

Cognitive Load and the Whole-Person Learner

On the campus of a large comprehensive university, a general-education biology lecture—size 750—is just letting out. One student in that class, a first-term freshman, is an academic all-star—a valedictorian, the child of professional parents, and a scholarship winner in the Honors program—but on this particular day, her mind is not on her studies. Instead, having received a letter stating that unless she remits payment immediately, she will be dropped from all her classes, she is making plans to go check on why her financial aid hasn't posted. She has just under two hours before she is supposed to be in history class. Arriving at the window of the financial aid office after fighting her way out of the auditorium, a 20-minute walk, and a long line, the student learns that she is in the wrong place, as she has a “scholarship” rather than “financial aid.” This necessitates another long walk, another line, a trip to the Honors program to verify her scholarship award, and then a repeat of the same line again. The student never makes it to history class, and whatever she may have learned in biology that day is gone with the wind.

On another campus—a virtual one—a veteran is reading the short story he has been assigned for English class. The story, Hemingway's “Soldiers Home,” interests him because he finds its premise—a WWI soldier returning home from war and struggling to re-engage as an active participant in everyday, small-town life—personally relevant. The story is available in a no-cost full-text version, for which he is grateful, but he finds the format distracting, as clothing and home décor ads continually interrupt his reading. And the story's “helpful” illustrations are anything but—photos from war scenes that he knows happened in WWII or Vietnam rather than the Doughboy experience about which he is reading. He now and then has to consult an online dictionary to decipher some of Hemingway's more antiquated words and phrases, which introduces another distraction: a new browser window. After he finishes, he is eager to share his experience with the story and hear from others, but instead, he finds himself irritated by his classmates' comments about why the protagonist Krebs has trouble socializing or embarking on a career path. Social anxiety is Krebs' problem, they suggest, or perhaps he has mother issues: if he just takes his time to be true to himself and find a career about which he is passionate, they say, his problems will go away. None of them understands veterans, he thinks, yet he does not know how to say this to his young

classmates without causing offense and possibly risking getting canceled. He considers consulting his instructor, but he knows that office hours were from 12-2 p.m., and he has to do his class work at night after his workday ends. A late discussion board submission will have to do.

The two scenarios above are both real and typical, in that they represent the sorts of scenarios that stymie learning across delivery formats, creating barriers that impede students' movement through their programs of study. The first student's academic success is compromised by an extracurricular demand, a financial aid paperwork error, that takes far too long to resolve. The second student's learning load is made heavier by the format of the course text, by his instructor's lack of accessible office hours, and by the stress resulting from disparities in his own and his classmates' life experiences. As the two cases above illustrate, the tasks and concerns that fill the extracurricular space both can and do impinge on the controlled space of instruction—and that space is not necessarily designed ideally to begin with. Although a century of work in learning design and Cognitive Load Theory (CLT) has given us a set of sound principles that, when applied, will improve the instructional experience, the scenarios above suggest that these can—and should—be applied beyond the classroom space, addressing a wide-reaching understanding of the whole of a student's learning context. A full-time student carrying the equivalent of 15 semester hours typically spends 45 hours a week on academic work, the equivalent of a full-time job. Yet that student also spends another 123 hours outside of class doing other things—sleeping and eating, commuting, working a job, socializing, and traversing campus to visit necessary offices. For a half-time student, the percentage of a week's hours dedicated to academic labor is smaller, only 11% of the 168 hours in a week. Differences abound as well in the types of life experience, responsibilities, and concerns that different students carry into the learning space. Allowing CLT to inform all of these areas will improve the learning experience not just within the course but beyond it as well.

I. What Is Learning?

One can trace a strong trajectory from late nineteenth-century scientific investigations of topics such as memory and repetition (see Ebbinghaus) to Piaget's and Vygotsky's landmark theories on child

development to recent brain-based work on cognitive load. Most recent work in the field describes learning in the broadest sense as a process by which a person sorts through stimuli, processes information in short-term or working memory, and passes it to long-term memory, where it can be called upon later (Vogel-Walcutt et al., 2010). Cognitive Load Theory (CLT) rests on the notion that we can hold only a few items in our active or working memory at any one time; no matter how hard we might try, we cannot increase the number of items about which we can think actively. A classic article on information processing sets this number at seven, plus or minus a few (Miller, 1956). We also know from other early work that any given piece of information has a shelf-life of only about 30 seconds once it enters working memory, unless it is somehow rehearsed or encoded (Peterson & Peterson, 1959). For more effective and efficient learning, it makes sense to reduce the amount of labor that the working memory has to do at any one time, and it also makes sense to speed up the processes by which information moves from working to long-term memory. Some of the load our working memory has to bear cannot be substantially reduced; it is *intrinsic*, or tied to the difficulty of the task at hand. Calculus, for instance, is typically a difficult subject, so its intrinsic load is high. Some of the load our working memory bears, however, can and should be eliminated in the learning space; *extrinsic load* refers to those distractions and redundancies that occupy space that should otherwise be left free. Finally, *germane load* refers to the effort required to move information from working to long-term memory and to organize it into schemas, or chunks that can later be recalled. As a rule, CLT-aware pedagogy works to keep intrinsic load at a manageable level given a learner's prior expertise, reduce extrinsic load, and increase the space used to process germane load.

CLT emphasizes not just the transfer of information from working to long-term memory but also the organization of that information into schemas, or larger organized chunks, that can be called upon for later use. To take an example: those of us who came of age before No Child Left Behind will likely recall memorizing the capitals of the 50 states, the types of conjunctions, the stages of photosynthesis, and multiplication tables. For us, memorization was often taken to be synonymous with learning—the

“stuffing in” of information in order to regurgitate it later.¹ While we have probably forgotten a great deal of what we once memorized, we likely remember those bits and chunks of information that we regularly rehearse, that connect to other knowledge that we use, and that reside in our memory in more than one form, as they are part of meaningful schemas of knowledge. If we regularly fly through a state capital whose name we memorized as a child, we can likely identify it (though by this logic, we might be inclined to think that the capital of Illinois is Chicago rather than Springfield). If we learned a foreign language, we might be able to list and identify the types of conjunctions and other grammatical constructs. If while we learned about photosynthesis, we set its terminology to music or drew a picture, we probably recall at least parts of that schema. And if we regularly use multiplication for cooking or banking, we likely do not have to pull out our phones to make a basic calculation. When learning is reinforced through repetition, personal experience, application in a different context, or translation into another mode, it becomes part of the store of knowledge and skills that a person can call on later to approach problems, questions, and challenges in everyday life—whether those occur in the classroom or not (Cooper, 1998, p. 7). By contrast, knowledge that is not organized into schemas will, like any other creature attempting to live in isolation, eventually go extinct. Thus, “the goal [of instruction] is to give learners specific guidance about how to cognitively manipulate information in ways that are consistent with a learning goal, and then store the result in long-term memory” (Kirschner et al., 2006, p. 77).

