouldn't get the full gist. Unless you're very adapted... (Chianne, Saint Mary's student with a learning disability, Year III)

It is encouraging to see that many students develop strategies to manage the errors in the text. It is hoped, however, that as the technology improves, it carries out a more fundamental role in contributing to students' learning experiences. As shown in the above quote, the resolution of accuracy problems emerges once again as a critical priority.

Online notes: Many students who reported frequently obtaining online notes expressed positive views towards them. Notes were used primarily as a means of comparison with hand written notes, for review purposes, as a study guide, and to assist in tutoring sessions. For example:

... a lot of times if I'm looking through the notes that I took in class and there was like a word or a sentence and then that's all I have, I'll try to find it in the notes to see if there's anything else from there that I should have that kind of links things together a bit more for me [Molly, Saint Mary's student, Year III]

Some students used online notes to refresh their memory of the classroom lecture. As these students observe:

... when I reread his notes, um, for review, it sort of...seeing again what he had said, so it's in your memory, but it's sitting there... it's hiding underneath all the other rubbish, and when you reread the notes it sort of jumps up and you go "oh yeah" [Nancy, USC student with a physical disability, Year II]

I guess it gave like a second chance to help me, because I have a short attention span, so it meant that if there was moments where I had tuned out it didn't mean that the whole lecture was going to be [lost]. [Travis, Trent University student, Year III]

A Cambrian College student similarly observed:

...it's like you're in the classroom again and she's reading it to you and you're reading it at the same time. Like, I read it online as I listen to her so... it helps. [Cathleen, Cambrian College student with a learning disability, Year III]

These responses parallel the observations made by a student who was interviewed in Year I of the project. Kelly observed:

It's like going back in time and taking the class again and really really listening and understanding the notes and everything... and learning all over again for a second time [Kelly, Saint Mary's student with a learning disability, Year I]

Some students did not access online notes because notes were not available, or the turn around time for online postings was too long. Others were simply not interested in obtaining lecture material beyond what they already used (i.e., their own notes, textbooks, reserve readings). In two cases students felt the lecture itself, as well as the accompanying materials, precluded the need for notes.

On the issue of Editing – A Brief Digression: The consistent and timely distribution of notes currently requires an editor on every Liberated Learning test site to correct digitized lectures for word errors, content and, depending on the type of file, punctuation. The cost of editing can be an issue for many universities faced with hiring full time editors. Moreover, editing time varies in direct proportion with the level of accuracy in voice recognition generated transcripts, which in turn impacts upon turn-around time for notes. For example, a one hour unedited (or “raw”) lecture with low accuracy (typically in the low to mid-seventies) can take a skilled editor up to five hours to correct.

In partial response to these concerns, some lectures were made available in Year III in simultaneous audio and text format. Students could simply listen to the lecture and review the scrolling text on their own computers. It was believed that an audio alternative would obviate the need for full text editing. In Year III, two small focus groups were held with a random selection of students in a third year Arts course at Saint Mary's University. The outcomes are worth a brief overview.

The focus groups comprised 9 students in total (four in Group I and five in Group II). Students were shown the following options of notes: Audio and unedited streaming text only; audio and notes edited only for word error (no

punctuation); audio and unedited notes, audio and condensed notes in point form. Outcomes suggest unequivocally that unedited notes are not an acceptable option. Students' comments are summarized as follows:

Uses for audio files and streaming text

- Audio files of lectures were mainly considered useful if students had the option of navigating through the audio lecture to extract the desired sections. Students indicated they would probably not listen to a lecture again in its entirety as this was considered too time consuming
- For some students, audio files with unedited streaming text of lectures were considered useful for fillings in gaps in their notes or reviewing parts of the lecture they missed, however students felt the text needed to be edited for word errors.
- Audio files are generally considered useful if the student missed a class, or missed something in the lecture and wished to review the lecture for clarification
- Students felt that if the professor's lecture style is straightforward and comprehensible, they would be less likely to review the lecture in audio format
- Audio lectures was considered more beneficial for second language students

Students' concerns and preferences

- Students felt the scrolling text would be more readable if it was extended across the page instead of "broken up" phrase by phrase (as it appears in the classroom)
- Students were unanimous about needing a printable version of the lecture (one audio file option shown to the groups was not printable)
- Unedited text was considered unreliable and unreadable if the error rate was high, and students felt the text was difficult to follow in spite of the accompanying audio files¹³
- Unedited text was considered difficult to follow due to the absence of punctuation in the text.
- Text edited for word accuracy only, but no punctuation, was still deemed too difficult to read. Students did not feel they would bother to insert their own punctuation.

