Cognitive Load Theory: Script

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B5T0: Introduction to Module

Hi there! Welcome to this module on Cognitive Load Theory, and thank you for tuning in. This module was created in partnership between 1 Million Teachers and Pastel Education, and is part of our Creating Inclusive Classrooms learner pathway.

If you have ever wondered, “how can I design my instruction around the cognitive processes of my students?” this module is for you! Cognitive Load Theory helps uses concepts of working memory to understand how certain learning tasks are processed by students. It primarily focuses on how to free up our limited short-term memory to focus on learning, and these concepts can be particularly helpful in understanding and supporting children with learning disabilities. In addition, this provides additional understanding of learning processes that can be integrated with our skills in differentiated instruction and universal design for learning.

Through this module, we will cover what is cognitive load theory?, intrinsic load, extraneous load, germane load, how these relate to learning, and how we can apply these concepts to individual leaners.

As always, we challenge you to think about this module through the lens of our three guiding principles: understanding the individual, empathy, and patience. These are three pillars that are fundamental to designing instruction, and thus, the success of our students.

We hope you enjoy this module as much as we did making it. To start off this module, we will be covering some basics in What is Cognitive Load Theory?

B5T1: What is Cognitive Load Theory?

Hi! Before we discuss how cognitive load theory can be applied to help the learning of our students, we need to discuss: what is Cognitive Load Theory? Cognitive Load theory is based off of the understanding that our working memory has a limited capacity. During learning, there is a certain amount of usage or load on this working memory, and if it becomes overloaded, learning is negatively impacted.

To better explain this, I like to think of it in terms of “mental energy.” We only have a certain amount of mental energy, and if we expend too much on things that don’t contribute to learning, we don’t have as much left for productive processes!

Since Cognitive Load Theory is based off of working memory, let’s take a look at how working memory is conceptualized.

In the Baddeley model, working memory is split into three subsystems: the phonological loop, the visuospatial sketchpad, and the episodic buffer. The phonological loop is responsible for processing and maintaining verbal information such as spoken language. The visuospatial sketchpad takes sensory input from vision and dictates capacity to identify visual and spatial relationships. The episodic buffer integrates this information with long-term memory to help us process and make decisions. So, in Cognitive Load Theory, when these subsystems become

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over-loaded, learning is impeded. These subsystems will be important to remember throughout this module.

Another aspect of Cognitive Load Theory that is important to understand is how learning is conceptualized. In this context, learning of students is thought of as the formation of schemas and automation of skills. A schema is a cognitive framework to organize, interpret, and apply information, so if a student learns something, they have created an organized framework to understand that information. Automation is simply gaining a degree of mastery in a skill that it becomes automatic for an individual. These skills carry almost no cognitive load and probably the best example of this is riding a bike.

When learning a task, there are 3 types of cognitive load: intrinsic, extraneous, and germane load. Intrinsic load is the is inherent amount of processing or energy that is required to learn instructional material. This would be the inherent load associated with learning addition. Since intrinsic load is related to the nature of the task, it cannot be changed. Instead, our goal is to control the intrinsic load in a way that best supports learners – and we will further explain this through this module.

Extraneous load is the load that is placed on learners by the materials of instruction. This might be making sense of a practice problem sheet. Our goal is to reduce extraneous load.

Lastly, germane load, which is the load associated with cognitive processes in understanding information. We can think of this as productive or “good” load. Because of this, as educators, we want to promote germane load.

We should also note that cognitive load theory is very useful in assisting children with learning disabilities. Working memory is impaired in students with learning disabilities and may be a contributing factor to challenges in school. By managing the load on working memory, or cognitive load, we can support all students to succeed in our classrooms!

That wraps-up the most important concepts in understanding cognitive load theory. To recap, cognitive load is based off of working memory, which can be split into the phonological loop, visuospatial sketchpad, and episodic buffer. Our goal is to manage the cognitive load to best support student learning, and to summarize, we want to control intrinsic load, reduce extraneous load, and promote germane load.

Thank you for watching and in the next video, we will delve deeper into Understanding Intrinsic Load.

