

Language Model Information Summary (LMIS)
Improving Reading Comprehension
in the Classroom

Achieving Integration by Design

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Using LMIS to Improve Comprehension

There are a significant number of individuals who struggle with low reading comprehension. Several research studies concur that, on average, as many as 15-20% of the general population experience reading challenges. These challenges range from mild to significant impairment. In an attempt to level the playing field for these individuals, there has been a substantial amount of research in the development of different assistive reading technologies. These technologies have proven to be helpful because they capitalize on multi-mode input – visual and audio.

As a low vision individual, I have easy access to many different tools that can read digital information to me. However, I often use my hand-held magnifier instead of my reading tools. I did not realize that I was doing this until one day somebody asked why I was not using my reading software. I had to think about it for a while, but it became very clear that initially I do not read every word, because I am just targeting the overall theme / message of an article. I am fortunate that even with my limited vision, when I need to quickly go through an article, I am able to skim read through an article picking up key information and many times if I need more detail, I will go back and read it in its entirety using my reading software.

We work with students of all ages that struggle with reading comprehension. One of the major factors contributing to reading comprehension issues for such individuals is that for them, the truly essential information “gets lost in the noise of reading”. They have a very difficult time differentiating the “essential” content from “non-essential”. Some have to read content multiple times to understand the central theme, while others have to read at such a painfully slow speed that it is nearly impossible for them to keep up with the demands of the curriculum. Many students in these situations are starting to use audio as an alternate (and supplemental) form of input to assist them in keeping up with class and improving comprehension. The audio can come in the form of “books on tape” from the

RFB&D (Recordings for the Blind and Dyslexic) or tools that utilize Text To Speech technologies that convert digital text into digital audio.

Many students' comprehension improves through the use of these audio technologies, especially the technologies that help the students with "word tracking" whereby they can see each word as it is being read along with the corresponding graphics. However, the fundamental problem with this technology is that it limits the success that a student is going to have with it, especially the technology like "books on tape" because a student does not have the ability to skim through the information quickly to gather important essential elements. If you were presented with a hardcopy document, often times your eyes are first quickly drawn to components the bullet points. Unfortunately, a document in audio format will not show you the "bullet points". The only way you can get the information is to read/listen to the document from beginning to end. Once again, bullet points easily get lost in the noise of the reading, especially with just a "running audio stream".

However, let's reflect on bullet points again because the concept behind their use can be critical to techniques necessary for overall reading comprehension. Bullet points are usually short concise pieces of information that are used to quickly give the reader the important points to be taken from some portion of a document. You often see bullets and outline being used throughout lengthy documents to help a reader focus on key content. That is the purpose—to make those tidbits of information stand out so that you can remember them. Unfortunately, many documents do not come with convenient bullet points to allow a reader to pick out the most important information.

Individuals with low reading comprehension find it very difficult to digest the contents of a document and mentally regurgitate the topic or the main theme of the document. It has been my experience that even when these individuals have the document read to them, although it helps, it still generates information overload, and the topic is lost in the noise of the reading, regardless of whether they are seeing it or hearing it. What they REALLY need a way to get to the theme of the document as quickly as possible.

Consider the example of a student writing a term paper. Research is a fundamental part of writing a term paper, and this means sifting through many articles until you find the ones that are relevant to your theme. Until my vision started to fail, this was a fairly simple process as I skim read through the article picking up bits and pieces to quickly determine whether or not the article fit my intended purpose. If the article did fit, I would then set it aside and read it for detail later, make notes, or even do some highlighting. Now that I can no longer efficiently skim read, it takes me hours to go through information and it is very difficult to find something again if I did not mark it or write it down. I do not suffer from low reading comprehension, but due to my blindness, I suffer from the inability to visually decode information quickly and effectively. If I suffer from information overload, I can only imagine how hard it can be for someone who has low reading comprehension when you make him or her read or listen to every word.

