Webinar Transcript: Understanding how our students with LDs process information:
Contextualizing working memory and cognitive load
Presented by: Jeffrey MacCormack and Ian Matheson

[SLIDE – Understanding how our students with LDs process information: Contextualizing working memory and cognitive load]
[*Text on slide:* Presented by: Jeffrey MacCormack & Ian Matheson
Queen's University
For technical assistance, please call at 416–929–4311 ext. 27
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[SLIDE – What We Will be Sending You]
[*Text on slide:*
1. Power Point Slides;
2. Webinar Evaluation Survey;
3. Link to Access the Webinar Recording.]

[SLIDE – Image of LD@school logo]
[*Text on slide:* Funding for the production of this publication was provided by the Ministry of Education. Please note that the views expressed in this webinar are the views of the presenters and do not necessarily reflect those of the Ministry of Education or the Learning Disabilities Association of Ontario.]

[Cindy Perras]: Provided by the Ministry of Education. Please note that the views expressed in this webinar are the views of the presenters, and do not necessarily reflect those of the Ministry of Education, or the Learning Disabilities Association of Ontario.

[SLIDE – Understanding how our students with LDs process information: Contextualizing working memory and cognitive load]
[*Text on slide:* Presented by: Jeffrey MacCormack & Ian Matheson
Queen's University
Assistant Professor
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[Cindy Perras]: The LD@school team is very pleased to welcome our guest speakers, Jeffrey MacCormack and Ian Matheson, who will be presenting this afternoon on "Understanding how Students with LDs Process Information, Contextualizing Working Memory and Cognitive Loads". For your information, all webinar participants, with the exception of the presenters, have now been muted for the remainder of the presentation. Once Jeffery and Ian have finished their presentation, we will be opening up the floor for questions. Over the course of the presentation, if you would like to ask any of the LD@school team a question, you may enter your text in the box at the bottom of the control panel, and choose to send it to the staff from the drop–down menu underneath. We will also be tweeting throughout the webinar, so if you would like to participate, you can send us a tweet. Our Twitter handle is @LDatschool, which is displayed at the bottom of this slide.

[SLIDE – Welcome]
[*Text on slide:* Jeffrey MacCormack & Ian Matheson
Photo of the guest speakers: Jeffrey MacCormack & Ian Matheson.]

[Cindy Perras]: That takes care of housekeeping for this afternoon, so let's get started. It is now my pleasure to introduce our speakers, Jeffrey MacCormack, and Ian Matheson, who are both published authors on the LD@school website. Jeffrey is a PhD candidate at the Faculty of Education, Queen's University, with a focus on cognition. He is certified by the Ontario College of Teachers, with nine years of experience teaching elementary school. He has worked as an instructor at Queen's University, and has taught and authored online courses for educators. He is currently conducting research on several topics, including social skills intervention for children with autism, emotional well–being, and rates of physical activity of school–age children, using interest–based programs to increase motivation, and the effect of morphological instruction on elementary–age children. Ian Matheson is also a graduate in the PhD program in Education at Queen's University, with a focus on learning and cognition. Along with teaching and research experience at Queen's University, Ian has experience as an occasional teacher with the Limestone District School Board in the elementary division. Welcome Jeffrey and Ian, the cyber floor is now yours.

[SLIDE–Understanding how our students with LDs process information:
Contextualizing working memory and cognitive load]
[*Text on slide:* Jeffrey MacCormack and Ian Matheson.

[SLIDE–Agenda]
[*Text on slide:* photo of the guest speakers*:* Jeffrey MacCormack and Ian Matheson

1. Rationale and purpose
2. What are learning disabilities?
3. What is working memory?
4. What is cognitive load?
5. Optimal and deficient working memory
6. Optimal and deficient cognitive load
7. Case studies
8. How can we help? (e.g., strategies, assessments, environments, self–advocacy).]

[Ian Matheson]: As you can see from our agenda, we'd like to begin the webinar with a discussion about the rationale for, and purpose of our topic. We'll next move to definitions of learning disabilities, the working memory system, and cognitive load theory. After our definitions, we'll discuss and provide examples of optimal and deficient working memory functioning, as well as what optimal and deficient cognitive load looks like. We'll then provide case studies to illustrate the experience of students both at the elementary and secondary school levels, with regards to working memory and cognitive load. Finally, we'll conclude with a look at how, as educators, we can help our students, including a discussion of strategies, assessments, environments, and self–advocacy, all to promote support of our students. Here's Jeff.

[SLIDE–Rationale and Purpose]
[*Text on slide:*
- Range of learners and needs;
- Diverse backgrounds in psychology;
- Understanding working memory and cognitive load.

Image of two human heads that represent the sharing of knowledge and information exchange.]

[Jeffrey MacCormack]: First off, let me say thank you for taking your time to be a part of this. You took some time out of your schedule to attend this webinar, so you can better support your students with LDs. In recognition of the value of your time, our purpose is to provide a thorough and engaging look at working memory and cognitive load. We want to maximize the effective strategies you're already using by informing them with a cognitive foundation of learning memory. As you move in this webinar, we encourage you to think about the challenge that we, as instructors, faced in the design of this webinar. Much like the classroom where you teach, this webinar is filled with a wide range of learners with unique and specific learning needs. The people in this webinar represent a diverse range of knowledge and understanding of psychology. I want you to think for a moment about where you fit on that continuum of knowledge on this topic. Some of you focused on psychology for your undergraduate degree as a major or a minor, others among you have only taken a few psychology courses, or none at all. Whatever your experience with working memory, Ian and I have designed this webinar so that it will be useful for you.

[SLIDE–Remember this!]
[*Text on slide:* This is Michael Caloz. He turned 30 last May.
Picture of Michael Caloz.]

[Jeffrey MacCormack]: We have included interactive elements in this webinar so that you will have opportunities to use and think about your own cognitive processes. Starting off, we'd like you to look at Michael. Now try to remember his face, name, age, and birth month. We'll quiz you later long after you've totally forgot about him. Now let's talk about learning disabilities with Ian.

[SLIDE– What are Learning Disabilities?]
[*Text on slide:* Image of the top of a tower
Medical definition
Functional definition
How definitions determine our perception and strategies.]

[Ian Matheson]: After a brief discussion of how we can understand learning disabilities, we'll contrast medical and functional definitions of this exceptionality, as well as how these definitions can inform practice. Learning disabilities are one type of exceptionality that still puzzles a lot of people. We consider it to be a hidden disability, because it only appears when there is an interaction between whatever the disability is, and the learning environment. Otherwise, you may never know it is there. We consider learning disabilities to be academic–based disorders because, as mentioned, they influence the way we learn, and therefore our academic experience. Researchers consider them to be a result of neurological deficits, and according to the *Diagnostic and Statistical Manual of Mental Disorders*, "learning disabilities are categorized into three types, based on the primary literacy areas, mathematics, writing, and reading." While we may hear educators talk about a student having an LD, or even a math or reading LD, research is increasingly showing that there is great variation between types of LDs, as well as within types. For example, you may have a student that experiences difficulty processing phonemes, and another student that has difficulty processing semantic information. Both could technically qualify as students with reading LDs, but the support provided should be different.

[SLIDE]

[*Text on slide:* Image of a head with visible brain structure on the left–hand side of the screen.
Medical/Clinical Definition

- Focus on Skill Deficits

Image of a head, with gears and cogs in place of a brain, on the right–hand side of the screen.
Functional Definition:

- Focus on Student Experience.]

[Ian Matheson]: This is where it is important to distinguish between medical or clinical definitions of LD, and functional definitions of LD. Medical definitions emphasize the still deficit, for example, phonological processing. Functional definitions focus on the student experience, for example, what it is like for the student experiencing a deficit phonological processing, as well as how the deficit manifests during learning. A functional definition emphasizes the interaction between the learner and the task as a problematic area, rather than having it tied to the learner. An easy way to understand this is that a person who has paraplegia would likely be considered disabled for a typical Phys. Ed. class where physical skills are the focus of learning. That same person would not be considered disabled during an English lesson in a typical classroom where students are working at desks. For learning disabilities, a student who has difficulty processing phonemes would not be considered disabled when doing arithmetic calculations in mathematics. The disability appears at the interaction between the learner and certain environments. Let's think about a couple of examples to better differentiate these definitions. Tom has a deficit in the verbal working memory system. This is focused on the skill deficit, and particularly, we can identify that Tom has difficulty processing verbal information. A solution could be to avoid verbal text, and provide him with accommodations that allow him to access text in other forms. Alternatively, we could observe, and talk to Tom, about what particularly he experiences difficulty with. He might explain that he finds it hard to match words with their meaning, which slows him down. A solution might be to supplement verbal text with visual information, such as a diagram or image of some kind, to support his recall of meaning. You can see the medical definition, while specific in terms of a skill deficit, can miss important information about how the learning disability manifests for the student. I compare it to how I do research to learn about a topic. Just as you can use Wikipedia as a starting point for learning about a topic, you can use a medical definition to identify an area of difficulty. Once you want to engage in some deep analysis of a topic, you move to primary sources. When you want to engage in deep analysis of what a student is experiencing in terms of learning difficulties, you move to a functional definition for LDs, to really examine what is going on.

[SLIDE]

[*Text on slide:* image of a lever and fulcrum resembling a teeter–totter. Two X marks are at either end of the line, the farthest possible distance from the center fulcrum. The X marks represent giving too much or not enough support. The teeter–totter can only remain balanced if the proper amount of support is given, indicated by the check mark directly above the fulcrum.
No support = No Success
Too Much Support = Learned Helplessness.]