¹³ The accuracy rate for the files shown to the students was approximately 85%

- Above all format choices, students preferred “quality over quantity”, i.e., notes that were constructed in point form.

Cross-site comparisons: Students’ responses to the LLI concept were largely consistent across test sites. Students made several comparable comments about the merits and limitations of SR despite some of the variations in testing environments. Similarly, changes to the appearance of the digitized text (i.e., from Lecturer software to IBM Netscribe software) over the course of the project did not appear to significantly affect responses. Fluctuating accuracy scores did, however, have an effect on student’s attitudes toward the LLI concept.

The few site-specific responses that emerged are worth commenting on. One student from an Australian test site suggested that the digitized text would serve better in a smaller lecture environment. Shehara observed:

Yeah if that was a smaller lecture theatre, I think it would be useful. Lecture [theatres] are just too [big]... and if they improve the technology they could view them in bigger lectures [Shehara, USC student with a learning disability, Year II]

Some students commented on the applicability of speech recognition for specific courses. “John” felt speech recognition would be more useful in an “easier” course than the one in which it was tested:

...Business programming is very hard...I had heaps of trouble just to grasp the concepts there... to keep up with the lecturer... and to have a distraction in the room, then you would lose it. But for a subject which was easier to comprehend, then yeah it would be alright [Bob, Murdoch student with ADD/ADHD]

Gill commented that the speech recognition was difficult to apply to a “hands on” class:

...like methodology class[es]...like you know, those would be the good place[s], the great classes to have where you can just listen and take in what the teacher is saying... because this class [wherein the LLI concept was tested] was hands on, and like you know we’re doing labs... so it was kind of hard to have. [Gill, Cambrian College student with a disability, Year III].

Califone, a student in an engineering class, felt the LLI concept was less appropriate for a course that focused on mathematical equations:

I would recommend a [Liberated Learning] class to other students provided the class was basically lecture-oriented. That is more linguistic. And not necessarily mathematical. [Califone, UCCB student with a physical disability]

RESEARCH QUESTIONS RE-VISITED

What is the nature of students' interactions with speech recognition? Do students' interactions serve as an indicator of its efficacy as an alternative learning tool?

Students' interactions with SR vary according to factors such as the accuracy of the digitized text, their sense of need for a new learning medium, their levels of dependency on current supports, and individual learning styles. As noted previously, the research suggests that when SR is functioning well, students consider it effective as a back up resource in the classroom. The digitized text also assists in reinforcing lecture ideas, clarifying information, allowing the student to verify their own notes, and in some cases expands the volume and quality of their notes.

What is the effectiveness of displayed text and software generated notes as a means of improving access to lecture material?

Ultimately, the effectiveness of the LLI concept relies on many factors, such as the performance of the technology, the student's sense of how he or she can best make use of the medium, the compatibility of SR for individual learning styles, and the skills of the instructor in delivering SR in the classroom. The research shows that fundamentally, the digitized text does improve access to lecture material provided the text is readable and accurate. Online notes improve access by virtue of the superior volume and quality of lecture notes in comparison to notes students receive from note-takers, and in comparison to their own notes. Students who used online notes also remarked on their utility as a study guide, as a means of jogging their memory of key lecture ideas, and as means of strengthening their own classroom notes.

What is the effectiveness of the Liberated Learning concept relative to students' specific learning needs and methods, levels of dependency on supports, and students' disabilities?

The outcomes pertaining to this question have remained consistent throughout the three years of research and strongly suggest that the effectiveness of the LL concept varies in accordance with individual students' learning styles, current supports and different types of disabilities. The most persuasive outcome of the research is that visual learners who are adaptable and amenable to new mediums seem to respond with the most approval towards SR. Students who depend more heavily on an established system of learning supports, or who rely on auditory information, tend to favor the online notes but are less able to adapt to visual text.