Skim reading applies to more than just finding the article. For skilled readers, when they skim read something, you are mentally picking out what you perceive to be essential information and building a mental summary. When you go back to reading the article, you already have an idea of what you are looking for and when you are reading, you are looking for information to fill in the gaps for the mental summary. You can take any book for nearly any class from middle school to post graduate work and at the end of every chapter, there are usually review questions and in some cases, there are summaries. These cover the contents of the chapters or sections and are very helpful because they can be used to reinforce what the reader has read. Many times, at the beginning of the document, you will even see some topic bullet points of what is important in the chapter. I think we will agree with the fact that all this helps a student identify the important information in the chapter. Well beyond the classroom, businesses are bombarded with more information than ever before. Look at business publications such as the Harvard Business Review, in the back of each issue you will see what they call “executive summaries” of the articles. These summaries allow busy business professionals to quickly skim read the article to see if it fits their interest. The magazine does this because they understand that an executive’s time is valuable, and they don’t want to waste time on information that is not relevant. In their own right, a student’s time in school is every bit as valuable too!

Life does not come with a summary feature – until now. I have been struggling to find ways for “at-risk” students to keep up with the demands in the curriculum. The at-risk population consists of up to 20 percent of the total population. These individuals need tools that allow them to be competitive in the existing environment. As a legally blind individual, I realize that the world is not going to accommodate me in ways that will allow me to live and work on an equal footing with others. “At risk” individuals suffer from those same disadvantages, perhaps more so, because, unlike blindness, the entire concept of “at risk” is misunderstood and often ignored by educators and employers. What is needed are skills and tools that let individuals accommodate the world for themselves, regardless of their respective literacy challenge. We cannot change the curriculum (a.k.a. “dumbing down”) for the at-risk students because that would be doing them a disservice. They are expected to have the same basic knowledge as others when they graduate. Most people would agree with the fact that we should not lower the educational bar, therefore, we need to show the students how to reach that bar.

Students are increasingly turning to the Internet as the first point of research. I have interviewed several students at a local community college, who are almost done with their second year, and have never set foot into the library. The Lansing Community College provides an online reference section for students to use, enabling them to access the information anytime from any where. Some of the classes are all online and are taken in the lab at school or from their own personal computer. This trend is increasing rapidly as virtually EVERY institution of higher education in the world is opening their curricula to online learning. The challenge of the Internet is that instead of a few articles to pick from you can literally get “tens of thousands of hits” with just a single search. Students who struggle with reading are finding this more difficult than using traditional books because it takes them even more time to sort out the increased volume of information.

While electronic reading tools can help, simply increasing the reading speed as a way to get through the document faster has inherent limitations. . . . studies have found that individuals have an “optimum reading speed”. If an individual has the reading speed set faster or even slower, than their optimal speed, their comprehension of the information begins to decline. We need a way for students to be able to get more out of what they read by overcoming the limitations that sheer reading speed alone cannot address.

Through the direction of some very brilliant educators and researchers, I have uncovered some ground-breaking theories and models. These concepts are what I call “on-the-fly information summarization”. Of course, the idea of content summarization is not new. However, current thinking and paradigms related to content summarization use mathematical formulas to identify and isolate information. Unfortunately, these formulas effectively work from pure content structure (based on some established rules and guidelines for composition) and essentially ignore the linguistic elements of content. While this approach may be adequate for content that fits very rigid structural guidelines, we can easily see that most content we encounter in today’s world does NOT conform to rigid structural tenets, thereby reducing the efficacy of a formula-based summarization.

To be truly effective in a world where content is increasingly less structured and more dynamic in presentation AND coming at all of us at an accelerating rate, a new paradigm of summarization needs to be based on a “language model”. The new term I am going to introduce to you is the Language Model Information Summary (LMIS). The LMIS can be dynamically adjusted to meet the variable needs of the entire spectrum of individuals who need to read. While we have focused on struggling readers in the preceding discussions as potential beneficiaries of these new technologies, it should be emphasized that EVERYONE can benefit from these tools, regardless of their roles and responsibilities (education / government / business), to enable them quickly and efficiently digest large volumes of text-based content.

How Does Language Model Information Summary (LMIS) Work?

The LMIS works very similar to our conceptual translation software. The essence of the LMIS is that it analyzes a document and determines the concepts or themes of the document AND it does this based on parameters that YOU supply to indicate the level of summarization you wish to perform. You can reduce a document to a fraction of its original size or to a specific number of sentences. Even though you can literally reduce a document down to 1 percent of its original size, there is a realistic reduction limit below which summarized content is not meaningful. It can be interesting to use the LMIS to reduce a document down to two sentences to see what the most important sentences are for the entire document. We will discuss some of the limitations of any summarization a little later in this document.