[Ian Matheson]: One more point on LDs. Decades ago we provided no support to these students because we didn't understand LDs. In some cases today, we provide too much support to students with LDs. An example could be avoiding certain tasks altogether, because they have to do with the type of LD, or providing accommodations that provide more support than is needed. When students start to believe that they need more accommodations than they actually do, they may experience learning helplessness, an increasingly passive pattern of behavior that can be a result of them not thinking they have skills that they actually do have. For students with LDs, we want to aim for the middle where we match up the accommodations, and support perfectly with the areas of need. Not to working memory with Jeff.

[SLIDE–What is Working Memory?]

[*Text on slide: image of a blue mansion*

- It is important to experience working memory;
- How many windows are on the front of the building where you live?
- The voyage of sensory information.]

[Jeffrey MacCormack]: Before we get into the architecture of the mind, I'd like you to think about some other types of architecture. I'm going to ask you to remember a couple of things and I want you to think about how you recall the answer. Don't just come up with the answer; be prepared to explain how your mind works. Answer this question. How many windows do you have on the front of your building? Whether it's an apartment, a house, a downtown loft or a tree house, how many windows do you have in front of it? I'll give you a few seconds. Now I hope you have an answer that you're generally sure about. The actual number of windows in your house is less interesting to me than how you figured it out. If you're like me you probably brought up an image of your house and literally counted the windows that you saw. Or, perhaps you took a virtual tour through your house, sweeping from room to room counting the windows. This is important because visual memories are powerful ways to store a lot of information. Okay here's another one. How many times is the line, "O Canada we stand on guard for thee", found in the Canadian national anthem? I'll give you a few moments.
So the answer is three. Did you get that number? Well it doesn't really matter, what is important is what strategy you used. You likely had to sing the anthem to yourself, and count the lines on your fingers. This is important because some information is coded as sounds. We just experienced two of the ways that memories are encoded and retrieved through sound and through images. Now let's look at that blue building again in the image. You might have thought I chose it because I was asking about the windows on your building but that's not the entire reason. The mind is a little like this mansion. In this metaphor, the upstairs is the long–term memory. Okay, let's play the imagination game for a moment. You are a bit of sensory information, like the first time you heard the name Baddeley. Baddeley, B–A–D–D–E–L–E–Y. Got it? Got a little bit of sensory information, that's you right now. So, now, I want you to imagine going into this house. You'd walk up to the front door, and the doorman tells you where to wait. Perhaps you

wait in the front lobby, perhaps the doorman asks you to wait in the west wing library. Perhaps he asks you to wait in the east wing sitting room. You chill there on the first floor for a little while, about 30 seconds, until one of two things will happen. Perhaps you're being processed and synthesized with other information, at that point you'll be transferred to your new forever home upstairs in long–term memory. But if that doesn't happen to you, it means that you're not making it to long–term memory, you'll be tossed out the window. It seems cruel but they don't have all the room in the world up there, they need to only store relevant and meaningful sensory information. Actually, what happens to sensory information that is not encoded in long–term memory is not quite clear, some cognitive scientists believe that everything goes upstairs, even if it's not encoded. But even though it's impossible to retrieve it, it's still up there.

[SLIDE–Cognition processes]

[*Text on slide:*

- We have known for a long time that we have two different kinds of memory;
- Immediate (short–term) memory, which we now call working memory;
- Long term memory;
- We receive data from our senses and, based on a variety of conditions, we process and store the data for later or forget it entirely.]

[Jeffrey MacCormack]: Cognitive processes. We have known for a while that we have two different kinds of memory. We've always had a sense that we store information in our long–term memory, but what we know about how memory is stored there has developed quite a bit. What was previously known as short–term memory is now known as working memory. Working memory is more than just the amount of time that you can keep a phone number in your mind as you scramble to find a pen to write it down, working memory is a series of processes and systems that help us encode and store numbers. Sorry memories.

[SLIDE–Cognition processes]

[*Text on slide*:

- There are specific conditions on what kinds of data we can perceive;
- For example, Donald Broadbent hypothesized that our attention is like a Y–shaped tube;
- We can't focus on more than one conversation at a time.

Image of the y–shaped tube: The simple model for attention.]

[Jeffrey MacCormack]: So how does it all work? Well, first you should know that there are limits to what we can process. Broadbent theorized that our attention is like a y–shaped tube, which explains why it's hard to listen to two conversations at the same time. We also have a hard time processing more than seven bits of information at the same time; we'll talk more about that later. What would happen if you had to listen to two simultaneous audio files? Well let's try it. I'll tell you two things at the same time and see how that works for you.

Sorry. Here we go: Memory. We lose our memories because they were not encoded properly, they were not retrieved properly, but they somehow decay while being stored. What I ate for breakfast last Tuesday is probably locked away somewhere in my mind, but it would take a calendar, my grocery receipt, and a long look in my cupboards to try and figure it out. So how did that work for you? Well it's likely you may have picked up a few words but overall it was just a big audio mess. No surprise I'm sure.

Even though we have two ears, we have a hard time listening to two conversations. So let's listen to what I said again, this time one at a time.

[SLIDE–Memory Cues]
[*Text on slide*:
- "spider–webs" of memory;
- Retrieval cues glom together and it can be effortful to untangle ("why am I thinking about my Grammy right now?");
- Better retrieval cues can improve memory.]

[Jeffrey MacCormack]: Some cognitive scientists explain memory with the metaphor of spider webs because memory strands seem to stick together. We often encode sensory information in bunches which is why I think of my Grammy when I smell brown bread buns. Using better retrieval cues can help improve memory because it helps us find the data where and when we need it.

[SLIDE–Loss of memory]
[*Text on slide*:
- We fail to encode it (we didn't store it effectively);
- We fail to retrieve it (we can't access the memory that is in there);
- We experience storage decay (we have simply forgotten)

Image of a filing cabinet.]

[Jeffrey MacCormack]: We lose our memories because they were not encoded properly, they were not retrieved properly, or they somehow decayed while being stored. What I ate for breakfast last Tuesday is probably locked away somewhere in my mind but it would take a calendar, my grocery receipt, and a long look at my cupboards to try and figure it out.

[SLIDE–The Kessel Run problem]
[*Text on slide*: Image of the Millennium Falcon – Han Solos's spaceship from Star Wars
As you hear the explanation of the Kessel Run Problem, try to be aware of your thinking process.
How are you storing the information?
Conceptually? Visually? Phonetically?]

[Jeffrey MacCormack]: One of our goals here is to not only teach you about working memory but to give you some opportunities to experience the processes as we work through the content of the webinar. To that end, I'm going to teach you something that you may not have already known. We have carefully chosen this topic because, although you all certainly know something around this idea, you may not have heard of this little piece before. I'm going to tell you about the Kessel Run problem. I know it's related to "Star Wars" and I know it may seem off topic but please be patient, it will only take three minutes, and even if you aren't a "Star Wars" fan, I'm sure you have a niece or a nephew who might want to hear about this from you. While I'm telling you about the Kessel Run problem, we want you to try and be aware of your process of learning it. Think about what goes into learning something new, you have to perceive the information, and determine what makes sense, then apply it to your previous knowledge and store it for later, and then at some point in time when your nephew asks you, you're going to try and retrieve it.

Here we go: In the “Star Wars” universe, power fans have debated the problem known as the Kessel Run problem. As you may recall, at one point in one of the earlier movies, “Han Solo” tries to persuade “Luke Skywalker” that, ‘Even though it may look like a bucket of bolts, the Millennium Falcon can do the Kessel Run in 12 parsec.” That statement is a little problematic though because a parsec is a length of distance, not an amount of time. Because a parsec is a measure of distance and not a measure of time, “Solo’s” statement that the Falcon did the Kessel Run in 12 parsecs is a little like someone saying, my car is so fast that it traveled to Toronto in 250 kilometers. Long story short, “Solo’s” statement doesn’t make any sense. So for those people who care about this sort of thing, how can “Solo’s” statement be explained? There are three schools of thought on this question. First, “Han Solo” thought “Skywalker” was a country bumpkin from the Outer Rim and was just boasting some nonsense statements to win a contract. Not likely though, “Solo” was a proud and experienced smuggler who would not have to make things up. The second explanation is that the creator of the series, George Lucas, didn’t know enough about space and didn’t care to find out. He might have thought parsec was a cool, spacy way of measuring time, and he borrowed the term from astronomy with no idea that the movie would be such a huge success, and we’d be using it as a webinar almost 40 years later in this webinar. That is a really persuasive argument, at least to me. After all, Lucas was not known for his scrupulous attention to accuracy. The third explanation is that “Solo” said parsec because he meant parsec as a distance. The Kessel Run was an 18 parsec route, used by smugglers who shipped glitterstim spice to avoid Imperial ships. This smuggling route was pot–marked with black holes, the largest was called “The Maw” black hole. By skirting closer to “The Maw” black hole, “Han Solo” was able to reduce the distance of the run by over six parsecs. Less impressive ships had to travel the longer distance, but The Falcon was so powerful, it could do the run in 12 parsecs. You know, I love that explanation by the way, what a satisfying solution.
All right, lesson over, that’s what the Kessel Run problem is. Now that you’ve heard about it, think about what you could reasonably repeat to someone else. Do you know what the name of the spice was that was shipped along that run? Do you know the name of the biggest black hole? What will you remember about the Kessel Run problem tomorrow, or in two weeks, or next year? What you remember in a year will greatly depend on how you perceived the information, processed it, made meaning from it, stored it, and how you try to retrieve it later. All right, now that we have experienced something new, let’s talk about how it happened.