The presence or absence of organizational schemas for knowledge defines the difference between a novice and an expert: the expert has organized myriad “bits” of information that overwhelm beginners into meaningful “chunks” in long-term memory (Miller, 1956, p. 93). In a well-known study on chess mastery, Chase and Simon (1973) demonstrated that chess masters showed no greater ability to process information than did beginners; rather, they had stored more relevant background knowledge in their long-term memory and hence had more information to call on when approaching a possible move.

¹ This definition includes only “instructable” learning, or biologically secondary learning. In addition to this, we all benefit from the biologically primary learning we all do automatically from infancy—learning our native language, learning to apply general problem-solving skills in multiple situations, or learning to recognize faces and voices (Tindall-Ford, Agostinho, & Sweller, p. 2).

Because of this greater depth of knowledge, experts in a field tend to understand categories of things with greater richness and more precision, and they also tend to see more connections among categories (Murphy & Wright, 1984, p. 144). For example, while even a young child can understand the difference between a chair and a bed, it would require more expertise to differentiate among a ladder back chair, a Windsor chair, an Eames chair, an office chair, a daybed, a recliner, a sofa bed, a canopy bed, a bunk bed, a futon, and a chaise—yet an expert can not only correctly identify these types of furniture but also explain their relationship to each other, their cultural valences, and so on (Rosch et al., 1976). When learners are new to a subject such as furniture-design (or, more likely in a classroom setting, algebra), it thus becomes necessary to take a “structured and systematic” approach (Martin & Evans, 2020, p. 17), in which the instructor introduces basic skills and knowledge, such as the difference between a chair and a bed, without extraneous, distracting, or complicating material, and then assists the learner in practicing it until “fluency and automaticity in skill and knowledge” result (Martin & Evans, 2019, p. 18). An expert has performed this process over and over, taking basic categories and populating them with new knowledge and skills that can later be called upon quickly, almost unconsciously, for use in any given moment. The expert thus has “maximum working memory capacity . . . available” (Sweller et al., 1998, p. 258) to approach any problem at hand. It is the task of instruction to help students build that automated organizational system, then fill it out in a logical and straight-forward way.

While no instructor can account for every factor that may influence the way a student constructs knowledge into a schema, savvy learning design will incorporate any known factor that may affect learning, as “cognitive load depends on the interaction of three components: the learning goal and its associated content, the learner’s prior knowledge, and the instructional environment” (Clark et al., 2005, ch. 1). Extrinsic load such as distractions or challenges created by technological interfaces (Puma & Tricot, 2020, p. 50) play an especially outsized role in cognitive load-aware pedagogy, as do the conditions under which learning occurs. Not only does the learner’s context affect how he processes information (a student who decides to study in a night club while on a date will likely not learn much!), but context can also be processed and encoded as part of the learning itself. If that student who studies in

a night club while on a date manages to memorize something like the names and basic content of a few landmark court cases, it is not unreasonable to suppose that when that information is recalled, it will bring with it a throbbing beat and some strong emotions. Far more learning—including emotions and motivations—can be schematized and automated than might at first seem evident (Bargh, 2004, p. 7).

This presents both an opportunity and a complication for those charged with instructing students, as clearly much more than a simple transfer of factual information is at stake in any given pedagogical scene. Take, for example, the case of a student who prefers to major in social work rather than nursing—but to please her family, she opts for nursing. Consciously, she fully intends to be a nurse, and she is on track to graduate on time. However, at the same time, she routinely engages in unconsciously goal-directed behaviors, such as reducing her study time for required anatomy courses in order to volunteer with a social justice organization. She thinks that her behavior reflects her interests and proclivities rather than her desire to make a life change, but unconsciously, she has begun moving toward a goal she has not stated even to herself. Meanwhile, as she learns (or not) the names of muscle groups for her anatomy exam she finds little reinforcement in the other parts of her life, something that might have been drastically different if her primary social contacts had been other nursing students and her volunteering had taken place at a health clinic. Learning may be either compromised or supported by emotional or cultural baggage. Should the nursing major wind up studying social work, her classroom performance will likely be bolstered by her already keen interest in social justice issues, which figure large in the content of many social work courses. Similarly, should the veteran student reading Hemingway find a graceful way to explain how his own experiences in returning to civilian life mirror or differ from Harold Krebs', he might amplify the learning of his classmates while also, through reflection, solidifying his own understanding. On the other hand, if because he is afraid or anxious he withdraws altogether from the conversation, his success will have been harmed not by too little knowledge but by too much experience.

CLT has provided valuable insight into the learning process that is needed in today's educational environment now more than ever. Distraction, lack of motivation, and other roadblocks to learning have always been present in the learning space (or, at the very least, in students' own heads), but rarely have

there been so many other detractors from learning present in students' everyday lives. An online student, for instance, is by the very nature of her learning tied to the digital environment, where she most likely also encounters significant interruptions from personal messages and website notifications—not to mention the temptation a machine with ready access to a world of information presents. A 2022 survey demonstrated that people check their cell phones more than 300 times per day on the average, more than once every five minutes (Wheelwright, 2022). Working memory, in seems, is a crowded place—and this is before an educational experience even begins. The primary goal of CLT, to find ways to reduce the amount of information in working memory, either through limiting the amount that enters working memory to begin with, or through finding ways to move information more quickly from working to long-term memory (Sweller et al., 1998), takes on special urgency in this over-loaded educational environment.