The LMIS differs from Microsoft Word Summary in some very fundamental principles. Microsoft document summarization is “formula based”. For example, it takes the first

sentence of every paragraph as the topic sentence because that is a common structural tenet of composition. If you are writing a formal research document, that may work fairly well. However, apply that same logic to fiction or even the daily news and you will likely get some interesting and unusual results. The Language Model Information Summary works using **weighted language principles** –all words are NOT created equal and NOT every paragraph contains information that should be included in a summary. Creating **meaningful content compression** of any content is far more complex than just a mechanical method of reducing the number of words in the document based on their position in the document.

The LMIS algorithms used by Premier Assistive for summarization are dramatically different than any other approaches in use today. Of course, a model without actual real-world implementation would not be of much value other than to make for some interesting conversations. ***Premier Assistive has now developed the first content summarization software tools using these exciting new models.*** The true differentiation that makes Premier Assistive’s information summarization unique in the world today lies not only in the underlying technologies of the summarization itself, but also in our methods for integrating the “information summary” features into our other proven reading technologies.

For example, if you were to use the information summary feature in Microsoft Word, you would have to “cut and paste” everything into Word before you could summarize the information. Then, if you wanted the summary to be read to you, unfortunately, you would still have to paste the summary into yet another reading program. Conversely, the LMIS has been fully integrated into several of our products. It is now included in the Universal Reader, E-Text Reader, Talking Word Processor, and Scan and Read. Each one has a unique way of applying the LMIS to real-time information summarization.

Universal Reader will let you surf the web. If you want to read an article, just select the article and have Universal Reader read it to you using its standard reading features. Now, you have the ability to turn on the Summarization feature and you can have Universal Reader read you the whole article OR just a summary of the article. This is the first technology to allow you to do “on-the-fly” information summary. **This will work with any text on the computer that is selectable.**

E-Text Reader is a reading tool for E-Text. Users have the option of having the summary highlighted in the original document or have it extracted into a separate document. If the user decides to have the information highlighted in the original document, they can see the main topics of the document as they are reading.

The ***Talking Word Processor and E-Text Reader*** have specific features that make Information Summary very unique, namely, you can have **multiple summaries in the same document.** You can even pick the summary colors. For example, start out doing a summary at 50 percent using pink highlighting. This will summarize the original document to half of its original size and highlight that summary in pink. Then, perform another summary at 25 percent and have it highlight in yellow. The yellow highlight that

is part of the 50 percent summary will overwrite the pink highlight. Now as you are reading, you see pink and yellow. The yellow is the most important and the pink is usually supporting information for the yellow. Imagine the power of being able to rapidly make multiple passes of a document, changing the degree of summarization for each pass to incrementally analyze content, thereby, making it much easier to sift through and organize the purpose and meaning of any volume of text-based material!!

If you want to read just the summary, you can quickly do an extract of just the yellow or all colors- both pink and yellow. As you are probably aware, sometimes applications are not perfect and may even pick out information that is not important or miss something that is important. With the E-Text Reader and the Talking Word Processor, you can use the built-in highlighters to add and remove information from the summary.

The LMIS also works with the translation features of our IGT software. You can select a document, summarize it, and translate it all in a single step.

How Does Information Summary Help Students?

Bullet points draw your attention to the part of the document that should be most interesting and relevant to you. Many of you who are reading this jumped right to this section and skipped some of the other babble because you are busy and this is really what you wanted to know. There are many ways to use Information Summary as a comprehension improvement tool. The first thoughts are it can reduce the amount of information that an individual needs to read, which is true, but that may not be the best use of Information Summary.