[SLIDE–Working Memory Schematic Diagram]

[*Text on slide*: Image of Baddeley’s model of working memory

This model holds 4 components independent of each other: the phonological loop, the visuo–spatial sketchpad, the central executive and episodic buffer.

According to this model, sensory input, represented by the image of an eye and ear, enters the working memory as sensory memory. This sensory memory then moves up to be processed by the central executive. The central executive is the central part of the working memory and is the attentional control system of the working memory. The Central executive has no storage of its own, instead its role is to determine which sensory information to store and how it should be stored.

Language based sensory memory will most likely be stored as a Phonological Loop which contains the articulatory control system and a phonological store. The articulatory control system is the verbal rehearsal system and the phonological store is used as a speech based storage system with a limited capacity.

Visual sensory memories are processed by the visuo–spatial sketchpad, which is used as a spatial and visual information store with limited capacity. This area of working memory is sometimes called “the inner eye”.

Episodic Buffer is responsible for linking information across domains to form integrated units of visual, spatial and verbal information. This encodes to long term memory with a limited capacity.]

[Jeffrey MacCormack]: This is Baddeley's model of working memory. I know that theoretical models can be a little intimidating, but you've already experienced this process just a few moments ago. Think back to when you had the sensory information and you were going into the mansion. At that time you were the first time that someone heard the name Baddeley. What was the first thing you did? Well, you walked up to the door, and the doorman told you where to go. In this metaphor, the doorman is known as the central executive. The central executive has no storage of its own, and it determines which sensory information goes onto the storage systems. In theme of "Star Wars", I'm showing the central executives as "Yoda".

[SLIDE–Working Memory Schematic Diagram]
[*Text on slide*: Image of Baddeley's model of working memory. The central executive has been replaced by Yoda from Star Wars.]

[Jeffrey MacCormack]: Our sensory information is the Kessel Run problem, which I represent with an image.

[SLIDE–Working Memory Schematic Diagram]
[*Text on slide*: Image of Baddeley's model of working memory. The sensory memory has been replaced with an image of the Millennium Falcon, used to represent the information given in the Kessel Run problem]

[Jeffrey MacCormack]: Our sensory information is the Kessel Run problem, which I represent with an image. Although we all know that sensory information is multifaceted, I used words and an image together. As you processed the information, you synthesized it.

[SLIDE–Working Memory Schematic Diagram]
[*Text on slide*: Image of Baddeley's model of working memory. The Visuo–spatial sketchpad shows an image of the Millennium Falcon.]

[Jeffrey MacCormack]: You may have processed it as an image, as the sound of my words, or as an episode within the entire experience of this webinar.

[SLIDE–Working Memory Schematic Diagram]
[*Text on slide*: Image of Baddeley's model of working memory. The Phonological Loop shows words related to the Kessel Run problem. These words are meant to represent the information heard.]

[Jeffrey MacCormack]: Those are the three main ways that we process information, using our visual spatial sketchpad, using our phonological loop, or as an episode.

[SLIDE–Working Memory Schematic Diagram]
[*Text on slide*: Image of Baddeley's model of working memory.The Episodic Buffer shows an image of a computer with the Kessel Run problem slide on the screen. This is to represent information encoded as visual and verbal information.]

[Jeffrey MacCormack]: It seems that the path by which the information is processed also affects how the memory is stored in and retrieved for our long–term memory.

[SLIDE–Working Memory Schematic Diagram]
[*Text on slide*: Image of Baddeley's model of working memory. The images from the Phonological Loop (words), the Episodic Buffer (computer screen with slide), and the Visuo–Spatial Sketchpad (image of Millennium Falcon) have all moved up to the section of the chart that represents long term memory.]

[Jeffrey MacCormack]: From this point forward, you may find yourself recalling the Kessel Run problem when you see the Millennium Falcon, when you hear the phrase Kessel Run, or when you're thinking about webinars in general.

[Slide–Working Memory]
[*Text on slide*: Image of a road sign that represents maximum working memory load: 4–5 things.]

- Working memory has strict limitations;
- Some of the challenges that students with LDs face are related to weak working memory;
- The capacity of working memory is not easily increased.]

[Jeffrey MacCormack]: In sum, let me remind you that our working memory is an extraordinary series of processes by which we process, encode, or ignore, all the sensory information that we receive over a day. Even for typically developing students, working memory is strictly limited. As we move into the lived experience of youth with learning disabilities, you can imagine how a weak working memory could cause difficulties for memory systems and learning in general. One of the questions that I get asked when I talk about working memory is, how can it be increased? If it's not working at full capacity, then what can be done? Here's the easy answer, not much. While modest improvements can be made to working memory through practice and effort, the best way to help students with weak working memory is to reduce their cognitive load. And to that note, I'll pass you back to Ian.

[Slide–Cognitive Load]
[*Text on slide*: Image from uber humour. Text written on top of an image of the brain: has a degree, a masters and nice playing job. Needs to sing the alphabet to remember where J goes.

- The brain is a powerful tool, but it has its limits;
- Let's explore its limits by trying some activities.]

[Ian Matheson]: One of the best ways to understand cognitive load theory is to experience the limits of our processing capacity. Let's explore a few processing tasks to learn more about our own brains.

[Slide–Working Memory–Our minds are always working]
[*Text on slide*: Image of objects including a purse, a car seat and an airplane where components are arranged in a way that resembles a faces.]

[Ian Matheson]: Recognize a pattern here? Our brains have a tendency to organize information based on our past experiences, and in this case, for most of us, they organize them into something we see a lot of. Our brains do a lot of processing that is automatic, like with these images, but now we'll look to the type of processing that we are most interested in with students, effortful processing.

[Slide–Working Memory–Our minds are always working]
[*Text on slide*: Say the colour, not the word you see printed
Image of the names of colours: Blue,red,black, orange,green, yellow, blue each in a colour that does not correspond to the name of the colour.]

[Ian Matheson]: Some of you may have seen this type of task before. Try to say the color you see, not the word you see printed.Our automatic response is to match the word with the sound, but through effortful processing, in this case something we call inhibition, we can perform this task. To understand cognitive load theory, it is important that we understand effortful processing as it is where we want the learning to take place. More on this shortly.

[SLIDE– Thinking task]
[*Text on slide*: Add one to each of the digits. 2941.]

[Ian Matheson]: To another processing task: try adding one to each of the digits.

[SLIDE– Thinking task]
[*Text on slide*: Add one to each of the digits. 2941+1111=4052.]

[Ian Matheson]: Was this your answer? Did the nine slow things down for anyone? Here's another.

[SLIDE– Thinking task]
[*Text on slide*: Add one to each of the digits. 8372.]

[SLIDE– Thinking task]
[*Text on slide*: Add one to each of the digits. 8372+1111=9783.]

[Ian Matheson]: No nine here, was this easier? Try one more of these.

[SLIDE– Thinking task]
[*Text on slide*: Add one to each of the digits. 5639.]

[SLIDE– Thinking task]
[*Text on slide*: Add one to each of the digits. 5639+1111=6750.]

[SLIDE– Thinking task]
[*Text on slide*: Add two to each of the digits. 3417.]

[Ian Matheson]: Now try adding two to each of the digits.

[SLIDE– Thinking task]
[*Text on slide*: Add two to each of the digits. 3417+2222=5639.]

[Ian Matheson]: And here's one more.

[SLIDE– Thinking task]
[*Text on slide*: Add two to each of the dogs. 9898.]

[SLIDE– Thinking task]
[*Text on slide*: Add two to each of the dogs. 9898+2222=12120.]

[SLIDE– Thinking task]
[*Text on slide*: 9898+2222=12120 and an arrow pointing at: add two to each of the dogs.]

[Ian Matheson]: Did you notice the word digits changed to dogs? If not, it's an example of your brain's automatic processing. Your intentional control may have assumed the words were the same given what we've been doing. These tasks help distinguish another important piece of cognitive load theory, various levels of effort. I imagine no one here would say that the adding tasks were automatic, or at least not as automatic as matching simple words with sounds. You probably had to do some processing. I would wager that you made more of an effort with the examples that contained the number nine, given the fact that these operations affected more than one digit. Were any of you completely overwhelmed by this last example? Keep in mind that some operations and exercises may feel automatic to students, some may feel somewhat effortful, and some may feel very effortful, maybe to a point of cognitive overload. When we identify skill deficits for students with LDs, and then hopefully make an effort to understand how they experience their learning difficulties, we can identify tasks, or approach the tasks, that may be some of the most effortful learning these students do.

[SLIDE– Rule of Seven]
[*Text on slide*: My problem is that I have been persecuted by an integer. For seven years, this number has followed me around."
George Miller, 1956
–quickly counting quantities of seven, give or take a few, is usually easy for us
Yay! Test.]

[Ian Matheson]: One final task on processing before defining cognitive load theory, thinking about our limits. You may have heard of George Miller's famous rule of seven that we are able to remember up to seven items by strict recall before we need to start to employ strategies. Some researchers contend that the number is more accurately understood as seven, plus or minus two, to take variance into account. Let's put our processing limitations to the test.

[SLIDE– How many are there?]
[*Text on slide*: 4 pictures of Michael Caloz.]

[Ian Matheson]: How many are there?

[SLIDE– How many are there?]
[*Text on slide*: 7 pictures of Michael Caloz.]

[SLIDE– How many are there?]
[*Text on slide*: 6 pictures of Michael Caloz.]

[SLIDE– How many are there?]
[*Text on slide*: 10 pictures of Michael Caloz.]

[SLIDE– How many are there?]
[*Text on slide*: 5 pictures of Michael Caloz.]