In terms of fluctuating accuracy rates, the research suggests that some students are flexible in adapting to errors, while others regard errors as a major inhibitor to the effectiveness of SR. The extent to which adaptability to errors in the text is related to different learning styles is not yet apparent from this research but is worth pursuing as this work continues.

FUTURE RESEARCH DIRECTIONS

Several new avenues of inquiry are possible as this research moves forward. Ideas have been proposed and debated at various stages of this project. The complex nature of these research questions are worth considering in more detail.

Impact of SR in context: At present, there are only hints of how the impact of SR differs across categories of disability. Consequently, conclusions cannot be drawn with confidence from the current research. Such questions are important ones, however, and qualify as second generation research pursuits. Below are just a few considerations:

- What is the impact of the LL Concept on a deaf student who uses a sign language interpreter versus a deaf student who does not?
- What is the impact of the LL Concept on a student who is hard of hearing versus a deaf student?

- What is the impact of the LL Concept on a student who has a disability and is an English as second language (ESL) student (such cases have arisen over the course of the current research)?
- What is the impact of the LL Concept on students who have difficulty with their reading and writing skills?

Accuracy: While the project provides thorough, standardized training and continual follow-up consultation for instructors, the goal of achieving "across the board" accuracy scores of 90%+ remains a challenge. Several questions concerning possible contributors to error rates may provide an initial framework for more intensive research into these issues:

Environmental

- To what extent do environmental factors such as distractions in the classroom or technical difficulties have a bearing on accuracy rates for individual instructors?
- Are there significant differences among teaching environments which impact on individual lecturers' successes with SR technology?

Speaker-related:

- There is some evidence to suggest that speaking too rapidly can diminish accuracy rates. To what extent do other speaker-related characteristics such as the flow and clarity of speech affect accuracy rates?
- Instructors participating in this project have various levels of experience using SR technology. How much experience, knowledge training, and pre-lecture preparation is needed before an instructor can achieve high accuracy in the classroom?

Lecture Style

- How do digressions from the lecture topic, or dialogue with students, affect accuracy?
- How do differing lecture styles affect accuracy?
- If error rates increase during spontaneous speech, why is this so and how can this be rectified?

Speech recognition and learning: Future research into the impact of SR on students would benefit greatly from a deeper examination of students' learning styles as they relate to their uses of, and attitudes towards, the LLI concept. If it

can be shown that speech recognition can be implemented and delivered with consistently high accuracy in the classroom (90+%), and that a large enough majority of students with disabilities respond favorably to this technology, the next step may be to understand the implications of SR for such things as academic performance and comprehension. What are the considerations that must be made in the pursuit of new lines of inquiry? A few questions may serve well to frame these general research interests:

- How does SR affect students with different learning disabilities? What is the response, attitudinally, of a student with ADHD, versus a student with strong visual learning skills, versus a learning disabled student with strong auditory skills, etc.?
- How do varying language skills affect the way students (e.g., deaf students) respond to this technology?
- What are the indicators of successful integration of this technology as a learning tool?
- How will it be shown that SR improves academic performance? What are the indicators? How will the measures be established, and how do they need to adapt to different categories of disability?

SR and note-taking: Does the digitized text improve students' note-taking skills? Current research has provided anecdotal evidence to suggest that SR strengthens in-class notes for some students, and that online notes are sometimes used to supplement notes received from note-takers, or a student's own notes.

Studies of note-taking indicate that students often record less than 25% of lecture content in their notes and students with disabilities even less than this.¹⁴ Accordingly, research into the impact of SR on note-taking skills is worthwhile, considering that one of the fundamental purposes of this technology is to compensate for insufficient access to notes.