I have been working a lot with a student who has Asperger's Syndrome- my son. He can read, but if you ask him what he read, he cannot tell you, especially when it comes to fiction. He uses Information Summary to summarize the chapter of the book to 15 percent before he reads the chapter. He reads the summary to pull out the information that he needs to look for while he is reading the chapter. Once he is done with the chapter, he creates and reads the summary again. This gives him another exposure to the important information of the chapter. This is the same model used in your classroom books. In fact, there are some publishers who have made a separate business out of creating independent summaries of books, especially classic novels. At the beginning of the chapter, it tells students what they are going to study. They read the chapter and then they read the summary of the chapter to reinforce what they have read. This model has been around for years and is proven to be very successful. Tell them what you are going to tell them, then tell them, and then remind them what you told them. Just because it is not a new model does not make it a bad model.

The Information Summary is not only limited to reading, because it can also be a very helpful tool for writing as well. Write your term paper, letter, or story. Run a summary of your writing. Did you get your point across? Did you leave out anything? Does the

summary reflect the theme of what you were trying to say? Information Summary can be very useful in helping users to re-examine their composition to ensure they are meeting their expected requirements for reporting and communication.

Information Summary can also be helpful for those who simply have difficulty interpreting information. Have you ever read a medical document or maybe even a tax document? Have you been forwarded a large article and you do not have time to read it? All you want is to quickly figure out the nutshell of what this document contains. Just select or open the document and in a second you can “boil it down” to the main themes and ideas.

How Does LMIS Differ from Microsoft Word and why is it better?

The LMIS takes a completely different approach to finding the most important information in a document. The LMIS is based on research developed for conceptual matching. For a detailed article on this research, you can review the following article:

Towards the development of a conceptual distance metric for the UMLS.
Journal of Biomedical Informatics, Volume 37, Issue 2 (April 2004), Pages: 77 – 85.
ISSN: 1532-0464

The LMIS uses a two-step process. First, it determines the high level concepts by using high level weighted language models. Once the concept has been determined, the LMIS uses the theory of conceptual matching to complete the summary. Microsoft has a grammatical rule based summary technology. In formal writing, this works fairly well with that structured model of writing. However, fiction and many struggling writers fail to write in that formal writing style resulting in very interesting and unpredictable summary results when based strictly on structural composition formulas.

The best way to see the difference is to do a side-by-side comparison. Take a document that you are familiar with and then create a summary of that document using both technologies. Create summaries at 50 percent and then 10 percent of the original document and read the two side-by-side and you will really see the difference. Here is a link to [A Christmas Carol](#) by Charles Dickens

<http://www.premierathome.com/Library/Family%20Fiction/Family%20Fiction.htm>

Download the story and condense it. When you read the condensed version, is the story the same? Can you understand the story? Appendix A and B are the first two pages of the summary of [The Christmas Carol](#) condensed to 10 percent of the original document.

Practical Limitations to Summarization

Summarization is the reduction of a concept to its essential information. Typically, a paragraph contains a topic sentence and the rest of the paragraph builds or explains that topic sentence. But it is also true that many documents have a general theme and many of the paragraphs are used to build or defend that general theme. The Information Summary selects that general theme and then goes through the document and uses the conceptual matching model to build a summary around that theme. There are limits to the reduction in size for these summaries to get an accurate summary. That is what we would call “Meaningful Content Compression”. By that, we mean that for each document, there is a variable threshold, below which, summarized content is not sufficiently meaningful to give a user the essential ideas. Additionally, “Meaningful Content Compression” means that it is not sufficient to identify and extract just any words (regardless of the total number of words) purely for the sake of word count reduction and then call that a summarization. You must be able to identify and extract those words, in their appropriate context, to yield the proper and essential intended meaning of the content. This is what we now achieve with LMIS.

Summarization is most effective when it is applied to a single theme. A news article typically contains a single theme, as do novels and stories. I have had individuals try to summarize an entire science book at once. If you look at a science book, you will see that the main theme is science, but the topics covered are very diverse and the summary of the entire book was not what was expected. That is because it looked for a theme for the book and each chapter contained a significantly different topic. Each chapter is equally important, so the summary contained a lot of information about everything. The LMIS should be used as you would for reading. A student does not read the science book all at once, but typically an educator would cover one topic at a time. One lesson will be the study of the clouds and the weather and in the future, a lesson will cover human anatomy. Use the Information Summary to cover a topic, summarize the specific section on weather, and when it is time for human anatomy, summarize that section separately.