CLT provides an immediate and practical benefit to those looking to design learning experiences that are as effective and efficient as possible. Because applied CLT assumes a learner ready to adopt the instructor's learning goals, however, we may fail to see its relevance beyond the official learning environment. As the two opening examples suggest, even in cases where the student really does want to learn the material—if only because he knows she needs to pass a certain course to earn a degree—outside factors such as financial aid issues, personal emotional history, or structural issues caused by the organization of university systems may interfere, occupying valuable space in working memory and hindering in-class learning. Or, as the case of the would-be social work major suggests, sometimes a difficult learning task might be made easier or harder when social support systems and personal motivation either grease or slow the wheels of cognition. Students are whole people, and their learning is affected by the whole of their life situations. CLT, understood in a wide-ranging and flexible fashion, can improve the approaches we take to educating students both inside and beyond the learning space.

II. CLT in the Classroom

The question of how best to educate students for maximum learning could be asked in more than one way. In order to arrive at the question of what creates load to begin with, for example, we might

examine the reasons that students fail to learn or retain information. A military-focused study identified nine potential points of loss during the learning process, seven of them occurring in working memory and transfer and two in long-term memory (Vogel-Walcutt et al., 2010). These potential points of loss, along with strategies that may improve learning outcomes, are summarized in the table below:

Table 1: Learning Loss and Mitigation Strategies

Potential Point of Learning Loss	Suggested Mitigation Strategies
Failure to Attend – the student is not interested, not paying attention, or not alert enough to learn	Create interesting learning activities; mix up the pace, complexity, or approach to learning; reduce distractions
Forgetting – the student initially understands information but fails to retain it	Present information orally and visually simultaneously; reduce distracting or repetitious information; personalize information to students' experience; allow students to interact with information at their own pace; emphasize which parts of information are most important; disclose to students the structure/goals of the information to be presented; allow students to complete one task before introducing another; create opportunities to rehearse information
Task Shedding – the student may be overwhelmed with too much information and ignore some important tasks	Present information in a sequence based on the expertise level of the learner; scaffold information in response to the students' performance, removing information that has already been mastered and introducing a manageable amount of new information at each stage of learning
Disinterest – the student may feel bored or uninspired by information that is presented and thus determine that information to be “not worth it”	Present information in an interesting way by showing its relevancy to the learners, using engaging presentation techniques, and setting an appropriate level of challenge; allow students some measure of choice in how/what they learn
Incorrect Filter – the student may be overwhelmed with too much information and may choose to focus on the wrong information; in addition, the student may attend to all information but not know how to “file” it in long-term memory	Explain clearly what information is important, how it fits together, and what the student needs to do with it; complete “worked examples” where the instructor demonstrates for the student how to solve a particular problem or approach a task
Misconception – the student misunderstands the information presented	Offer opportunities for students to reflect on their learning to check comprehension and narrate their own learning process
Incorrect Label – the student mislabels or incorrectly files the information in long-term memory	Outline the information to be presented ahead of time; as new information is presented, refer back to the organizational system that has already been communicated
Retrieval difficulties – the student has problems recalling or re-conceptualizing information already stored in long-term memory	Rehearse the information to be learned or even guide students in relearning it if it is foundationally important
Transformation – student is unable to apply learned knowledge in different scenarios	Practice applying information in various scenarios and contexts; offer feedback on the student's learning and application process

Broadly, the barriers to successful learning and recall might be summarized as follows: students may not fully attend to, misunderstand, ignore, misfile, misremember, or misapply information. Instructors who want to work against these potential learning errors, then, should adopt a set of practices that provide students with a clear organizational schema for information to be presented; introduce that information in an engaging way; structure the presentation of information logically and in response to students' performance; reduce distractions and assist students in focusing on the task at hand until it is complete; provide opportunities for practice, application, and feedback; model ways to use that information in different scenarios, and create space for students to reflect on their own learning. CLT offers practical guidance for how that process might look.

CLT research has identified at least five primary effects associated with learning that can be incorporated into a best-practices approach to pedagogy: the split-attention effect, the modality effect, the redundancy effect, the goal-free effect, and the expertise reversal effect. These serve as both the “why” and the “what next” for the learning loss factors identified above—the reason that each of those areas of possible learning loss happens and how to make a course correction. The, first of these, the split-attention effect, occurs when “two or more sources of information must be processed simultaneously in order to derive meaning from material” (Sweller et al., 1998, p. 283). The classic example of this effect involves a diagram with accompanying text that must be read and understood for the diagram to make sense—a poor use of student's attention and working memory capacity. A better solution would be to integrate these sources of information, so that the diagram contains labels that integrate the verbiage students needs to understand it (Chandler & Sweller, 1992). In the same fashion, a beginning philosophy student would benefit from the use of a course text that defines basic terms (epistemology, ontology) as they are introduced, rather than having to pause to consult a glossary. In the language of CLT, this is referred to as reducing “element interactivity” (Cooper, 1998, p. 13). Pedagogical techniques such as these allow students to stay focused on only one task and thus to avoid the learning losses that can occur from distraction, task shedding, or simply having to pay attention to too many things at once.

The modality effect and the redundancy effect represent two sides of the same pedagogical coin, one desirable and one not. The modality effect occurs when learning occurs in more than one sensory mode at once—a way of helping students to do the heavy lifting that learning requires by spreading the load around. A lecture accompanied by pictures that reinforce rather than detract from the learning goals is likely to prove more pedagogically effective than a lecture alone (Tindall-Ford et al., 1997). By contrast, the undesirable redundancy effect occurs when the information is presented in the same mode multiple times simultaneously, such that one presentation competes with the other. For example, if an instructor distributes a transcript of a lecture, then proceeds to read aloud that same lecture, the repetition of verbal information will create unnecessary load in students' working memory, making it harder for them to process the information at all (Kalyuga et al., 1999). As a principle, when choosing to include or exclude content in a pedagogical scene, instructors should make sure that information is presented a single time, minus extraneous, “nice to know,” or repetitive elements (Cooper, 1990, p. 112), and in a way that allows learners to interact with that information using various modes of processing—auditory, visual, tactile, haptic, etc. In this way, the modality effect can be achieved and the redundancy effect avoided. Auditory information competes with other auditory information, so mixing modes of presentation is key to achieving the modality effect (Sweller, 1994).²

The desirable goal-free effect occurs when students work through a problem step by step, rather than by having to intuit the steps needed to arrive at the learning goal. Asking students to chart their own path to solving a problem adds significant cognitive load because it requires them to envision both the