[SLIDE– How many are there?]
[*Text on slide*: 15 pictures of Michael Caloz.]

[Ian Matheson]: How was that? Did you find that some recognitions were automatic, some were a little effortful, and others required individual counting that maybe you couldn't quite finish?

[SLIDE–Germane Load]
[*Text on slide*: Image of a learner in front of a computer. This image shows information processing for verbal and visual material.
Processing or Understanding.]

[Ian Matheson]: Effortful processing is the germaine load of a task, it is all the things we do to count, recognize, sort, chunk, and think critically as we learn. Cognitive load theory suggests that learning experiences require an intentional or processing load, and that this load can be broken down into three parts. Individual differences, like having a learning disability of some form, change the load ratio, as it is different for everybody. For someone with a skill deficit in processing phonemes, like Tom who we spoke about earlier, the load ratio of a text reading task would be different than for a student that doesn't struggle with reading text in any way. Understanding the load ratio of a task means understanding our individual learners. But cognitive load theory isn't really just about reducing the processing load, in fact, according to this theory, we should be increasing the germaine, or processing load in tasks we provide to our students. More on this shortly.

[SLIDE–Intrinsic Load]
[*Text on slide*: image of 2 Rubik cubes: one with 9 squares per side, one with 25 squares per side.
Inherent to task.]

[Ian Matheson]: The intrinsic load is the second type of load, and the only one that doesn't change according to this theory. The idea is that tasks each have an inherent load that is required, and it is the same for everyone because it is tied to the task. It is important to highlight that this doesn't mean that everyone finds the same tasks easy and the same ones hard. Remember that load ratio is all about the interaction between the learner and the task, kind of like that functional definition of LD. It may be irrelevant, or even impossible, to quantify intrinsic load, but the important thing is to understand that there's a certain amount of load tied to tasks, and that some tasks carry a heavier load than others, like these two rubric's cubes.

[SLIDE–Extraneous Load]
[*Text on slide*: Image of a lecturer standing in front of a blackboard that is full of writing and diagrams.
Presentation of Information]

[Ian Matheson]: Finally, we move to the extraneous load. Look at the image. What do you see? What do you feel? Extraneous load is all about how we present information, where presenting things one way may add to the difficulty of the task. In a way it adds to the processing, which sounds like germaine load, but this example should clear things up. Let's say a student struggles with processing verbal auditory information; if I lecture about our solar system, this student will likely struggle to take much away from it. If I lecture with a PowerPoint presentation, as I am now, that includes visuals to help illustrate my points, this student will likely retain more information, and engage with the material more deeply. I have changed the extraneous load in this case, as I have changed the way I present information. Because the student has difficulty with verbal auditory information processing, they will likely struggle with information presented in this format. This I cannot change during the lesson. What I can control, as the educator, is the way I present information to the student, and therefore, the extraneous load.

[SLIDE–Foundational assumptions about how we learn]
[*Text on slide*: Image of 2 people discussing an idea. The top of both human heads has been swung open to show cogs, images, and documents to represent the processing and transfer of information.]

[Ian Matheson]: At this point we have all three components of cognitive load theory, shortly we'll look at optimal versus deficient loads, which is where the rubber hits the road for educators. But first we need to recognize some foundational assumptions about how we learn.

[SLIDE]
[*Text on slide:* Image of a tree. The leaves are composed of words written in red.]

[Ian Matheson]: Let's start with the dual channel hypothesis. Research suggests that we process visual and verbal information separately. Think back to the working memory system Jeffrey spoke about; remember the phonological loop and visual spatial sketch pad? We are seeing a pattern here. Look at the picture. According to this hypothesis, your brain will see the image maybe as a tree. If this is the first thing you see, this information has been processed by your visual system. As you look closer, you will recognize letters as the leaves, still all visual. If you begin to process the letters, a switch happens. The letters are technically visual, they are sorted through the verbal system as soon as your brain recognizes them as letters, and thereafter, the visual and verbal information are processed separately.

[SLIDE]
[*Text on slide:* Images shows a human head opened to see three cogs turning inside. This is meant to represent information processing.
Limited Capacity: By Channel.]

[Ian Matheson]: Research also suggests that our processing capacity is limited. We've spoken about this, but the new piece here is that it is limited by channel. Too much verbal information can be overwhelming, as can too much visual information. If my slides were all words, you might feel overworked in trying to get the message. If it were all images, the same thing could happen with trying to make sense of the images. A combination of verbal and visual information, according to the hypothesis, splits the load between two systems that are limited in processing capacity. Think about this as extraneous load. When we supplement verbal information with visual information, or vice versa, we are allowing students to access double the amount of resources.

[SLIDE]
[*Text on slide:* Image of an educator teaching a lesson in class.
Active Processing: Thinking (includes motivation, building comprehension, etc.)]

[Ian Matheson]: Finally, we are active processors of information, we think, we feel, we are motivated, and we have to build comprehension, something that is effortful. While the focus of our talk is less on this last piece, it is important to think about as we move to our section on supporting students. Back to Jeff to discuss optimized working memory.

[SLIDE–Optimal systems vs Problematic for working memory]
[*Text on slide:*
- Neural recall of coded information;
- Implicit memory and explicit memory;
- We retrieve memory using working memory systems (visuo–spatial, phonological, episodic).

Image of chart that shows how external events (or sensory input) travel through the three levels of memory: sensory memory, work/short term memory, long term memory storage. The sensory memory encodes information and transfer this into working/short term memory. Working/short term memory encodes information and transfer it to long term memory storage, information are retrieved from long–term storage.]

[Jeffrey MacCormack]: Thanks Ian. As I mentioned earlier, when working memory is working optimally, we encode the sensory information from external events, and process it in our working memory. The bidirectional processes of encoding and retrieving move information between the long–term memory and the working memory. When we can't remember things that we want to remember, we have lost the memory because of three main causes. First, we lose our memories because they were not encoded properly in the first place. Second, the memories were not retrieved properly. Or, third, the memories somehow decayed while being stored. For the purposes of supporting students in the classroom, we are most interested in the first two reasons. There's not much we can do about memory decay, and frankly, for the healthy minds of children and adolescents, loss of memory is most likely in encoding, or a retrieving problem. Ian.

[SLIDE–Optimal vs. Problematic Cognitive Load]
[*Text on slide*: Image two pie charts that compare Optimal and Problematic Cognitive Load. In the image of the optimal cognitive load pie chart, the largest section is occupied by Germane Load. In the image of the problematic cognitive load pie chart, the largest section is occupied by Extraneous Load.]
Legend: Germane in colour blue, Intrinsic in colour red and extraneous in colour green.]

[Ian Matheson]: Now we come back to that point about increasing the germaine load. What do we mean by that? Look at the pie here. In this example of the limited processing capacity for the student, a certain amount is devoted to the intrinsic load, which, as we said, is tied to the task. A smaller amount is devoted to the extraneous load, meaning that not a lot of processing is due to the way the task is presented. The largest piece of the load is devoted to the germaine load. This means that the student is able to devote most of their cognitive resources to counting, recognizing, sorting, chunking, and thinking critically. This is where the learning happens, and so it makes sense that we would want as much of the load here as possible. This next pie is less ideal, and so we can distinguish the two pies as optimal and problematic. You can see the intrinsic load doesn't change because we can't change it, the task remains the same. The extraneous load is by far the largest piece, and the germane is the smallest, meaning that most of the students' cognitive resources are devoted to navigating the presentation of information, and the small amount to the actual task that is the focus of learning. Remember that the intrinsic load doesn't change, but the germaine and extraneous loads are different for everyone. The best question we can ask ourselves for each learner, and for the larger class, is what can I change, and how will it affect my learners? Now to Jeff for a case study.

[SLIDE–Elementary Case Study: Newsha]

[*Text on slide*:

- Math problem solving;
- Frustration with understanding the "heart" of the question;
- Solving math problems complicated by visuospatial and phonological weaknesses;
- Strategy of repeating the phrases;
- Two channels of auditory input.]

[Jeffrey MacCormack]: Okay, let's talk about Newsha. Newsha has a difficult time solving math problems, she has a hard time determining which information is most important. Part of the problem is that she developed a bad habit, early on she was taught to try and recognize the important words in the math problem so, once she finds the words that she thinks are important, she tends to repeat the information to herself, even if the teacher is still explaining the problem. By repeating the important phrases to herself, she inadvertently creates a conflicting audio channel, which is taxing on her working memory. That means that she is not fully conceptualizing the heart of the problem, and that she often ends up focusing too much attention on the details of the drawings. Having difficulty with work problems… sorry, having difficulty with word problems is common for students with learning disabilities. It really doesn't matter whether the LD is characterized as math or language based because for students like Newsha, the foundational challenge of a learning disability is a weak working memory. So let's look at her math problem.

[SLIDE]

[*Text on slide*:

The comic store is 4.4 kilometres west from Vera's house. The video game store is 2.8 kilometres west from Vera's house. How far is the comic store from the video game store?]

[Jeffrey MacCormack]: The comic book store is 4.4 kilometers west from Vera's house, the videogame store is 2.8 kilometers west from Vera's house, how far is the comic book store from the videogame store? Many math problems require that students imagine the problem, so students must be able to translate verbal and textual information into visual information. The process of visualization requires students to identify and synthesize information which is done in the working memory. Once the student has conceptualized the problem, the student must choose a diagram method. Now this is difficult because many students don't realize that there are various types of diagrams. Let's start there. What students need to learn first is that diagramming math problems is more than just drawing the objects included in the problem. Let's look at Newsha's diagram to see where she made her mistake.