B5T2: Understanding Intrinsic Load

Hi, in this video we will discuss intrinsic load more in-depth. As we discussed previously, intrinsic load is the load associated with the nature of learning a task. Not only is it inherent to a task, it cannot be changed by instructional modifications. Because it cannot be changed, our focus as instructors is to control the exposure to intrinsic load in ways that are manageable for students. To better accomplish this, we need to understand factors that contribute to intrinsic load and be able to identify tasks that have a higher cognitive load.

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When looking at intrinsic load in relation to learning, we can better control load by understanding the complexity of a task. We can classify tasks as low complexity or high complexity. Low complexity tasks are usually simple and straight forward. The elements of the task can be learned in isolation, meaning it is does not require us to draw connections with many other concepts. For example, when we are learning how to spell a word, we can learn this by simply drawing upon our knowledge of the alphabet.

High complexity tasks are the opposite, they require students to interrelate many elements to understand the task. A good example of this is the Pythagorean theorem, a^2 + b^2 = c^2. When first learning this, students need to draw upon their understanding of right angles, addition, exponents, addition, and square roots. Because of the complexity of this, learning the Pythagorean theorem has an inherently larger intrinsic load.

Not only is the intrinsic load dependent on the complexity of task, it is also related to how abstract the learning topic is. Some things are easier for us to wrap our heads around than others. For example, grammar and sentence structure is less abstract than writing short stories. If we are teaching more abstract topics, we need to ensure students have the time to understand the information and acknowledge that certain students will learn concepts faster.

When looking at intrinsic load in relation to our students, the background of a student determines how ready a student is to learn the content. If you have seen our other modules, we often refer to this as learner readiness. For example, if a student has not mastered skills in addition, they do not have the background to learn Pythagorean theorem. So as an educator, we need to have a continual understanding of the learner readiness of our students. This is where formative assessment can help! Small quizzes, assignments, and other assessments can gauge where students are at in their learning, and if they are ready to tackle new topics. This way we can understand intrinsic load in relation to our students. With this in mind, in our next video, we will discuss how we can control intrinsic load to support success in learning!

Thank you for watching and see you in the next one!

B5T3: Controlling Intrinsic Load

As we covered in the last video, intrinsic load is the cognitive load that is inherent to learning a task. It is dependent on the complexity and abstractness of the task and cannot be modified. Not only can understanding intrinsic load inform the amount of time that students may need with a concept, but as an educator, we can control the exposure to intrinsic load to make learning easier. Let's take a look at some techniques we can use to benefit both our class and specific learners.

By controlling intrinsic load, we are referring to how we introduce a task or concept to our students. If we have a topic that is high complexity, we can begin by only introducing a particular part of the task that can be learned in isolation. This way, we can break up the highly complex task into smaller and more easily understood segments.

If we look at the example of teaching double digit addition, we might control exposure to intrinsic load by first having students do vertical single-digit addition, then move to double by single digit addition, and lastly double by double digit addition.

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Task analysis is a versatile and adaptable tool to help deconstruct complex goals into smaller, achievable steps. It is simple to implement and can be combined with visual supports to provide instructions that are more comprehendible for students. This allows for improved understanding for students, and allows educators to better identify areas of strength and weakness. To conduct a task analysis, we go through the process of identifying the sub-tasks in a task, for example vertical addition of single digits in double digit addition, and then identifying the steps in the subtask, conducting the addition, writing the solution and potentially carrying the one to the next column. We can apply the same process to more complex tasks, and decide which subtasks may require more time to learn, and which can be learned together.

Another technique to help control intrinsic load that is similar to task analysis is to structure our teaching from simple-to-complex sequences. This involves identifying which tasks or subtasks are most complex and working up to them. By beginning with simple low complexity subtasks, learners do not experience the full-complexity of the task at the beginning, and when they do, have already built a foundation to better learn the material. Another option, is to introduce the full-complexity of the task, but then bring instruction to focus on particular elements or subtasks and how they interrelate. Overall the concept remains similar: breaking down one high-complexity task to its smaller parts for better understanding.

As we discussed in the last video, we should understand the background and readiness of learners in learning new tasks. This is another technique to use in controlling intrinsic load – determining when students are ready to handle the next task. Formative assessment is a great tool to continuously monitor progress of students, and when they are ready to progress.

Lastly, we can help control intrinsic load by drawing connections to previous concepts. One example of this is to use “problem categories.” In a science class, we can identify a certain skillsets into “application of math skills” such as calculating distance. When we introduce a new concept like speed, we can relate back to application of math skills in distance and how this a concept built upon that. It can also help to utilize similar examples, such as riding a bike.