The LMIS can literally reduce a document down to a single sentence. Sometimes it is interesting to see what the most important sentence is in a document, but a single sentence is not going to tell you everything you need to know about weather. As mentioned earlier, a single sentence generally lies below that “threshold” of meaningful content compression.

However, if you were to reduce a document down to 25 percent of the original document, you are going to get a significant amount of the meaningful information. The size of the summary should be based on the scope of the document. Many times, a news article can be reduced to about 10 percent of its original size because the topic in a news article is very narrow in focus. On another level, due to its more complex nature, a novel should not be reduced to less than 25 percent and 35-50 percent would be preferred. It is important to note that the information written in a document is for a purpose. The role of the summary is to allow individuals to quickly sort out the most important elements, so they can take away the most meaningful information in a document. After that, they can exercise their own discretion to decide the level of additional review they wish to pursue for a deeper comprehension of the details to meet their individual needs.

Summary

The ability to effectively process and retain relevant information is a critical step toward success. Assistive Technology has made great strides in making things accessible. Assistive Technology should be able to give many individuals the opportunity to INDEPENDENTLY compete effectively - not by lowering the educational bar, but by showing users how to reach and exceed that bar. Once an individual graduates from school, there is no resource room, no extended time to do things, and most of all, not a reduced workload.

Due to the accelerating pace of content being delivered to the world via multiple mediums like digital text, digital audio and digital video, combined with the exploding use of the Internet in many facets of our lives, the sheer volume of content that each person must process just to live daily DEMANDS that each and every one of us must adopt more effective tools to process all of this information. The LMIS is a tool with mass appeal and benefits that enables users with literacy challenges – mild to severe – or even no challenges at all other than the desire to be more efficient - to get the most out of what they read by helping them quickly identify what is important in a document.

Appendix A

First Two Pages at ten percent summary of The Christmas Carol produced by Microsoft Word 2003

A CHRISTMAS CAROL

Stave 1: Marley's Ghost

Scrooge's name was good upon `Change, for anything he
Old Marley was as dead as a door-nail.

Mind! a door-nail. Scrooge knew he was dead? Scrooge and he
were

Scrooge

Scrooge never painted out Old Marley's name.
door: Scrooge and Marley. Scrooge and Marley. business called Scrooge
Scrooge, and sometimes Marley,
stone, Scrooge! Scrooge. handsomely, and Scrooge never did.

gladsome looks, `My dear Scrooge, how are you?
Scrooge. was what the knowing ones call `nuts' to Scrooge.

on Christmas Eve -- old Scrooge sat busy in his
counting-house. The door of Scrooge's counting-house was open
Scrooge had a very small fire, but the clerk's

`A merry Christmas, uncle! It was the voice of Scrooge's
`Bah!' said Scrooge, `Humbug!'

fog and frost, this nephew of Scrooge's, that he was
`Christmas a humbug, uncle!' said Scrooge's
nephew. `I do,' said Scrooge. `Merry Christmas! What

Scrooge having no better answer ready on the spur
Merry Christmas!

Out upon merry Christmas! What's Christmas

If I could

work my will,' said Scrooge indignantly, `every idiot
`Keep it!' repeated Scrooge's nephew. `Christmas among the
time: the only time I know of, in the long calendar
Scrooge, `and you'll keep your Christmas by losing
`Why did you get married?' said Scrooge.

`Because you fell in love!' growled Scrooge, as if
than a merry Christmas. `Good afternoon,' said Scrooge.

`Good afternoon,' said Scrooge.

`Good afternoon,' said Scrooge.

`Good afternoon,' said Scrooge.

cold as he was, was warmer than Scrooge; for he returned
`There's another fellow,' muttered Scrooge; who
Christmas. This lunatic, in letting Scrooge's nephew out, had
in Scrooge's office. of addressing Mr. Scrooge, or Mr. Marley?'

Scrooge replied. night.'

spirits. At the ominous word `liberality,' Scrooge greatly at the present time. `Are there no prisons?' asked Scrooge.

then?' said Scrooge.

useful course,' said Scrooge. Scrooge replied.

`It's not my business,' Scrooge returned. `It's Scrooge returned cold. `God bless you, merry gentleman! house arrived. With an ill-will Scrooge dismounted Scrooge.