[SLIDE]
[*Text on slide*: Diagram of a math problem, which shows the comic book store, a drawing of Vera, the video game store, Vera's house, and a compass.
The comic store is 4.4 kilometres west from Vera's house. The video game store is 2.8 kilometres west from Vera's house. How far is the comic store from the video game store?]

[Jeffrey MacCormack]: Newsha probably spent too much time repeating west from Vera's house, west from Vera's house because she included extraneous information, such as a compass, in her diagram. The focus on direction may have been why she ended up mislabelling it as well. Okay let me step away from Newsha for a minute and talk about diagramming as a strategy, because I think it's a great example of a tool for students like Newsha, who have challenges related to working memory. Researchers demonstrate that students with LDs tend to use diagramming less often, and less effectively, than their typically developing peers. The fundamental problem for all students, and especially those with LDs, is that visualizing word problems is a developmental skill that typically matures around the age of eight, nine, or ten. Even for those elementary students who can visualize the problem, applying that thinking to external images, i.e., the math diagrams, is really challenging, and that's why it's common for elementary students like Newsha to focus on extraneous details, mislabel the diagram, or exclude important information. Newsha's diagram is ineffective because it does not help her solve her problem, diagrams like hers are called pictorial because they only go so far as to depict the visual appearance of variables in the word problem. What Newsha needs to do is to learn to build what's called a schematic diagram. Schematic diagrams are tools to map solutions, because they represent the relational information, and they work to support thinking. Here's an example of a schematic diagram for Newsha's problem.

[SLIDE]
[*Text on slide*: Diagram of a math problem, which shows a number line labeled with CB for comic book store, VG for video game store, and VH for Vera's house.
The comic store is 4.4 kilometres west from Vera's house. The video game store is 2.8 kilometres west from Vera's house. How far is the comic store from the video game store.]

[Jeffrey MacCormack]: The use of the number line here is a tool. Newsha knew that the answer required a calculation of relative distance so she started off with a number line, that's a really great first step.

Explicitly teaching Newsha to use schematic diagrams will take a lot of work and, frankly, Newsha may feel frustrated trying to learn extra skills while still struggling with the foundational skills of visualizing the problem, and learning which parts are most important. Here's the thing though, it will be worth it for her. Schematic diagrams are a way for her to outsource her thinking. Once Newsha learns how to use schematic diagrams, her working memory won't be as taxed with the tasks of visualizing, and calculations in her working memory.

[SLIDE]
[*Text on slide*: Last month, the pet store sold four times more kittens than lizards. If the pet store had sold 18 additional lizards last month, the number of kittens and lizards sold would have been equal. How many kittens were sold last month?]

[Jeffrey MacCormack]: Let's look at another question. Last month a pet store sold four times more kittens than lizards. If the pet store had sold 18 additional lizards last month, the number of kittens and lizards sold would have been equal, how many kittens were sold that last month? Now schematic diagrams are simple and intuitive when it comes to distances and quantities, because the use of number lines and measuring cups make it really easy just to visualize what's happening, but what do we do when we have a question like this one which is not about distance or quantity? Well here's Newsha's first solution.

[SLIDE]
[*Text on slide*: Diagram of a math problem, which shows a central line separating 4 kittens on the left and an image of one lizard accompanied by 18 dots representing the increase in lizards sold.
Last month, the pet store sold four times more kittens than lizards. If the pet store had sold 18 additional lizards last month, the number of kittens and lizards sold would have been equal. How many kittens were sold last month?]

[Jeffrey MacCormack]: Again the problem is visualized. This pictorial diagram has some important information, the ratio of four kittens to every one lizard is there, but there is no next step, there are 18 more lizards visualized on the side but there's no way to step forward. For Newsha, I would recommend that she use bars to represent unknown quantities of pets, like this.

[SLIDE]
[*Text on slide*: Diagram of a math problem, which shows a drawing of a kitten next to four boxes of equal size. Underneath the kitten is a drawing of a lizard next to one box and a number line labeled 18 to represent the number of lizards that would need to be sold in order for the number of kittens and lizards sold to be equal.
Last month, the pet store sold four times more kittens than lizards. If the pet store had sold 18 additional lizards last month, the number of kittens and lizards sold would have been equal. How many kittens were sold last month?]

[Jeffrey MacCormack]: Each bar represents an unknown quantity of the ratio for one. The diagram shows that for each lizard, four kittens were sold, and that the difference between the pets sold is 18. Because three of the bars represent 18 pets, each bar must represent six pets. The diagram, now completed, has helped the student visualize the question, and also provide a visual strategy for solving a question. And yeah, if you're thinking that the use of these relational bars are a great segue to algebra, you're completely right. These visualizations of unknown quantities can be a first step for elementary aged students to understand algebraic formulations.

[SLIDE–Elementary Case Study: Newsha]
[*Text on slide*:
- Use of problem solving strategies (pictorial versus schematic problems);
- Provide options for content (e.g., written);
- Have another student paraphrase the question;
- Long term challenges (e.g., work place);
- Developing self–advocacy skills and strategies is important in the long run;
- Balancing the by–pass with working strategies.]

[Jeffrey MacCormack]: The explicit instruction of diagrams can be a valuable strategy when solving word problems, but more importantly, diagrams help students to think and solve problems in new ways. For students with LDs, diagrams may help with organizing, planning and implementing a solution, all processes that they may find challenging. As a problem–solving strategy, diagram use is highly adaptable and dynamic, and it gives educators a great opportunity to monitor how students think, and provide support where necessary.Now for a secondary example, I'll hand you back to Ian.

[SLIDE–Secondary Case Study: Tom's Graphic Text]
[*Text on slide*:
- Reading LD;
- Verbal processing deficit;
- The power of Tom's beliefs;
- A functional assessment;
- Moving forward.]

[Ian Matheson]: Let's come back to Tom. We discussed how he has a learning disability in reading, that it could be classified as a verbal processing deficit, and we even specified it as a phonological processing issue. Let's say Tom has struggled with this all through elementary school, and received more and more support with it. His support team have increasingly offered him accommodations with written text, to a point that he believes he cannot, and will never be able to read. I had a student just like Tom when I worked as a literacy tutor, and I sat down with a piece of text for us to work on. The first thing he said to me was, "I can't read this, I have a learning disability". This comes back to that issue we spoke about with learned helplessness. I can tell you that with my student like Tom, it took a lot of time and effort to combat that belief that he couldn't read. He may still believe it now, or at the very least he might avoid reading when he can, but part of my process was to unpack this belief with a functional assessment. My student like Tom worked through a variety of texts with my support, and we identified that he struggled with phonemic processing.

[SLIDE–Case Study – Secondary]
[*Text on slide*: How an Eco–Friendly Fish Farm Operates. Cleaned water is pumped into a large array of fish tanks. Water is continuously drained out of the tanks using gravity to send it to a filter tank. Once in the filter tank, solid fish waste and uneaten food sink to the bottom while the remaining water flows into a filtration pond….
Visual image of the concept: How an Eco–Friendly Fish Farm Operates. The individual parts of the fish farm are labeled and described with sort sections of text.]

[Ian Matheson]: Let me show you two types of text with the same content. This first type is expository text, in that it is nonfiction and provides information about a topic. It says, "How an ecofriendly fish farm operates. Clean water is pumped into a large array of fish tanks. Water is continuously drained out of the tanks using gravity, to send it to a filter tank. Once in the filter tank, solid fish waste and uneaten food sink to the bottom while the remaining water flows into a filtration pond." And it goes on. Tom would find this difficult as there are a lot of phonemes to process. This second type contains the same information, but has captions around an image. Think back to our assumptions about learning. This should allow Tom to use both visual and verbal resources in order to build comprehension, and ultimately, explain how an ecofriendly fish farm operates. Tom and I worked a number of times together, and we developed a sense, a system, of drawing what we read to support his thinking. This allowed him to access those visual resources, and use them in his processing. We modified the load ratio by decreasing the extraneous load through the inclusion of images, and therefore, increase the load devoted to processing and comprehension building, the germane load.

[SLIDE–Teaching Strategies]
[*Text on slide*:
Be aware of the processing time required for thinking (individual differences)
Isolate skills that are important, teach them individually (building automaticity–what is your learning goal?)
Organize information clearly and simply
MODEL!.]

[Ian Matheson]: So what can we do as educators to support our students? Let's start with teaching strategies. Given what we know about how the germane load is different for all students, we should allow for extended processing time. When you ask questions to students in class, how long do you wait for processing? Keep in mind the processing stops for all students as soon as the answer is shared. Are there ways you can modify the method you use for asking questions that allow for learners to work at their own pace? Next we want to think about isolating skills that we teach to build them individually, and increase automaticity. The better students can use skills, the less resources they need to use on a complex task to use that skill. Think about writing a summary paragraph. If this is your learning goal for a lesson, you want students to have already built other necessary skills like processing texts, making connections, activating prior knowledge, and finding the main idea. You want them to know how to structure a paragraph and what a topic sentence is. If your focus is on producing a summary paragraph, you will want as much of their cognitive load devoted to that specific task, rather than unrelated tasks that can complicate the process. To reduce extraneous load, always present information clearly and simply where possible, whether it is presented visually, verbally, or with some combination. Try to ask yourself, what are other ways I could present the same information? You can then think about which option is your best for the students, and go with that. Lastly for teaching, be a model of how to use skills. When we model how we think and how we perform skills, we provide students with that visual and verbal example that they can remember when they go on to perform the same tasks. Be explicit when you model by identifying exactly what you are doing, because you don't want to make assumptions about what your students infer from your modeling.