For learners with exceptionalities or students that are struggling with content, we can use the same tools and concepts to support them. We should consider their learner readiness, and determine how we can control intrinsic load to support their specific needs. Some students may need more time, require tasks to be chunked smaller, and may only be able to work on one or a few subtasks at a time. Remember, these same skills and concepts can be used in tandem with differentiated instruction to best support these students as well.

That concludes this video on controlling intrinsic load. Thank you for watching, and in the next video we will cover Extraneous Load.

B5T4: Extraneous Load

Hi there! In this video, let’s take a closer look at Extraneous Load. Extraneous Load is defined as the cognitive load that is due to the materials of instruction. Another way to think of this is extraneous load is the load associated with how we teach a concept or task. This might be the working memory that is occupied to remember instructions we give or to interpret a written handout.

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The key thing to remember with extraneous load is that it does not directly contribute to learning, and therefore, we should reduce extraneous load to free up space for productive processes. In other words, we should teach in ways that allow students to focus on what they are learning and minimize the energy they need to spend in interpreting how we present that information. Within the context of Cognitive Load theory, our goal is to teach in ways that are direct, and easily-understood.

Let's work through an example of reducing extraneous load in an elementary science lesson where we are teaching students about magnets. We utilize a visual diagram that we project on the board, with a bar magnet, labelled with a, b, c, for north pole, south pole, and magnetic field identified below the diagram. We then talk through the diagram and give the students an activity to play with some horseshoe magnets and objects.

Although, we did a good job utilizing a combination visuals and activities there are some areas of unnecessary extraneous load that we can reduce.

The first cause of increased cognitive load is due to the Split-Attention Effect. This is when students have to work harder to integrate information that is separated. Because of this, the learner has to spend energy searching for information that is being referred to. The diagram we are utilizing for teaching is an example of this. When labelling a, b, and c, and providing the explanation below, students have to move their focus up and down, while remembering bits of information, to make sense of the diagram. This is common in text books and older teaching materials and can be reduced by simply integrating key information directly in the diagram. This way, the students' cognitive capacity can be freed to focus on more important learning tasks.

Another area that is unnecessarily increasing the cognitive burden of our lesson is the inconsistency between instruction and activity. In our diagram, we utilized a bar magnet, and explained concepts using this, but during the activity used horseshoe magnets. In this case, we are leaving it up to students to integrate the knowledge of bar magnets and apply it to the other shape. This increases the cognitive burden, and does not necessarily help with the objectives of learning in understanding magnetic poles and fields. In addition, some students may make the connection themselves, but other students may not, decreasing the value of our activity. To help reduce this extraneous load, we should strive for consistency between our materials and activities by using bar magnets, a horseshoe magnet diagram, or simply explaining how a horseshoe magnet function prior to the activity.

The last area we can identify for improvement is that we have no supporting material during the activity. This increases extraneous load as we make students utilize cognitive capacity **remembering** what is taught rather than **understanding** what is taught during the activity. Not only does this decrease students' ability to relate knowledge to the activity, as students forget the lesson, the activity becomes less valuable as well. To help with this, we can provide a handout for that guides students through the activity and explains how the concepts relate, or simply leave our better design diagram on the board for students to reference.

To wrap-up, by addressing the split attention effect, increasing consistency in our lesson, and providing supporting materials we can reduce extraneous load during our lesson on magnets. This helps free up mental space for students to focus on their learning, and support all

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students to reach their goals. Thank you for watching, and in the next video, we will take a look at more ways we can reduce extraneous load!

B5T5: Extraneous load pt 2
Hi! In this video we will elaborate on reducing extraneous load, beginning by looking at two more areas in which educators may overburden students.

The first is the environment of learning. Posters, clutter, visuals, pictures, and other items that are in the classroom space can distract students from the material that is being taught. For example, if we are teaching a lesson on grammar and a student is distracted looking at a poster, the environment is increasing the extraneous load of the learner. To avoid situations like this, we should ensure that everything in the environment has a purpose for learning. We can build our environment over the school year to make sure students are familiar with all items in the room and how it can help their learning.