`If quite convenient, sir.'

twenty-fifth of December!' said Scrooge, buttoning

The clerk promised that he would; and Scrooge

Scrooge took his melancholy dinner in his usual

It was old enough

Scrooge, the other rooms being all let out as offices.

The yard was so dark that even Scrooge, who knew

in that place; also that Scrooge had as little of what

borne in mind that Scrooge had not bestowed one

that Scrooge, having his key in the lock of the door,

Marley's face. at Scrooge as Marley used to look: with ghostly

As Scrooge looked fixedly at this phenomenon, it

Scrooge was not a man to

Scrooge's dip.

Darkness is cheap, and Scrooge liked it. Sitting-room, bedroom,

lumber-room. ready; and the little saucepan of gruel (Scrooge had

Old fire-guards,

bitter night. `Humbug!' said Scrooge; and walked across the room.

Scrooge then remembered to have towards his door.

`It's humbug still!' said Scrooge. the room before his eyes. him; Marley's Ghost!' and fell again.

voice. Scrooge asked the question, because he didn't know

`I don't.' said Scrooge.

`I don't know,' said Scrooge.

`Because,' said Scrooge, `a little thing affects them.

for a moment, would play, Scrooge felt, the very

Scrooge could not feel it

`You see this toothpick?' said Scrooge, returning

`I do,' replied the Ghost.

`Well!' returned Scrooge, `I have but to swallow

Appendix B

First Two Pages at ten percent summary of The Christmas Carol produced by Premier's Talking Word Processor 9.0

Summary

Scrooge and he were
partners for I don't know how many years.

Scrooge never painted out Old Marley's name.

There it stood, years afterwards, above the warehouse
door: Scrooge and Marley.

The firm was known as
Scrooge and Marley.

But he was a tight-fisted hand at the grind-
stone, Scrooge!

Scrooge had a very small fire, but the clerk's
fire was so very much smaller that it looked like one
coal.

Scrooge having no better answer ready on the spur
of the moment, said `Bah!'

`Let me hear another sound from you,' said
Scrooge, `and you'll keep your Christmas by losing
your situation!

growled Scrooge, as if
that were the only one thing in the world more ridiculous
than a merry Christmas. `

`Good afternoon,' said Scrooge.

He stopped at the outer door to
bestow the greetings of the season on the clerk, who
cold as he was, was warmer than Scrooge; for he returned
them cordially.

`Scrooge and Marley's, I believe,' said one of the
gentlemen, referring to his list. `

Have I the pleasure
of addressing Mr. Scrooge, or Mr. Marley?'

`Mr. Marley has been dead these seven years,'
Scrooge replied. `

At the ominous word `liberality,' Scrooge
frowned, and shook his head, and handed the credentials
back.

‘And yet,’ said Scrooge, ‘you don’t think me ill-used, when I pay a day’s wages for no work.’

It was old enough now, and dreary enough, for nobody lived in it but Scrooge, the other rooms being all let out as offices.

The yard was so dark that even Scrooge, who knew its every stone, was fain to grope with his hands.

It was not angry or ferocious, but looked at Scrooge as Marley used to look: with ghostly spectacles turned up on its ghostly forehead.

Scrooge was not a man to be frightened by echoes.

Scrooge then remembered to have heard that ghosts in haunted houses were described as dragging chains.

Scrooge had often heard it said that Marley had no bowels, but he had never believed it until now.

‘Because,’ said Scrooge, ‘a little thing affects them.’

Scrooge was not much in the habit of cracking jokes, nor did he feel, in his heart, by any means waggish then.

Scrooge fell upon his knees, and clasped his hands before his face.

It comes from other regions, Ebenezer Scrooge, and is conveyed by other ministers, to other kinds of men.

It was a habit with Scrooge, whenever he became thoughtful, to put his hands in his breeches pockets.

‘Seven years dead,’ mused Scrooge. ‘

‘You might have got over a great quantity of ground in seven years,’ said Scrooge.

‘You were always a good friend to me,’ said Scrooge. ‘

Scrooge closed the window, and examined the door by which the Ghost had entered.

When Scrooge awoke, it was so dark, that looking out of bed, he could scarcely distinguish the transparent window from the opaque walls of his chamber.