[SLIDE–Assessment/Assignments]
[*Text on slide***:** Visual image of a geometric problem diagramed in two different ways. On the left is the example which demonstrates split attention; the diagram is located at the top and below are the solutions. On the right is an example which integrates all the necessary information into the drawing itself to avoid split attention
Visual image of a bump up chart that shows students what criteria is necessary to receive a higher mark. Labeled: schema building.
Visual Image of a checklist for students to make sure all required project objectives are met. Labeled: memory.]

[Ian Matheson]: When you produce assessments and assignments, you'll want to think about the limited capacity of resources we have available. In these two examples, we see the difference between having to split our attention between two different parts of the page, and move back and forth, and having all the information in one place. When you design assessments and assignments, think about how you organize information, and whether or not it is an optimal method for your students. Remind yourself of the skill you are focused upon, and whether or not the extra challenges you may be providing are necessary for everyone. I like to build schema for my students as they work on learning tasks by using things like bump–up walls, seen in this picture, that provide examples of what things could look like at different achievement levels. Students can take their work and visit the bump–up wall to see what level their work is at, and more importantly, what is necessary to improve. I also provide success criteria wherever possible with assignments. A checklist at the end of the assignment booklet allows students, if they want, to go and check things off as they complete them to make sure they have everything they need. Both schema building and memory supports are things we can put in place to support the access to prior knowledge and memory recall, two exercise that students with LD often present with difficulties on when compared to their typically achieving peers. Again, the less processing time spent on remembering information, the more processing time can be spent on the learning goal.

[SLIDE–Learning Environment]
[*Text on slide:*
- *Build* the learning environment ;
- Start with a bare classroom and add things that students need;
- Use anchor charts, success criteria;
- Provide information they may need (e.g., multiplication table, success criteria for writing a summary paragraph)]

[Ian Matheson]: As for the learning environment, I have always been a firm believer in this being something we should build with our students. Because I don't want to have things up that could be distractions for students, I start with as little possible up in the room. Even if certain posters or charts should be helpful to students, they could be increasing the extraneous load if they aren't used appropriately or effectively. I try to think about what resources students should have, and how they might use them, when I think about what I want up on the walls and around my classroom.

[SLIDE–Self–Advocacy]

[*Text on slide*:

- Recognizing learning environments that result in difficulty;
- Understanding elements that result in difficulty;
- Planning for overcoming obstacles or avoiding obstacles.

Image of a child using a megaphone.]

[Ian Matheson]: Further, we want to help our students become self–advocates. This requires us, as educators, recognizing, understanding, and planning as much as the students. We need to teach our students to recognize learning environments that result in difficulty. We need to understand what it is about these environments that resulted in the difficulty, and finally, we need to plan for how we will overcome this difficulty going forward.

[SLIDE–Advocacy Requires Metacognition]

[*Text on slide*:

- Thinking about thinking– what you might call strategy;
- Thinking about past stumbles in order to make future strides;
- Students need opportunities to develop metacognition (e.g., think aloud–model, assessment as learning).]

[Ian Matheson]: In order to be a self–advocate, or to become one, students need time to think about their own thinking, or engage in what we call metacognition. They need opportunities to recognize their difficulties and understand them, and so we need to provide opportunities for them to do so. I like to think aloud when I teach, as a part of modeling skills, by verbalizing my thinking process to the students, to make it as explicit as possible. I also encourage my students to think aloud. This is harder than it sounds, as they are completing certain tasks to give us both an opportunity to recognize problematic areas, as well as to understand the rationale behind decision–making. Finally, we can use assessments as learning opportunities by giving students opportunities to examine their own progress, and thinking, in low stakes learning experiences. Back to Jeff.

[SLIDE–In Closing]

[*Text on slide*: Thinking about our own thinking…]

[Jeffrey MacCormack]: Thanks Ian. Speaking of metacognition, let's reflect on our thinking. We've nearly finished this webinar so let's see where we are. Do you remember that man at the very beginning of the slideshow, we showed you his face? Well now that you've been bombarded with information, can you remember his age, and his birth month and his name?

[SLIDE–Do you remember his name?]

[*Text on the slide*: picture of Michael Caloz]

[Jeffrey MacCormack]: I'm sure a few of you can, you smarty–pantses, but for most of us we may only be able to recall his birth month. And wasn't he 30? But what about his last name? That feeling that you have right now, that feeling that his name is just out of reach, even when you're trying to visualize it, that's how many of our students with LDs feel when their working memory is overtaxed.

[SLIDE–Do you remember his name?]
[*Text on slide***:** His name is Michael Caloz.
He turned 30 last May.]

[Jeffrey MacCormack]: All right suspense over, Caloz, Michael Caloz. So why would I mention him at all? Well do you remember that wonderful children's TV series "Arthur?" Well I have two daughters so I'm a big fan. Michael was the voice of one of the characters from the "Arthur" TV series, any guess which one?

[SLIDE]
[*Text on the slide*: He was the voice of D.W. from the Arthur show (seasons 1–3).
Two identical images of D.W. from the Arthur show side by side. In the image on the right her face has been replaced with Michael Caloz's.]

[Jeffrey MacCormack]: He was "D.W.". Yes, mind–blowing, I totally agree. Well now that you're reeling in shock, I can only presume, let's review.

[SLIDE–In Closing]
[*Text on the slide*:
- Central Executive;
- Working memory;
- Phonological loop, visuo–spatial pad, episodic buffer;
- 30 seconds of memory;
- Decays or stores in long term memory;
- Central Executive;
- Cognitive Load;
- Cognitive load is the amount of extra effort required when thinking (e.g., ignoring distractions).]

[Jeffrey MacCormack]: Working memory is how we process and store information temporarily. Our working memory is strictly limited, and if we break our attention, or if we overload the memory system, we could lose some of that information that's stored there. So students who have working memory deficits, such as those with LDs, their weak working memory may be a huge obstacle.

[SLIDE–Classroom Applications]
[*Text on the slide*:
- Present materials with multiple modalities (e.g., images, sounds, experiences);
- Explicit instruction on method (e.g., schematic diagramming);
- Ask a variety of questions (a great question is better than a good answer);
- Q–matrix, be aware of what kinds of questions you ask.]

[Jeffrey MacCormack]: As teachers we can help our students by using bypass strategies to reduce the load of working memory by doing things like conducting an audit of the working memory loads. So what does that look like? Think about how many instructions you give to the students before sending them off to work. If you find that the students have to process a lot of information, you could reduce the complexity of the task, and eliminate meaningless materials. Find the balance between overwhelming your students with too many strategies, and leaving them stranded by relying just on one. You may also want to use explicit strategy instruction like schematic diagrams for math class. It may seem counterintuitive to heap another strategy onto a student who is struggling with basic calculations, but relational bars and number lines can be a really big help. They aren't just cognitive load, they're cognitive tools. Think about the types of questions you ask also, there's a whole science around the quality of question that, if you haven't looked into it yet, I recommend you check it out. Some school boards use the Q matrix.

[SLIDE]
[*Text on the slide*: Image of the Q–matrix table that shows a number of question prompts that range from simple questions to more complex questions.]

[Jeffrey MacCormack]: Now the Q matrix is usually used as a tool for students to ask richer questions. The questions on this grid are arranged by the richness of the question content. You see here in the top corner we have questions like what is and what did which are generally simple to answer, and as you move to the right and move down, the questions become more complex. More abstract thinking is required to answer something like how might, or how will. The Q matrix is useful when working with students with LDs because it helps us to audit the types of questions we're asking. We can extend students' thinking or, reduce the cognitive load of the question, by being aware of the type of questions that we use. Now I'm going to pass you back to Ian for some more teaching strategies for students with LDs.

[SLIDE–Summing it up: What can we do?]
[*Text on the slide*:

- Teaching Strategies: PRIME ;
- PLAN (be aware of processing time, consider alternative learning strategies);
- REVIEW (start each lesson with review of previous ideas);
- ISOLATE skills (teach the skills one at a time);
- MODEL skills (use gradual release of responsibility–skills can be modelled by teacher and peers);
- ENVIRONMENT (anchor charts, bump–up walls; avoid clutter, build them *with* the students)]

[Ian Matheson]: To consolidate, let's remind ourselves about what we can do to support students. Try to remember the word PRIME. We need to <u>p</u>lan. This means being aware of processing time and considering alternative learning strategies. We need to <u>r</u>eview. This means starting each lesson with a review of previous ideas, even if it is brief. Show the connections. How did we get here? Where are we going? We need to <u>i</u>solate skills. This means teaching the skills one at a time. We need to <u>m</u>odel skills. I like to use the gradual release of responsibility where skills are explicitly modeled by the teacher, and over time, the student assumes responsibility of using the same skills. And finally, we need to consider the <u>e</u>nvironment. Think about how anchor charts and bump–up walls can support your learners. Avoid clutter, and think about how you can build the learning environment to students.

[SLIDE–Summing it up: What can we do?]
[*Text on the slide*:

- Self–Advocacy Skills: I Can!
- Inventory strengths and difficulties ("What can I do here? What might be hard for me?")
- Chunk the task into pieces ("What are the elements of this problem?")
- Ask questions so you understand elements ("How can I find out more? Who might help me?")
- Name your goals ("What is the next step? What do I need to know for next time?)]

[Ian Matheson]: What about self–advocacy? Remember the words I CAN. Inventory students' strengths and difficulties. Get students asking questions like, what can I do here? And, what might be hard for me? Chop the task into pieces. You might ask yourself, what are the elements of this problem, to help you identify how to cut it up for your students. Ask questions so you can understand elements. Get your students to maximize resources they have available by asking questions like, how can I find out more? And, who might help me? Finally, name your goals. Your students should ask themselves, what is the next step, and what do I need to know for next time? This is all about planning forward.