² The modality effect can be observed at work in recent research that showed that students can read and use graphs better if they trace them with their fingers (Agostinho, Tindall-Ford, Giss, Howard, Leahy, & Paas, 2015), trace and draw shapes while learning geometrical constructs (Hu, Ginns, & Bobis, 2014), and include gestures or movements as part of early language learning (Mavilidi, Okely, Chandler, Cliff, & Paas, 2015). Similarly, students learn information more readily when an instructor incorporates physical movement such as gestures or pointing to draw attention to or assist in clarifying the content being presented (Sepp, Howard, Tindall-Ford, Agostinho, & Paas, 2019, p. 311). In a fully digital environment, including arrows or circles to draw attention to various pieces of content can accomplish many of the same ends as a gesture would in a live teaching scenario (Puma & Tricot, 2020). Careful adaptation of the learning content to match students' overall skill levels can reduce the redundancy effect and minimize learning losses caused by failure to attend or disinterest; no competent calculus student needs to spend time re-memorizing the multiplication tables, after all. Note: CLT's encouragement to present information in multiple complimentary modes ought not to be taken as an affirmation of learning styles-based pedagogy.

beginning and the ending of a problem or task (Cooper, 1998, p. 16), while guiding them step by step keeps cognitive load to a manageable level. For example, take the following math problem:

You have volunteered to provide cupcakes for your brother's Little League baseball team. There are 15 players on the team, plus three coaches. You anticipate that each player will eat two cupcakes and each adult will eat one. Your cupcake recipe calls for 3 eggs and will yield a dozen cupcakes. How many eggs do you need to purchase?

A person experienced in algebraic equations or who has simply been using arithmetic for a long time could easily conceptualize how to solve this problem. A younger student who has just learned to do multiplication and division, however, would likely struggle to lay out all the steps needed to solve this problem correctly: totaling the needed cupcakes, dividing the total by 12 to know how many batches are needed, rounding up, since the requirement to use three eggs makes it infeasible to make half batches, and multiplying that number by three to figure out how many eggs will be used in total. To achieve the goal-free effect, learning activities should be structured so that students take only one achievable step at a time as they work toward solving a problem or completing a task—not focusing on the whole, stopping to analyze possible alternative methods, or engaging in premature metacognition. This is best accomplished through showing students worked examples, where the instructor models a step-by-step approach to the task at hand, or through process worksheets that lay out the steps in the scientific method so students can follow them in an orderly fashion (Kirschner et al., 2006, pp. 79-80).³

Kirschner et al. (2006) include discovery learning, problem-based learning, inquiry learning, experiential learning, and constructivist learning under the category of “minimally guided approaches” that, they say, simply do not work: “The past half-century of empirical research on this issue has provided overwhelming and unambiguous evidence that minimal guidance during instruction is significantly less

³ The goal-free effect emphasizes that students should not have to chart their own course to achieving a goal—not that goals are themselves a problem. It is a sound pedagogical practice to clarify the overall learning goals and alignments of a course, module, or activity (e.g., “This unit will introduce you to basic Spanish vocabulary and grammatical constructions used in a coffee shop; at the end, you should be able to enter a coffee shop, order a beverage, and pay for it”). Doing this helps to avoid learning loss caused by incorrect labeling of information, simple misconceptions, task shedding, or incorrect filtering, and keeps students focused and motivated.

effective and efficient than guidance specifically designed to support the cognitive processing necessary for learning” (p. 75). In so doing, they call into question the conclusions of both Jean Piaget and Lev Vygotsky, whose approaches to learning have proven wildly influential for educational and child development theory over the past century. Piaget was an early proponent of hands-on learning as a key to progressing from one developmental stage to another, and he emphasized the importance of discovery learning, especially for younger children. Vygotsky, though a constructivist like Piaget, emphasized the importance of social influence in learning: for him, learning is a partnership, in which children acquire knowledge and skills by interactions with those close to them. While no CLT researcher has called into question the usefulness of Vygotsky’s or Piaget’s work for understanding child development, when their findings are extended into the classroom, they may lead to less effective pedagogy. For example, during the 1990s, writing center practitioners were urged to engage in “non-directive tutoring,” which involved asking questions and prodding a student to generate his own solutions rather than telling him what to do to fix a writing problem. While this can be a helpful practice for assisting students in clarifying their thought, when students simply lack information about how to address some shortcoming in their writing, there is no amount of non-directional tutoring that can lead them to the right answer. Similarly, many a student has struggled with a group project in which no one possesses the knowledge or skills needed to complete the assigned task: a group of doctoral students in economics likely has outstanding work habits, critical thinking and research skills, and a strong ability to collaborate; however, if with minimal prior instruction, they were tasked with recording a hit song, they would likely fail. There is simply too much skill and know-how that needs to be acquired for them to achieve the outcome, and working together would not help. What they lack—and what CLT has embraced—is an expert to guide them.

The expertise reversal effect describes the way in which the effects discussed above—the split-attention, modality, redundancy, and goal-free effects—will tend to reverse when learners are already very familiar with the topic or discipline at hand. An expert, for instance, will learn better when an explicit goal is stated and she has to construct the steps to achieve it, compared to a beginner, who benefits from a more systematic, step-by-step approach (Kalyuga et al., 2003). Given the pedagogical

landscape through with CLT guides us, this makes sense. An expert is already familiar with a great deal of basic information and processes and thus would find himself suffering from the redundancy effect if these are re-presented in a step-by-step fashion. Moreover, an expert would likely find himself not only disinterested but possibly annoyed if he were to be led through worked examples or asked to fill in blanks. His available cognitive space would fill not with the higher-level tasks and problems that he would prefer to take on, but rather with materials that could prove at best useless and at worst irritating. An expert is one who, by virtue of much repetition, has arrived at what Bruner (2000) calls “the deepest aha”—the fruit of an initial learning encounter and then a return (p. 1). The repetitions that turn novices into experts occur across time (from one class, module, course, or set of courses to another), across settings (classroom, real-life applications, outside encounters with the material) across voices (teacher, other students, media information, texts), and in deliberate reflective or metacognitive moments (Bruner, 2000, p. 3). Experts, already in possession of a deep “aha,” can make connections and find new applications for knowledge for themselves, without the need of an instructor to chart their path.