Impact of SR on Pedagogy: The Year III research report provided a preliminary descriptive account of the effects of SR on professors' work. This

¹⁴ Kiewra, Kenneth A, Bentons, Stephen L., and Lewis, Lance B (1987). "Qualitative Aspects of Note-taking and their Relationship with Information-processing Ability and Academic Achievement." *Journal of Instructional Psychology*. Vol. 14.

included the effects of the technology on overall lecture delivery, the impact of SR on professors' time, energy and resources, and the benefits and challenges involved in integrating this technology into the classroom. The research also documented the evolution of the LL concept, including its initial 52-step in-class implementation process to its current 5 step process, the streamlining of the editing process and faculty training protocols, the streamlining of hardware from Intellistations to high powered laptops, and the replacement of the Lecturer software to the more extensible IBM Netscribe software. At present we know that the use of SR as a teaching tool is effective in terms of offering structure and organization to lectures, but that the demands of achieving high and consistent accuracy rates remains one of the principal challenges of the project. These issues are important for future research efforts.

The question of how the use of SR technology in the classroom has implications for pedagogical practices and philosophies of teaching remains unanswered. This should be an important second generation research effort. In view of the fact that each professor who participates in the project brings to the table a unique set of teaching principals, methods and experiences, the challenge of understanding how SR impacts on pedagogy is great.

Non-disabled students: While the central focus of this research has been on students with disabilities, there exists an ongoing interest in tapping further into the non-disabled student population. Limited survey research conducted at Saint Mary's in Years II and III revealed general levels of acceptance of the LL concept on the part of this population.¹⁵ Opportunities exist with regard to further researching the non-disabled student population. Some questions include:

- What is the impact of SR on academic performance and learning?
- What is the impact of SR on study skills?
- How do students' attitudes and uses of SR differ across test sites, disciplines, courses and course levels?
- Does academic performance have a bearing on how extensively a student will engage the technology and online notes?

¹⁵ Outcomes from surveys conducted at Saint Mary's showed generally favorable attitudes towards the LLI concept. Outcomes in Australia show different results. See Hede, Andy (2001). "Student Reaction to Speech Recognition Technology in Lectures". ASET Conference Paper.

Editing and Online Notes: The outcomes of the focus groups with NDS vis-a-vis edited and unedited notes suggest that more research into this issue would be extremely valuable. A comprehensive survey, modeled perhaps on the focus group questions, would yield broader and more reliable data on students' preferences for the format of notes. It may also offer some further clarification into how the challenges associated with editing may be resolved.

Conclusion

The research has provided baseline data that suggests the LL concept can be a useful and effective medium, however several variables have emerged that need further consideration. The research questions enumerated in this report hopefully illustrate the complexities inherent in understanding the effects of technology on learning processes, within the context of different types of disabilities, and on pedagogical practices. More importantly, it is hoped that these questions highlight the need for more baseline data and larger samples of participants.

This report has also identified challenges that need resolution (i.e., fluctuating accuracy rates). As we continue to carry out this work, we remain committed to the spirit of collaboration in order to deliver research that speaks to the realities, challenges and benefits of this technology.

RECOMMENDATIONS

1: Recruitment of research participants

As noted in this report, one of the goals of the research is to acquire significantly larger sample sizes of research participants (namely students with disabilities). This would allow for greater reliability and generalizability of outcomes. Secondly, it allows for closer examination of research questions in the context of specific categories of disability, as well as other related variables such as age and gender.

The recruitment of students has been problematic since the project's inception, primarily because it has been necessary to recruit faculty members to test the LLI concept in their classrooms and follow with recruiting any SWD who might, by chance, be enrolled in these courses. To date, this method has not yielded the desired numbers of participants. It is recommended that

recruitment efforts be enhanced to reflect the ongoing need for broader samples of SWD.

2: Consistent testing environment

To ensure greater reliability and generalizability of future research, it is recommended that the testing environments continue to strive towards greater standardization of testing conditions, particularly when cross-site, collaborative research models are applied. At a minimum this entails consistency in the way the digitized text is displayed in classrooms, as well as uniform volumes of online notes postings across all test sites. Ideally, standardization would also include accuracy rates of 90% or higher “across the board”, in order to ensure that students across all test sites are responding as much as possible to the same intervention.