[SLIDE –Related readings on LD@School website]

[SLIDE]
[*Text on the slide*:

- Helping Students with LDs Learn to Diagram Math Problems, MacCormack & Matheson, http://ldatschool.ca/numeracy/diagrammath–problems/
- Executive Functions and Learning Disabilities, Matheson & MacCormack: http://ldatschool.ca/executive–function/executive–functions–and–lds/
- Working Memory and Learning Disabilities, MacCormack & Matheson, http://ldatschool.ca/executive–function/working–memory–and–lds/

[Ian Matheson]: Let's have a final look at related readings Jeffrey and I have produced for the LD@school website. Jeffery and I coauthored, "Helping Students with LDs Learn to Diagram Math Problems", "Executive Functions and Learning Disabilities", and "Working Memory and Learning Disabilities."

[SLIDE]
[*Text on the slide:*

- Expressive writing for students with LDs, MacCormack & Hutchinson http://ldatschool.ca/classroom/literacy/expressive–writing/
- Assistive Technology for students with learning disabilities, Young & MacCormack http://ldatschool.ca/classroom/literacy/assistive–technology/
- Spelling for students with learning disabilities, MacCormack & Hutchinson http://ldatschool.ca/classroom/literacy/spelling/
- Handwriting for students with learning disabilities, MacCormack & Hutchinson http://ldatschool.ca/classroom/literacy/handwriting/ <

[Ian Matheson]: Jeffrey produced the following pieces with other colleagues. "Expressive Writing for Students with LDs", "Assisted Technology for Students with Learning Disabilities", "Spelling for Students with Learning Disabilities", and "Handwriting for Students with Learning Disabilities."

[SLIDE]
[*Text on the slide*:

- Cognitive Conditions and Self–Regulated Learning, Matheson & Hutchinson, http://ldatschool.ca/executive–function/cognitive–conditions–and–self–regulated–learning/
- Working Memory and Cognitive Load, Matheson & Hutchinson , http://ldatschool.ca/executive–function/working–memory–and–cognitive–load/
- Visual Representation, Matheson & Hutchinson, http://ldatschool.ca/numeracy/visual–representation/

[Ian Matheson]: And I produced the following pieces with one other colleague, "Cognitive Conditions and Self–Regulated Learning", "Working Memory and Cognitive Load", and "Visual Representation." Thanks very much for your time.

[SLIDE – Welcome]
[*Text on slide:* Jeffrey MacCormack & Ian Matheson
Photo of the guest speakers: Jeffrey MacCormack & Ian Matheson.]

[Cindy Perras]: Thank you so very much Jeffery and Ian, for providing our participants with clarity and depth and understanding on working memory and cognitive load.

[SLIDE–Q&A]

[Cindy Perras]: If anyone has questions, you may either click the raised hand button on your control panel to be unmuted, to ask a live question to Jeffrey and Ian, or you may type your question into the chat box on your dashboard, and I will read your question to Jeffrey and Ian. Okay, Jeffrey and Ian, are you ready for your first question?

[Ian Matheson]: We're all set.

[Cindy Perras]: Excellent. So this is an interesting question. Is there a role for assistive technology in helping students who experience challenges with working memory?

[Ian Matheson]: That's a great question. Jeff actually has a lot of background working with assistive technology so he may jump onto the end of this but I'll get started if you don't mind. So we talk a lot about providing students with different ways to access information, so we've got a verbal presentation of information, supplementing it with visual information, or vice versa. What assistive technology can do is help offload some of those particular tasks or skills that students with learning disabilities are having difficulty using. We think of speech to text software, or text to speech software helping some of those students that experience deficits with processing language, or producing language. These are examples of assistive technology that can really help offload students when the focus of learning may be to use that literature, or to read literature for another type of task, like building reading comprehension for example. So if you think about pieces of assistive technology and what they do, a really nice way to use those is to help offset those specific deficits, to allow students to access the larger learning goal, whatever it may be in class. We like to think of it as an example like you wouldn't have a student write a test if they wore eyeglasses without those eyeglasses. They need the eyeglasses to access that text, and so a student who doesn't wear glasses wouldn't need those glasses, but you provide those eyeglasses because it helps that student to access the learning in an equitable way. You're not giving them any advantage, but you're allowing them to offset a deficit that they may have. In that case it may be eyes but in students with learning disabilities it could be deficits in any number of skills that we mentioned during the presentation.

[Cindy Perras]: Great answer, and great analogy about the importance of making sure that students with LDs have access to supports like assistive technology because it does equalize the playing field for them. Okay another question here, is there a support program you could recommend for students who have learning disabilities in the area of math?

[Ian Matheson]: That's a really good question, I know I personally don't know other than LD@school where I've gone myself actually to access resources, there are a number of articles written, some in the areas of mathematics, where educators of any kind can access different strategies and tools that would help students, but as for particular programs that are aware, like support programs, I'm not aware of any, I'm not sure Cindy if you have an answer to that, if there would be other ones, but my go–to again would be LD@school to access kind of as a starting point, and then I just try to do a lot of research as well, reading studies and accessing things online to see if it can point me to anything in particular.

[Cindy Perras]: Okay. Sure, and I'm glad you mentioned the LD@school website because we do have a recorded webinar by Dr. Daniel Ansari specifically looking at explaining and understanding dyscalculia and how to support students with LDs in the area of math. Okay we've got lots of questions coming in here now. How can you make students with learning disabilities feel good in the classroom and maximize their working memory?

[Ian Matheson]: Ah good question. So how can you make them feel good in the classroom and maximize their working memory? I think…

[Cindy Perras]: Specifically because they're doing things differently than students without LDs.

[Ian Matheson]: Right, right. This is a really big question and I think one answer I could give comes back to how you set up your classroom. I think if you pay particular attention to the fact that we are all different, we have variations in our brains and therefore variations in how we perceive the world, how we behave, some of us may experience deficits in phonological processing, others may not experience those problems. If you tell your class, and talk to your class, about how we are all different, and how we have difficulties with different types of information, I think that's the first step, hopefully at the beginning of the year, of creating that inclusive culture. Now I think you're talking about when you present information in different ways, like you might have an accommodation for a student with a learning disability that kind of, it identifies them or isolates them as being different from their peers. That's a really difficult question to answer because I think you could have a number of different approaches but, again, I like to build that inclusive classroom. And you might just think about giving different learning space as well so if it's for a particular test you could have a student writing in a different area, I know that still isolates them on their own but. Part of it too is the student themselves to be resilient, 'cause your question was really centered around the student, how can they feel good in this case. This would mean talking to them about their difficulties, and seeing them not necessarily again as being tied to them, but tied to the environment. Stressing that learning disabilities are not necessarily a problem with that student, but they have to do with the interaction between that student and the environment. This can be a really great, adaptive way for looking at learning disabilities for students, and it comes back to that functional assessment where I talked about that student Tom who just simply believed he couldn't read. Learning disabilities, as much as we can identify neurological deficits and learning challenges, I think the social cognitive variables like motivation and self–efficacy and confidence are perhaps even more important in some cases, and so we might just see, we might see more and more interventions over time that are focused on feeling good as you mentioned, and feeling competent and confident in our abilities. So I know I'm kind of dancing around the question a little bit here but I think, my two main answers to that would be, building the inclusive environment specifically, and then as for the student, building resilience by getting them to understand functionally what is happening. So Jeff talked a lot about working memory and was defining it and giving examples, talking about working memory with all of your students, and especially the ones who may have difficulty with deficits in working memory systems, that can help them to understand their challenges, and help them to understand ways to overcome those working memory problems. We also talked about presenting information in different ways, visually and verbally, this can help offset some of the problems by allowing students to access all verbal and visual resources we talked about. So as much as you can differentiate, provide different ways for students to access the learning, you might also present activities in different ways where you have one group working on a visual piece of information, one group working on a verbal piece of information, and a bunch of different ones kinesthetic, and you could have students strategically in those sections where it never becomes identified that they've got a learning disability in that area.

[Cindy Perras]: A very comprehensive response, thank you. Speaking of resources, one of our webinar participants had suggested that EduGAINS is another online resource to take a look at, and on the LD@school website, we do have a review of EduGAINS if anybody is interested in taking a look at that. A question, what do you think about Singapore Math it came to mind when you mentioned schematic diagrams?

[Ian Matheson]: I don't think actually either of us have heard of Singapore Math so we'll put that on our list to look into, but we're both very interested in schematic diagrams. As we mentioned, we published a piece with LD@school about that topic so that will be something that we'll look into. Sorry we can't provide kind of our insight on that but…

[Cindy Perras]: No, no.

[Ian Matheson]: …we'll look into that

[Cindy Perras]: No that's absolute fine. A question relating to students who are English Language Learners. How can teachers tell the difference between students who have English language acquisition difficulties and students with learning disabilities, and I'm actually going to jump in and answer that one because we have some excellent resources on the LD@school website, some articles that have been written specifically to help teachers to know how to differentiate and how to support both, and in some cases we also do have English Language Learners who also have learning disabilities.