III. Extra-Curricular Cognitive Load

Cognitive load comes both from within the learning space and from the contents of the learner’s life more broadly—misfiled financial aid paperwork, war memories, and the vicissitudes of everyday life. A student may experience learning loss through failure to attend not because the instructor is a boring lecturer but because the student’s girlfriend just dumped him, because he did not sleep well the night before, or because he is hungry. A student who plays video games for many hours a day may struggle to function in a largely textual online environment, not because there is anything amiss in that environment but because that student has come to expect to interact with technology in a specific way. And finally, a person who routinely scrolls for hours through an Instagram feed will internalize certain lessons about the nature of information: that it is transitory, that it touches and is claimed by people in a variety of complex ways, that it has emotional efficacy, and that it is largely shallow, reactionary, and performative in nature. By contrast, a student who has a stable home situation with minimal anxiety, who engages in a variety of

pursuits and hobbies, and who has a healthy relationship to technology, is in a strong position to learn using the tools that higher education typically employs. Repeated day after day, life and learning patterns wear deep grooves, creating pathways these learners will use again when confronted with a formal scene of learning. Students do not un-learn the lessons they acquire on Tiktok or at the family dinner table; rather, they apply those lessons in the space of the classroom or learning management system.

While no instructor can account for every extracurricular factor that may influence a student's learning, we would do well to remind ourselves that whatever material we present is already competing with each learner's preexisting contextual load. Sepp et al. (2019) describe learning as "a competitive process between individual self-conceptions (i.e., beliefs about how one learns most effectively), situational cues (e.g., instructions and emphases of the facilitator), and individual schemas (e.g., learned strategies for which behaviors and processes are needed to achieve one's goals in this context)" (p. 302). We must understand the learner as someone juggling many priorities, some of them self-generated and residing deep within the core of the individual, and whose attention must be martialled into a productive focus (p. 311). Broadly speaking, load-creating extracurricular factors include the learner's socio-economic status,⁴ strongly held beliefs,⁵ emotional state, desires and motivation, and pre-existing learning habits—not to mention the "life happens" factors that intrude on learning in unexpected ways. Although it is unlikely that an instructor could account for all types of cognitive load students may bring into their learning process, some "outside the instructional space" weight can be lightened by what happens within the classroom. For instance, shaping lessons in ways that approach questions of social class, identity markers, and beliefs as inclusively as possible, creating flexible assignments and ways of approaching

⁴ The socio-economic status of the learner's family affects the extent to which they can successfully self-regulate their learning (Stehner, Schuster, Dicke, Karlen, Wirth, & Leutner, 2020, p. 195). A number of studies have found that poverty impedes cognitive function. For instance, individuals displayed lower cognitive function during periods of the year when they were comparatively poorer than when they were wealthier (Mani, Shafir, & Zhao, 2013), and lower SES has been shown repeatedly to correlate with decreased cognitive function among individuals of all age groups (Hackman & Farah, 2009).

⁵ Multiple studies have shown that learners will often resort to cognitive shortcuts, such as stereotyping, to reduce their own cognitive load in moments when doing so seems desirable (Biernat, M., Korynowicz, D., & Weber, D., 2003, p. 2075).

course content to allow for some differences among learners, and being transparent about the best ways for students to achieve the course goals can reduce the cognitive load caused by students' concerns about whether they belong and can succeed in the course. Similarly, designing content with awareness of the students' motivation and emotional states helps students to manage their own cognitive load and learn more effectively (Plass & Kalyuga, 2019, p. 341).

Motivation occupies a space between confidence and desire; it is a wish to learn to do something new and as yet unattained, and the belief that doing so is possible. A seven year-old basketball player may be willing to practice for many hours a day because he truly believes that he might be the next LeBron James; when that seven year-old stalls out at 5'11", however, though his desire to play in the NBA may remain unchanged, his belief in its likelihood will likely fade—and with it his motivation to practice. Motivation, understood as “the processes that direct and sustain a person's behavior towards learning” influences the extent to which learners maintain cognitive engagement (Plass & Kalyuga, 2019, p. 343; Moreno 2005, 2006; Moreno & Mayer, 2007). Instructors can improve students' sense of self-efficacy (and hence learning outcomes) by increasing the amount of control students have within the learning process (Stark et al., 2018), perhaps by allowing them to choose among a few paper topics, by providing a check-list to help them pace their learning and by reminding them early and often about work that will be due, and by having some flexibility when possible, so that students may not have to sacrifice other opportunities they would have otherwise taken in order to complete their class work (Feldon et al., 2019). Pep talks—within reasonable and realistic limits—can also contribute to better outcomes, as can reminding learners of the value of the material they are studying (Eccles & Wingfield, 2002).

Just as it makes sense to help students increase their motivation for learning, it also makes sense to help them direct their emotions productively for the learning process, as memory can be enhanced and intensified when content is framed with emotion (Zhan et al, 2018). While the role emotion plays in cognition has only recently begun to be studied in earnest (Plass & Kalyuga, 2019, p. 345), four means by which emotion and cognitive load relate have been identified: (1) emotion may serve as extraneous cognitive load, distracting from a task at hand; (2) emotion may affect the encoding, storage, and retrieval

of information, as when a learner's mood affects the way he processes and files information, or when learning happens in the context of an event with emotive content; (3) emotion may affect a learning task's intrinsic load, as when a physician in training needs to learn to manage her emotions as part of learning proper patient care; and (4) emotion may affect motivation and, in turn, the effort a student expends on a learning task (Plass & Kalyuga, 2019). Given that memories with emotional content involve areas of the brain beyond the purely cerebral hippocampus (Phelps, 2004), it makes sense to infuse learning—where appropriate—with emotional content, so as to increase the effort students devote to filing their memories for the long term. For example, asking students to envision themselves in a historical scene, to apply statistics in a context local to them, or to articulate their personal reactions to a character in a story may increase their engagement in the learning activity at hand. Even a technique as simple as using personal pronouns such as “you” when teaching can increase students' motivation and response to the material at hand, as they feel personally addressed (Rey & Steib, 2013). And instructors may be able to create friendly feelings around the learning space by setting an upbeat pace (via lecture tempo, music, or other movement, and by avoiding long blocks of text and other fatiguing means of presenting information), using cheery colors, and maintaining a generally positive and approachable affect. Provided none of these attempts to create an emotionally warm and engaging mood detracts from the learning task, they can assist students with bearing the burden of cognitive load (Plass & Kalyuga, 2019, p. 349).