As we have discussed in many modules on our platform, for students with sensory processing challenges, it is even more important that our environment is purposeful and constructive to learning. If we think through this in the Cognitive Load perspective, students with hypersensitive sensory differences may experience a higher extraneous load from the environment as they are spending mental resources managing the extra stressors from their surroundings. On the other hand, for students that are hyposensitive to certain stimuli, they may spend more mental energy trying to remain focused when understimulated. We should find inclusive ways to decrease the extraneous load these students experience.

Another source of extraneous load is when our teaching materials overlap in an uncomplimentary way. For example, if we are teaching a lesson about the medieval ages and we provide 1 handout and 1 excerpt from a text on the same topic, we might actually be increasing cognitive load. During these scenarios, students must coordinate and align multiple sources of information, which requires more mental energy. If there are slight differences or conflicting information between the sources this can cause confusion and difficulty interrelating concepts. To emphasize, when we provide multiple sources of information it is about doing it right, we should ensure that the information is complimentary. We should choose sources so that either one supports deeper understanding of the other, or provides new information or perspective that is not covered. Other times, we can save one source of redundant information and provide it to students who have difficulty comprehending the primary source. It helps to have a clear understanding of the learning goal and how the sources synergise to help students achieve their objective.

The last technique we will cover in this video is an obvious one, providing information in multiple ways, or multimodality of presentation. As we know some students learn better visually, some learn better through written text, and some learn better verbally. By varying the way we present information we can decrease extraneous load. But, there is a little bit more to why it is effective. If we go back to our working memory model, we have two subsystems: the phonological loop and the visuospatial sketchpad. When we only provide information in one format, we can only access one of these subsystems in our working memory. Because of this, we aren't able utilize our full cognitive capacity. By providing a multimodal presentation of information, it allows us unlock the full processing ability of students to help them learn.

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That concludes this video on more techniques in reducing extraneous load. In the next video, we will wrap-up our discussion of extraneous load, looking at worked examples and considerations for learners with exceptionalities.

B5T6: Worked Examples
Let's wrap up our discussion of reducing extraneous load by looking at the value of worked examples. When we present students with practice problems, we often assume that they will easily apply the skills they are learning to build mastery. However, when students don't have well-developed background knowledge, students can have a hard time approaching problems. Instead, they may utilize a trial and error approach, keeping searching for information, or not know how to begin, unnecessarily adding extraneous load. To help with this, we can provide students with examples that are worked through for students to follow, and then allow them to apply these problem-solving skills.

This is very commonly done in math classes, where an example as solved through by the teacher while students follow along. For example, if we go back to the example of double digit addition, we can utilize task analysis in identify the steps of the task, and then go through those steps on a projector. Then when students are working through their practice, if they have challenges with a problem, they can reference the example to help guide them. This also can help students identify which steps they have the most trouble with and if we as instructors need to further clarify specific areas.

The worked example can be used in other ways as well. For students that are struggling with content, we can provide handouts with additional worked examples, written explanations of steps, and worked examples of word-problems as well. This allows us to use these as an instructional scaffold to help reduce the extraneous load for specific students.

Although mathematics is often the easiest subject area to utilize worked examples, this can applied to other subject areas as well. For example, worked examples can help students learn how to structure and write a paragraph, or assist a struggling student with how to organize a presentation in social studies. The key value of worked examples is that it provides students with an approach to the task they are trying to complete, and in doing so, helps them build mastery of skills.

If look back at reducing extraneous load, it involves a combination of eliminating unnecessary learning material or improving how we present information to help students focus on learning. If we shift our focus on how this relates to supporting learners with exceptionalities, it revolves around one question:

Do any exceptionalities or challenges increase the extraneous load of our teaching materials? In other words, are the ways that we teach inclusive of the needs of certain students? Depending on the perspective or approach that works best for you, we are applying the same concepts and skills in a more targeted way.

A student with autism spectrum disorder that impacts their ability to understand written text will experience a higher extraneous load when comprehending a written handout. To reduce this, we can add more visuals to the handout and talk with student during class time to assist their understanding.

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Again, our goal is to utilize an understanding of cognitive load to compliment ways to support inclusion through differentiated instruction or universal design for learning. It can give us context to the nature of the challenges a student is experiencing. For example, if a student with a learning disability is having difficulties with an activity, it may be because of extraneous load associated with remembering information from the lesson. As we know, learning disabilities are associated with impaired working memory, and we can reduce extraneous load by having a handout, summary sheet, or even a worked example. This way we can reduce this cognitive burden and free up working memory for learning.