3: Accuracy

As noted in this report, the prevalent function of speech recognition technology, at least in its current stage of development, is as an information reserve or back up in the classroom. Hence the importance of achieving and maintaining high accuracy is unmistakable. A considerable part of our future research efforts should be directed towards continuing to resolve the problems identified in this report as they pertain to error rates. The successful and consistent implementation of SR in the classroom not only provides the intended benefits for students, but honors our philosophical commitment to create a learning environment that students consider inclusive and accessible. Further, many of the next generation research ideas proposed in this report require a reliable and standardized delivery of the LLI concept (i.e. non-disabled student surveys).

4: Resolution of the editing issues

Recent focus group outcomes suggest that without high accuracy unedited notes are not a satisfactory option for students. If online notes continue to be a major component of the “Liberated Learning Concept”, then it is critical that we identify economically feasible alternatives to producing online notes that do not compromise accessibility for students.

5: SR and students' learning styles

The current research has drawn upon responses from students with vastly different learning styles, thus demanding circumspection in drawing conclusions about the current effects of SR. In view of students' varying learning styles, test sites may consider applying smaller research models on select groups of students who share similar learning styles, or students with similar types of disabilities. The research might also benefit from being carried out outside of the classroom, in smaller controlled environments where the technology can be consistently applied and managed.

6: Opaque Testing

Instructors who are new to the LLI may wish to engage in more opaque testing before projecting live in the classroom.¹⁶ The research suggests that good accuracy is in large part a product of continual training, practice, preparation, experience and knowledge. As such, new lecturers would benefit greatly from more time to adjust to the technology before displaying it before a live classroom. Ultimately, this would also forward our goal of achieving consistent accuracy rates.

¹⁶ This refers to SR being used during lectures without the projection of text.

APPENDIX A

DEMOGRAPHIC CHARACTERISTICS OF LLI RESEARCH PARTICIPANTS¹⁷
N=44

TABLE ONE

**NUMBER OF STUDENTS WITH DISABILITIES BY
UNIVERSITY**

	Frequency	%
Saint Mary's	17	38.6
Sunshine Coast	10	22.7
Murdoch	7	15.9
Trent	1	2.3
Cambrian	5	11.4
UCCB	1	2.3
Ryerson	1	2.3
Durham	2	4.5
Total	44	100.0

TABLE TWO

CATEGORIES OF DISABILITIES IN SAMPLE

	Frequency	%
Learning Disabled	11	25.0
Medical	8	18.2
Physical	5	11.4
Hearing	4	9.1
Visual	4	9.1
Mobility	4	9.1
Other	3	6.8
Psychiatric	2	4.5
ADD/ADHD	2	4.5
Unknown	1	2.3
Total	44	100.0

¹⁷ Sample is based on all SWD who participated in the LLI research since 2000.

TABLE THREE

GENDER		
	Frequency	%
Female	26	59
Male	18	41
Total	44	100.0

TABLE FOUR**ACCOMODATIONS USED BY STUDENTS**

	# of students	%
Exam accommodations	23	52%
Note-takers	14	32%
Tutors	14	32%
Assistive technologies	10	23%
Student Assistant	2	.04%
Sign language interpreter	2	.04%

Table Five shows accuracy scores for 17 professors. It should be noted that not all professors had the same amount of experience or classroom time using the technology. It is possible that this may be reflected in the accuracy score.¹⁸ The analysis is based on a sample of 1200 words. Word error count was subtracted from the total word count, which provided the number of words correctly recognized. The words correctly recognized, divided by total word count, produced percentage of words correctly recognized.

TABLE FIVE:**ACCURACY SCORES**

	Accuracy score		Accuracy score
Professor 1 ¹⁹	91%	Professor 11	71%
Professor 2	89%	Professor 12	51%
Professor 3	86%	Professor 13	84%
Professor 4	85%	Professor 14	81%
Professor 5	79%	Professor 15	79%
Professor 6	73%	Professor 16	71%
Professor 7	72%	Professor 17	84%
Professor 8	72%		
Professor 9	72%		
Professor 10	72%		

Mean accuracy : 77%, Standard deviation: 9.58

¹⁸ Accuracy scores were established using the NTID Test of Accuracy and Readability, developed by Dr. Ross Stuckless, NTID. See Leitch and MacMillan (2002) for details on method of analysis.

¹⁹ Over 30 professors have tested the LLI technology – not all lectures were available for analysis.