CLT's overarching pedagogical goal—to reduce cognitive load in order to improve learning—provides a laudable north star for instructional design. At the same time, given the myriad contexts in which students learn and the motivations and emotions they bring to any pedagogical moment, it may be more realistic to describe the work that CLT-savvy instructors do as “guided multitasking.” Multitasking or “task switching,” is governed by two separate executive control processes, one called “goal shifting,” which involves a decision to do one thing rather than another at any given moment, and another called “rule activation,” which involves following a set of rules and assumptions for one behavior or task rather than another (Rubenstein et al., 2001). So, for example, a person in a coffee shop may “goal shift” from people watching to listening to the gossip being exchanged one table over. Or more to the point, a student

may cease to follow classroom “rules” of decorum, which require quiet and attention to the instructor, in order instead to follow social “rules,” which require participation in a live-Tweeted stream of commentary on a campus social event scheduled for the weekend. The ways in which students (or people in general) multitask says a great deal about their values and commitments, what they choose to engage or what they choose to filter. Instructors who understand the role that task management plays in learning can thus help students to manage the many voices that occupy a scene of learning.

Not surprisingly, many of these competing voices come from our primary learning aid: technology. Wood et al. (2012) demonstrated, for instance, that students who take notes with pencil and paper fared far better than did their counterparts who used a laptop, given that technology presented an opportunity for off-task activities that narrowed the range of attention available for the learning task at hand. Similarly, Sana et al. (2013) showed that if students focus on only one primary task, they can direct their attention well and adequately process, encode, and store information. Other studies have found that while students may still be able to learn in the midst of distractions such as instant messaging, they will do so much more slowly (Bowman et al., 2010) and that routinely using information and communication technology while studying has a negative impact on students’ GPAs, likely because the consistent interruptions posed by such technology make advanced cognitive processing and deeper learning more difficult (Junco & Cotton, 2012). The changes that came with education’s technological shift, however, go far beyond the potential for distraction. In the Fall of 1995, when today’s average college professor entered college, the internet existed but was primarily used for email, light Q&A, and activities on intranet systems hosted by individual universities—an electronic card catalog, for instance. If courses had an online component, it was likely something like a web site the instructor had built for the course, a CD-ROM that accompanied a printed text, or a specialized software interface that students would access via a computer lab. For the most part, serious academic engagement still happened in a flesh-and-blood encounter, with students learning in a classroom or lecture hall, conducting experiments in a laboratory, or working through a list of books found after a search through the card catalog or a series of periodical guides at the university library. Recorded lectures, flipped classrooms, web-based simulations, and online

databases had yet to emerge as serious academic resources, and Google was not yet a company, much less a verb synonymous with “finding things out quickly.” A trip across campus to verify something as simple as whether the library had a book was a routine occurrence, and Amazon had been selling books for only one month. In short, in the Fall of 1995, when today’s average college professor started his bachelor’s degree, learning was costly, requiring an investment of time, energy, and effort—but the investment paid dividends in other ways.

As Sparrow et al. (2011) have noted, our collective shift from costly and time-consuming information-finding to low-effort and low-time Googling has brought convenience but, at the same time, an overall degradation in our collective ability to find and recall information. With something as easy as Google at hand, the benefits of learning and retaining information rarely outweigh the costs. Frein et al. (2013) found that those who use technology (such as Facebook) heavily in their everyday lives tended to perform worse on learning-related tasks, even when they are not allowed access to a device during the task itself. They speculated that that heavy usage of interfaces such as Facebook might, through repetition, train users to engage with information in the same way that they scroll through their feed: skimming without an intent to learn or recall. Alternatively, they suggested that applications such as Facebook may alter the cognitive architecture in which learning happens, a position that was supported by other research that suggests that distracted learning leads to storage of information in parts of the brain other than the hippocampus, the cognitive center of the brain. Cognitive load has been created by the very conditions under which we learn.

Given that technology is for many students a non-negotiable part of the learning experience, it makes sense that learners need, to some extent at least, to find ways to manage their own cognitive load (Mirza et al., 2020, p. 157) and to take responsibility for their own learning within an interface that may discourage deep engagement (Eitel et al., 2020, p. 171). Some pedagogical theorists have argued, in fact, that educational institutions should take on the burden in instructing students in the skills of managing cognitive load and learning strategies, along with more traditional academic content (Stehner et al., 2020). Given that a typical instructor in a college-level class will likely not have time to engage in sustained

instruction related to cognitive load management (and, to be fair, neither is that instructor likely to be an expert in it), institutions as a whole may thus choose to introduce instruction in CLT in a freshman seminar or orientation course. Beyond this, within courses in various disciplines, cognitive load can be addressed indirectly through activities such as metacognitive reflection and learning checks. When built into a structure of feedback and interaction, metacognition provides an opportunity for an instructor to see if students have failed to grasp any content, where their anxieties may lie, how they understand and approach their own learning process, and if they have understood how to file their new learning properly. Examples of productive metacognitive activities may include asking students to do any of the following: (1) to provide a few sentences of summary of the content of a session or learning module, perhaps by having them write on an index card, send an email, or respond to a survey; (2) to ask one good question based on the information they just learned; (3) to re-explain a concept or term to a classmate; (4) to reflect on what was gratifying and/or disappointing about their performance on an assessment; or (5) to make suggestions to the instructor, with a strong rationale, about better ways to present the material the next time. Metacognition, while not itself a means to reduce cognitive load, makes an investment in the long-term learning process, providing both instructor and student with opportunities to revisit, tighten, and improve on the initial encounter with new information.