Through the last three videos, we have looked at reducing extraneous load by addressing the split attention effect, increasing consistency in our lesson, providing supporting materials, modifying the classroom environment, using complimentary resources, multimodality teaching, and lastly worked examples. We hope that these tools can be helpful in your teaching, and in the next video we will discuss Germane Load.

B5T7: Germane Load
Hi, in this video we will being our discussion of Germane Load. This is the load associated with cognitive processes in understanding information. We can think of this as productive or “good” load.

Within Cognitive Load theory, learning is thought of as the process of internally organizing information into cognitive frameworks called schemas. This cognitive organization helps us to then perceive situations and make informed decisions. Because of this, as educators, we want to promote germane load.

If we look at all three types of cognitive load and how they interact we can think of our working memory using the analogy of a container. The container has a fixed size, just like our working memory. For intrinsic load, we can’t change it as it is innate to a task, but we want to choose appropriate tasks to make sure it doesn’t fully fill our box. Next, we have to place in our extraneous load, the extra load associated with how we teach, and lastly, we now have our Germane Load, which is our productive load. If too much space has already been taken up, there is no room for us to learn. Since Intrinsic load cannot be changed, we try to reduce extraneous load to make room for germane load. In terms of germane load, the more the better! We want to promote germane load to occupy as much of the rest of the space to maximize the learning processes of our students, if we do not, the space is wasted!

So how do we promote germane load? Promoting germane load comes back to how we learn: schemas. If we present information in ways that are organized schematically and easily understood, it helps students to learn. Many of the teaching strategies we will cover are common techniques that you probably use in your class! We hope that learning about Cognitive Load will provide some more perspective into why they work.

The first tool that we will look at is the use of mnemonics. These involve using key words, rhymes, or acronyms to remember important information. An example is the use of BEDMAS to remember order of operations for math, brackets, exponents, division, multiplication, addition, and subtraction. These work by creating associations of key information with easy cues, to aid the retrieval of information. We can thing about this as a memory bin that we can access by

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looking at the label which is the mnemonic. By presenting information in mnemonics, we create framework that can be easily internalized by our students.

Another way that we can promote germane load is to present information in visual frameworks. One example of this is to organize information in a flowchart or decision tree. For example if we look at tree classification, we can split this into coniferous and deciduous trees, and then split deciduous trees to region, like palm trees in a tropical climate and popular trees in a more moderate region. Integrating examples within the diagram can also help make it easier to understand and retrieve this information. Tables, idea webs, and other types of information modelling can be used in different ways to guide thinking processes and retrieve information.

The last technique we will discuss is the use of chunking. Chunking information allows us to retain more information by organizing common elements into groups. For example, with a phone number, each section is broken up to help us remember rather than a 10 digit string of numbers. By chunking a phone number, we are essentially remembering 3 more complex numbers rather than 10 individual ones, which is easier on our working memory. We can use this concept is more complex tasks as well. For example, if we are remembering the components of a plant, we can think of parts below the ground, the trunk, and information about branches and leaves.

That wraps-up our techniques on how to promote germane load through organization of information. In the next video, we will take a look at some more ways to promote germane load in other ways.

B5T8: German Load Pt 2
In the last video, we discussed some ways we can promote germane load by structuring the presentation of information in ways that are easily internalized and accessed by students. In this video, we will look at some other ways we can support learning of students.

To begin by looking at learning a skill, we can use elaboration to help students gain a deeper understanding of the material. This involves having students think deeply about the information which promotes germane load as it requires attention and focus. As students gain a deeper understanding of information they make connections to other topics and formulate schemas which help retain information long term. We can utilize guiding questions, point out connections, or have students complete information organizers, such as a t-table, to facilitate this.

When we look to learning skills and remembering information, we have all experienced the scenario in which we feel like we know something, and then the next day struggling with recalling what we've learned. Rehearsal helps with this. Rehearsal is the practice of a specific task with time and intervening task between each session of practice. This It is a very common practice in education, so we wanted to point out that it is an effective teaching strategy to continue to use. However, some types of rehearsal are more valuable than others.