[Ian Matheson]: Yeah and I think, that's a great answer Cindy, and I think that's a difficult question. I'm teaching a course right now on teaching at–risk students and understanding at–risk students and a question I get a lot is, how do you know what the problem is that students are experiencing? We talk about different types of risk factors and a lot of my students keep coming back to this, how do you know what's happening? I wish I had a great magic wand that could reveal the answer, or a great strategy that I could give, but the simplest answer I can give is spending time with that student and conferencing with them. Giving them an opportunity to share their difficulties with you, to talk about them, and then trying different maybe types of text or different reading related exercise, might help you to identify this. I understand that we're, you know, swamped with 30 different students in class and some of us in secondary school may have even more students than that across different schedules but, as much as you can find time to work with some of these students that you know are experiencing difficulty, the first step is always identifying, okay this student has a problem. And then the more time you can spend with them, and then giving them opportunity to speak, to talk about it, and then trying different types of exercises that will probably help you to identify what particularly is going on. Again try to use the systems in place, we're not alone as educators, we're part of a beautiful community of professional learners and educators, and we can try to access different resources online, in our schools, in our school boards so, that would be the simple answer, I wish I could be a little bit more helpful that way but that's the best answer I can give.

[Cindy Perras]: Okay, thank you very much. We have a question from an occupational therapist who works training students in assistive technology. The issue identified is that the OTs only meet students about one to two times before they're involved in the assistive technology training, and they have very little information about the student's specific learning disabilities. Are there certain questions that you would recommend asking a student in a sensitive way to help them, help the OTs or the other trainers gain insight?

[Ian Matheson]: That's a great question. I would always just start with what you enjoy and what you don't enjoy because sometimes our difficulties can be couched in what we like and what we don't like. We like to do things that we are really good at sometimes and we don't like to do things that we're not good at, so that could be a really nice, sensitive way to approach the topic. Ideally in a situation like this you'd have a student saying this is what I experienced difficulty with, and then for OTs or anybody working with students, you could pair different types of assistive technology or different resources or support systems, to work with that deficit or difficulty area. But if you start just with talking to the student and getting to know what they're motivated by, what they like and what they don't like, that could be a good way to then start to say what do you not really like about, if they say math, or what do you not like about reading? It may start to get at some of these difficulties, oh I find it difficult to read, oh I find things confusing. I understand it can be sensitive because students don't necessarily like to admit what's happening, what they're finding difficult, and they like to just say I don't like it, and in some cases they may actually not understand what's happening. Some of our students who are in the primary grades may not really understand why they're experiencing difficulty, but they may know that they don't like reading or they don't like writing or math. So I would just start with finding out again what they like and what they don't like and then starting to ask those questions, what do you like about it, what do you not like about it. And then, if you can at all possible, try to try some of the tasks with students. I don't know as much about those meetings, but if you can try some of the tasks with them, you may find a lot with observations, and if you can get them to think aloud as they're working through it.

[Cindy Perras]: Great, thank you. Another technology question and this is a terminology that I find quite interesting. What strategies can we use to tackle technology abandonment, as in, the students don't want to look different from their peers?

[Jeffrey McCormack]: Technology abandonment, as caused by something that it sort of marks the student as different, it's a problem, but I would say it's, that's a symptom of the problem, the actual problem is that the use of the technology is being framed or being perceived as being different. Now, in my grade five classroom, I had three or four students who had a really difficult time reading, they were at different levels, and as part of my literacy centers program, I had a chapter book reading center. And I loved how Ian framed the discussion about having an open conversation in your classroom about inclusion and how we're all different learners and I absolutely agree with everything that he said, but a different strategy, also when you're talking about the strategies that fall under the universal design for learning, is to not even necessarily frame it as a way that these tools are necessarily there to help people who have difficulty. So, in my language center, I had the books, and I also had the books on tape, and all the students, they have their earphones, and they were plugged into the center. Now, I knew that I was including the audiotapes as well as the books because two or three of the students had very low reading skills, but the students didn't know that, and so at no point did the use of the audio recordings ever get linked up with some sort of reading deficit or challenging the classroom. So, ultimately, when students feel like they are abandoning technology because it makes them feel different, that is a serious concern, but not because they've stopped using the technology, but ultimately it's because that tech has been linked up with some sort of like, negative or pejorative meaning.

[Ian Matheson]: I can also add two quick points to that, one being that if the problem is technology abandonment, one potential cause of that could be that the student doesn't actually understand how to use the assistive technology, or what the value of it is, so part of it could be that you need to re–educate them, give them an opportunity to learn how to use it, and when, I was a literacy tutor as I said, I had a meeting with the Principal at one point who had talked about a student that was resisting the use of technology and was abandoning it to help them write the literacy test, they said they didn't want to use it. And I remember the Principal said this to me and it'll always stay with me, he said, "The student is claiming it takes too long to use the assistive technology, it's taking too much time." And so the Principal's response was, "Well the only thing that takes more time is the OSSLC, the literacy course, which takes a full semester, compared to the maybe extra 20 minutes or so that it might take to use the assistive technology." So with some students, it could just be getting real with them and saying, listen, this is something that's meant to help you, like eyeglasses, overcome a difficulty to do a task that you need to do anyways. We're trying to help you, we're trying to get you through this, please use this as a support, and not as something that's supposed to mark you or identify you to your peers.

[Cindy Perras]: Great, thank you. Another question, do you think that difficulties with working memory and cognitive load could be mistaken for attentional issues?

[Ian Matheson]: Yeah that, I mean that's a great question, I think, I mean I don't really necessarily think of things as being a difficulty with cognitive load or a difficulty with working memory, or even a difficulty with attention, I try to always start with identifying the problem, and if the problem in one case is that a student doesn't know, let's look at our times tables, it could be a result of a weak or working memory as we talked about, it could be a result of cognitive overload and poor cognitive load when it was being taught, or it could be an attentional issue that they weren't paying attention when it was happening. But I try to focus on the problem, the problem there is that they don't have the skill that I need them to have to move on. And so then it comes to identifying why they don't have that skill and talking to them, and again, you can easily confuse attentional issues, cognitive load issues, working memory issues but, in talking to the student, and working with them, you can probably help to distinguish between what actually happened. If they don't have any recall of what happened it could be an attentional thing, that they weren't paying attention. If they have bits, it could be just that they have a recall problem with working memory, or they may even say to you it wasn't presented in a way that worked for me, it was overwhelming, I didn't really get what you saw but, in their language and the way they talk to you about it, you can probably help to identify what the root cause is, and more importantly, what the next steps are, where you go from there, and what a better was is to present that information, help build those skills.

[Cindy Perras]: Thank you, and this is going to be our last online question for this afternoon. Given that you are both advocates for using schematic diagrams, is there a place where a teacher could go to find samples of the basic and, or important schematics to teach?

[Jeffrey McCormack]: As you, sorry, as we wrote that article we had a really hard time finding clear examples of the pictorial and the schematic diagram use. In fact, I really had to dig to find the strategy of the relational environment. There's not a lot out there, I know that earlier on someone mentioned the Singapore Math, you know, strategy, and there are conflicting math strategies and curriculum core ideas, and it doesn't seem that sort of any one group or school of thinking has created resources for that tool. So, not to toot my own horn, or our own horns here, but I recommend that you first go to the article that Ian and I wrote because there are four examples of the word problems that are answered both as pictorials and schematic, and we included them in there, even though they were difficult to work through, because it was, because those resources are not usually found other places. And the references were in the slideshow.

[Cindy Perras]: Would you please remind our webinar participants as to the title of that article?

[Ian Matheson]: Yeah we'll just go back through and I think it was, let's see, sorry. "Helping Students with LDs Learn to Diagram Math Problems." And as Jeff said, the references for that, for each of the articles on the LD@school website are included in the articles, so if you go through you could find some informational piece, but you may also find that, going back to the roots, those references that we will give you some more supplementary information.

[Cindy Perras]: Okay, that's wonderful. Thank you so much Jeffrey and Ian for providing our participants with clarity and depth of understanding on working memory and cognitive load. If anyone has questions. Oh I'm so sorry, I'm actually reading from an incorrect slide here. I meant to say that's all the time that we have for today and we do intend on responding to the different questions, a number of people have submitted questions and we will have various staff members get back to each of you.

[SLIDE – Other Questions?]
[*Text on slide:* Image of LD@school logo
Email: info@LDatSchool.ca.
Twitter: @LDatSchool
Image of LD@school logo.]

[Cindy Perras]: Should you have any further questions, above and beyond the ones that have been submitted, please either email us at info@LD@school.ca. or send us a Tweet to LD@school, and we will ensure your questions get answered.

[SLIDE – Save the date]
[*Text on slide: Image of 2016 Educators'Institute Logo*
August 23rd & 24th, 2016
Hilton Mississauga/Meadowvale.]

[Cindy Perras]: Save the date. LD@school's third annual Educator's Institute will be held August 23rd and 24th, 2016 in Mississauga. The call for presenters is now open, and additional information on our website is available on the LD@school website.

[SLIDE – Upcoming Webinar]
[*Text on slide:* Lead with Pedagogy, Follow with Technology
Wednesday, April 20th.
Photo of the guest speaker: DJ Cunningham, CEO LEARNstyle.]

[Cindy Perras]: Another date to save. Mark your calendars for the next LD@school webinar on Wednesday, April 20th. DJ Cunningham, CEO of Learnstyle, will be presenting on assistive technology, "Lead with Pedagogue, Follow with Technology". Information on how to register for this webinar will soon be posted on the LD@school website.

[*SLIDE*]
[*Text on slide:* image of the word *thank you*!]
[Cindy Perras]: On behalf of the LD@schoool team, I would once again like to thank Jeffrey MacCormack and Ian Matheson for their presentation, and thank you to all of our participants for joining us. Please remember that we will be sending out presentation slides, as well as a short survey, following today's webinar. The feedback we receive through this survey provides us with important information for

producing future webinars. As a reminder, we will be sending out a link to this recorded webinar in approximately three weeks. Thank you again for participating in this LD@school webinar, and have a wonderful day.