Like the brain itself, cognitive load is a complex and multivalent concept that can quickly grow unmanageable if as instructors and course designers we attempt to exert perfect control over students' learning processes. Some instructional design principles remain constant across delivery formats and levels of students, however: (1) reduce intrinsic load by presenting content in a step-by-step manner that is appropriate to the learner's level of expertise; (2) reduce extrinsic load by eliminating distractions and unnecessary information and by using techniques that encourage focus and attention; and (3) increase germane load by using strategies designed to help students transfer information from short- to long-term memory, such as presenting information in both verbal and visual modes, increasing students' motivation and emotional engagement, revisiting and reflecting on information, transparently presenting the course's and learning activity's organizational scheme, and engaging in behaviors that encourage students' well-

being. These address only content that lives in the learning space, whether a physical classroom or online. However, the same principles can be expanded to the level of the institution as a whole, thus reducing the load a typical student carries into any particular class. A typical faculty member cannot solve a freshman's financial aid issues or a veteran's discomfort with a discussion board conversation, but the university for which he works can assure that resources are accessible enough to help these students navigate the choppy waters of higher education.

IV. Some Broader Applications of CLT

Any student's educational journey will have moments of unusually high cognitive load. A calculus class may present high intrinsic load for a student who struggles with math; a student may fall ill with a stomach flu and spend two days in bed that he had planned to spend working on a project. During any given semester, a student may find that exams pile up during particular weeks or that life is simply happening. While typically a college or instructor cannot plan ahead for all such instances, careful and sensitively composed campus policies that shape the campus experience not in silos but as a whole, that seek to take a hospitable and welcoming tone, that prioritize clarity and transparent communication, and that seek to help students focus on what they came to do—learn—can do much to help. So also can helping students to understand where their resources are—support services, human connection, and otherwise. Thus, instead of “data dumping” every piece of information an incoming freshman might need to know during a two-day orientation scheduled two months before she starts classes, a university might consider providing a mentor figure—a peer, an adviser, or both—and developing a year-long onboarding communication plan that delivers in-time information, chunked appropriately. A college might consider offering workshops on study skills, time management, and reducing distractions, while also providing dedicated study spaces for younger students transitioning to college for the first time. A college might consider presenting its own “how to” materials (how to find accessibility resources, where to get counseling, how to buy football tickets) in multiple formats and in ways that engage students' attention.

Beyond this, institutions would do well to ask questions about wayfinding: how students get from point A to point B, both within the learning space and beyond it. On the physical campus, do students know where to go to find what they need? Are campus maps up-to-date and accessible in multiple formats? Can students find descriptions of what happens in each space? On the web site, are guiding resources such as the Course Catalog, Student Handbook, and department pages easy to find, navigate, and understand? Within the learning space, is there is a consistent way that courses are set up, so that students do not have to look in a variety of places for standard course components? In short: students should spend less time looking for what they need than using it. Of course, making improvements in wayfinding might drive a university-wide project of significant size. Updating the learning management system interface so that students entering Canvas or Blackboard in one class find a similar space to what they found in the previous one, for instance, will likely require cooperation among the faculty, IT, student success and teaching and learning offices, instructional designers, and student support offices—not always an easy thing to accomplish on a campus with a multitude of structural silos but an effort well worth the investment it takes.

Terminology and nomenclature provide another area of cognitive overload for many college students. Do students know what the names of offices on campus mean; for example, how does a student learn the differences among Financial Aid, the Bursar, and the Registrar? When office names change to reflect industry practices, does clarity suffer?—e.g., when mental health counselors are now located in the “Office of Well-Being” and when disability accommodations can be sought through the “Office of Accessibility and Inclusion,” do students who may not yet know the updated terminology have a quick way to find out where to go for the help they need? Does the campus employ acronyms more often than is helpful? Do front-line personnel around campus know the names of the typical processes, resources, and offices that students consult, where to find them, and what they do? Within the learning space, do faculty and academic support staff employ consistent terminology (e.g., “syllabus” versus “course chart” versus “course outline” versus “course schedule”) and use boilerplate verbiage when possible? In short: campuses should describe themselves in ways that assume little to no insider knowledge.

Discussion about accessibility ought to include as a high priority ADA-related design issues, as well as larger “access” questions about the everyday difficulties the student encounters in performing typical education-related tasks. For example: do students need to visit multiple offices or obtain multiple wet signatures to file a single form? Do they need to peruse multiple documents to find a relevant policy or procedure? Will a student visiting an office be given the run-around when that student’s problem is very easy to solve? In general, institutions should ask questions about how user-friendly their services and resources are and whether faculty are accessible in a meaningful sense. For example, can students access resources and services at times that make sense for their schedules and mode of study? Can a student who works full-time and is enrolled in a fully asynchronous program make person-to-person contact with a campus support office or instructor? Does the institution work to help students know what deadlines affect them and what to do to prepare (e.g., FAFSA filing, grade appeals, registration), so that the services they need are available at the right time? Within the class, do instructors proactively accommodate learning differences? Do instructors feel authorized and encouraged to work individually with a student who may need some flexibility with deadlines or assignment requirements? Are instructors sensitive to major campus events or holidays that may be occurring when they schedule major assignments? In short: campuses should think broadly about what students need—times, accommodations, delivery formats—to be able to access courses, faculty, student services, and other resources.

In addition, institutions should reflect well on how they manage communication to students, such that messages are timed appropriately, accessibly worded and formatted, and delivered in ways that students are likely to hear. Communicating effectively, of course, is easier said than done. Do students receive an overwhelming number of all-campus emails, and do they frequently find irrelevant-to-them university-initiated communication in their inbox, their text messages, or elsewhere? Is messaging consistent across the campus, and are communications scaffolded appropriately? For instance, if the Registrar’s Office distributes information about a student’s inadequate progress toward degree and Financial Aid distributes a message about the appeal a student must undertake to keep his federal aid, do the two offices work together on a communication plan, and are the messages consistently worded? Are

messages delivered in accessible and appropriate ways, and does the medium suit the content? Within individual courses, do instructors use a variety of methods of communicating with students, including official documents such as the course syllabus, announcements, and personal outreaches? Are there guidelines for how quickly faculty and staff should respond to student queries and other submitted paperwork? In short: communication needs to be strategic, with clear guidance for timely, appropriate, and effective messaging.