Maintenance rehearsal, also known as rote rehearsal, involves the repetition of information to memorize it. This might be repeating a phone number as we are looking to write it down. Just like in those scenarios, once it is written down, we tend to forget it. Straight repetition helps us keep information in our working memory, but is less effective in encoding it into our long-term

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memory. In the context of education, it is less valuable as our goal is for students to learn and retain material.

Elaborative rehearsal on the other hand, involves rehearsing information by thinking through it and making connections to related concepts. Like elaboration, elaborative rehearsal requires more energy and focus, stimulates deeper understanding, and ultimately promotes germane load.

The last strategy is overlearning. This is when we practice a skill that has already been mastered by a student until it becomes automatic. Not only does that information become extremely accessible to be used by the student, but by doing so, they can now focus on other parts of a task to further build their understanding or skillset. One example of this is moving from addition to single digit multiplication to double digit multiplication. When students overlearn or automate their times tables, double digit multiplication becomes much easier to understand, as it is an extension of these other skills.

That concludes our discussion of promoting germane load. In this video, we looked at some common techniques that you likely already use and how they can assist learning of our students. Thank you for watching, and in the next video, we will recap the module by discussing how these principles can be applied to support individual learners.

B5T9: Applying Cognitive Load to Individual Learners
Hi there and thank you so much for watching this module on Cognitive Load. In this module we have looked at what working memory is, what is cognitive load theory, and how we can manage intrinsic, extraneous, and germane load to support the learning of students in a classroom. Let's recap what we've learned and how this can benefit individual students that may have learning disabilities or other exceptionalities.

Intrinsic load is the cognitive load that is inherent with learning a specific task. If we use the example of learning about the solar system, we can think of this as the total number of planets students need to remember. Because of this, there is no way for us to change or modify this. However, as we have learned, we can control the exposure to the total intrinsic load through a number of techniques and matching this with learner readiness. Some strategies we identified are splitting up a learning task, allowing appropriate practice time, and introducing elements from simple to complex. We could do this by introducing the inner planets first - Mercury, Venus, Earth, Mars – and then moving towards outer planets.

For students with learning disabilities, we can apply these same concepts in controlling intrinsic load in a more individualized approach. We need to identify learner readiness, what the learner objectives are, and how we can introduce elements of tasks in a way that fits the student. Perhaps for one of the students, it is better to introduce the planets one at a time, rather than as a group.

Next, we looked at extraneous load, which is the excess cognitive load associated with how the information is presented. Extraneous load does not directly contribute to learning, and we should find ways to present information that is easy to remember. One consideration we covered is ensuring that any diagrams we use have key information integrated within the visuals. If we go back to teaching the solar system, we should ensure any diagrams we use are

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efficiently developed. We also want to make sure that the teaching materials are consistent with each other, and what is taught. When students move on to activities, we should try to have reference resources available so they can dedicate more energy to comprehending information, rather than remembering it. Every time we teach about a planet, we can post a picture onto our wall to create a classroom solar system. This way we are also ensuring our environment is constructive to learning and not providing excess distractions.

These are all strategies that will help students with learning disabilities as well. Some students may have exceptionalities that impact understanding of resources, and we can take the same approach to ensuring our resources are inclusive of these needs. Other times, adding visuals, having handouts, and worked examples can help support all students to better learn. Certain resources may just need to be tweaked to better fit the needs of a particular student.

Lastly, we covered Germane load, the productive cognitive load associated with the mental processes of learning. We discussed how we want to support students in the development of schemas – mental frameworks that help organize information. We can present information in mnemonics, visual frameworks, and chunked sections to support learning of the class as well as students with exceptionalities. Not only have we already chunked planets into inner and outer ring, but we can use the mnemonic My Very Excellent Mother Just Served Us Nachos to remember the order of the planets. Each time we revisit the topic, we can elaborate on the content by providing more information, such as size, composition, and defining features.

In addition, when we provide practice problems, we can have guiding questions to help walk students through their thinking to elaborate on their understanding of the concepts. When utilizing elaborative rehearsal, we can find time to talk with struggling students, and help them make connections to related concepts.

That concludes this video and this module on cognitive load. We hope you enjoyed this module as much as we did making it! Thank you so much for watching and, as always, thank you for supporting Pastel Education.

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