Socioeconomic factors may serve as significant sources of additional cognitive load for students. Students who arrive in the higher ed space after four years in a selective private high school, for example, are likely to find some elements of transition easier than will a classmate from an inner-city public school, a recently discharged veteran, or someone who has been in the workforce for a few years. Are campus financial and socioeconomic expectations—even implicit ones—clearly communicated to students? For example, will business majors need to be prepared with formal interview-ready clothing during a particular semester? Do students need a car to be able to navigate to and from the campus? Will online students struggle to complete all their coursework if their only device is an iPad? Will students be required to supply additional materials, travel to and from campus or other locations, or spend significant funds to remain enrolled in their program? Is there an unofficial “dress code” for campus? Beyond this: what might a typical student expect to spend to participate in a campus’s extracurricular offerings? If, for example, 40% of the undergraduates on a particular campus join a fraternity or sorority and another 40% play a sport, what will a student sacrifice who chooses to work a job rather than rush or play a sport? In short: given the already steep financial commitment that college entails, students should receive transparent information about other costs that may affect a student’s ability to participate fully in their program or campus culture.

Finally, interpersonal support systems, or lack thereof, can significantly affect the amount of cognitive load a student bears in any given day. While it is beyond the scope of most colleges to attempt to engineer friendships among students, they would nevertheless do well to offer students a chance to get acquainted with one another, meet other students in their major, and establish formal relationships with

“go to” people. What resources are in place to provide interpersonal support to students who struggle with, for example, eating disorders or mental illness? How do students meet their academic advisers, other students in their major or incoming cohort, and key contact people in different student support offices? Do students know what people will serve as their front-line contacts for everyday Q&A (“Do we have someone in the library who can help me with APA formatting?”) or any concern they may have? What opportunities are in place for students to connect socially or to meet people with similar interests? In addition to this, what is the campus as a whole doing to promote inclusion, civil discourse, and communal feeling? Do students who disagree with a roommate, with a classmate on a discussion board, or with a political statement made by a faculty member have safe ways to process their reactions? In short: students should know that they are not alone.

The Spring of 2020 provided us all with a master class in the effects that cognitive load can have on student success, as well as—in some cases—hard lessons about how unprepared our campuses were to help students bear that weight. Besides the obvious academic effects of the pandemic,⁶ people in general expressed collective struggles to be productive, to think clearly, and to maintain a sense of control and well-being amid great disruption. The BBC examined the cognitive load implications of pandemic realities such as shifting (or non-existent) habits and routines, juggling multiple tasks and commitments (such as having children learn from home while Zooming a class meeting), concerns about the availability of consumer goods such as toilet paper, challenges with navigating information overload (or in many cases, *misinformation* overload), and fears related to health, unemployment, and economic uncertainty (Jarrett, 2020). Even something as simple as having to Zoom a class meeting that would previously have been held in person contributes to increased cognitive load because of the intense amount of eye contact required in that format, the challenges of constantly being able to self-observe, the inability to move around, and difficulties with reading visual cues given the latency time and lack of camera quality that

⁶ The disruption caused to math and reading scores for students at the K-12 level as a result of the pandemic was larger than what was observed as a result of other disruptions such as natural disasters (Kufeld, Soland, & Lewis, 2022).

characterizes most Zoom meetings (Bailenson, 2021). Given all these new phenomena, it is no wonder that many of us struggled with “brain fog.” On the other hand, imagine how much more easily a student studying on a CLT-aware campus might have made this transition. If the LMS is already set up in such a way that the student knows where to go to find information and contact instructors; if campus communication channels work steadily and reliably in a format that makes sense; if campus offices have already established relationships with students who need them; if students know whom to contact with questions and if those helping personnel are already prepared with relevant information—then this is a campus that is ready to weather a disruption.

Even now, with the pandemic to some extent behind us, cognitive load continues to show up in new and unexpected ways on campuses, such as general anxiety resulting from the highly charged political environment in the U.S. currently. In addition to the flood of media coverage from all positions on the political spectrum mocking “woke” young left-leaning students, deriding the bigotry of the right, or something between the two, there has grown up a cottage industry in rehashing on social media any shame-inducing moment, ranging from serious moral failures to the accidental and harmless blunders of everyone from A-list celebrities to everyday people who happen to visit Wal-Mart. To wit, a subreddit called AITA (short for “Am I the Asshole?”) with more than 4.6 million subscribers, gives users a space to ask about the propriety of their own actions and invite judgment from fellow subscribers—yet many of the posts clearly have as their end game a general crowd-shaming of whoever the other character in the story is. Who, for instance, is going to criticize the behavior of a poster whose question reads as follows: “AITA for my reaction when I learned that my fiancé returned my wedding dress and replaced it with the one his mom picked for me?” Public shaming rituals create fear, and the possibility of such affects the way students approach learning. A 2021 survey indicated that more than 80% of students have self-censored as they interact at their colleges, and two-thirds of students say that it is acceptable to shout down a speaker with whom they disagree to prevent them from speaking on campus (College Pulse, 2021). In this context, asking a student to comment in class or on an online discussion board requires the student to perform a complex mental calculus, weighing their own thoughts against any possible reactions

from those who may feel offended or triggered. While no responsible instructor wants to authorize hate speech in a learning space, some allowance for ideas to be exchanged, mistakes to be made, and various viewpoints to coexist without fear is both a precondition of civil discourse and a key way of making sure that students' learning does not bear more cognitive load than is necessary (Goodman, 2022).

A campus and faculty who consider well the sorts of burdens that students are already bearing and who do what they can to help those burdens to feel a bit lighter will, in turn, find that students learn better, as they have improved the learning process itself and worked actively to increase students' sense of well-being. When a student who needs an accommodation for a learning difference and who deals with stress-induced anxiety encounters a curriculum that has been developed with ADA-compliant design choices, resource links in every class that provide up-to-date information about student services, and an adviser who checks to make sure the student has not encountered any problems with paperwork or bureaucracy, that student's chances for success improve dramatically, if only because the student is free to use her cognitive space for learning new material rather than for navigating the university bureaucracy. Similarly, an instructor who takes the time to remind students of an upcoming deadline, make some careful and efficient suggestions about how to approach an assignment, and send a well-wish to a student who misses a class meeting because of illness is likely to find that student does not take the roadblock that illness presents as indicative of a coming failure in the class: rather, the strong schema the instructor is helping to build, combined with the sense of emotional well-being that comes from a caring gesture, sets the student up to be able to concentrate well enough to complete the task at hand. Cognitive load awareness pays heavy dividends for instructional design—especially when the “instruction” that campuses seek to deliver addresses the whole of the college experience.

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