Miller's Lens on Attention, Memory, and Thinking

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Introduction

Dr. Michelle D. Miller breaks down a multitude of learning theories and practices in her book *Minds Online: Teaching Effectively with Technology*, organizing an abundance of information and research into easy-to-follow strategies for an educator to apply to their profession. In my professional work as a Healthcare Educator, I do complete education in person but often develop digital learning modules for distribution through Learning Management Systems and web environments. My student base is healthcare workers who are actively employed in their field and are often required to complete continued education credits on a regular basis to maintain their professional certifications. Online courses that include continued education credits are used most frequently as they are easy to fit around job responsibilities vs. an in-person course and can be tracked through digital certificates and receipts stored in your email or profile on a specific educational website. Most of the strategies Miller proposes were developed for application through technology and a digital environment, and many are applicable to my professional environment and not restricted to K-12 and post-secondary learners.

Miller on Attention

In Chapter 4 of *Minds Online* (2014), Dr. Miller opens with the summative statement that "attention is limited". She continues to review the cognitive psychology behind attention and how that impacts memory and student performance in a learning environment. Miller discusses the relationship between memory and attention and states that "we remember very little in the absence of focused attention". She offers examples and definitions of factors that may add to inattention; touching upon inattentional blindness, multitasking, a lack of focused "targets" to keep the students engaged and working towards a specific goal, or environmental factors that

encourage student attention to shift. Miller then introduces the reader to the cognitive concept of working memory, which is interconnected with attention in a manner that it does have to be introduced in this chapter, while further detailed in Chapter 5. Across many research studies, a strong correlation has been drawn between attention and working memory to the point where they may actually be forms of one another (Varao-Sousa 2018; Long, Kuhl, & Chun 2018; Oberauer 2019).

Oberauer (2019) defines working memory using the more traditional theory of "the mechanisms and processes that hold the mental representations currently most needed for an ongoing cognitive task available for processing." Miller defines working memory within the context of attention and writes "attention directs what is going to be held in working memory – i.e.., information that is critical to accomplishing one's goals at the moment – and keeps that information readily available…thus, working memory and attention are constantly playing off one another, selecting relevant information and keeping a small amount of that information in the 'ready' state." (Miller 2014). Carter (2016) offers five steps to build working memory skills in students, applying theory to practice in an easy-to-implement format: 1. Make the problems clear. 2. Prioritize knowledge retention. 3. Break it down. 4. Make the implicit explicit. And 5. Pre-teach where possible.

With this cognitive base defined, Miller offers four strategies for an educator to consider in encouraging student attention, and thus learning.

Strategy 1: Ask Students to Respond. Miller (2014) writes that attention is all about matching resources to goals – if the students have a goal or a target that they are working towards in the short term, they will pay attention to achieve that goal. This short-term goal can be achieved simply by designing activities that encourage or require a student response. In online learning, this can be done by setting up questions, simulations, synchronous cooperative activities, or using learning management system tools that offer students instantaneous feedback to their interactions.

Strategy 2: Take Advantage of Automaticity. Miller (2014) defines automaticity as a state where individuals can perform certain tasks with less active attention – "automatically" – after practicing these specific tasks, even when multitasking. This skill does not translate to other tasks not included in the practice, but does remove some of the cognitive draw when performing that particular task. Automaticity is, in essence, a direct application of attention (Logan, Taylor, & Etherton 1999). Miller endorses online learning platforms as great ways to have students engage in the same practice activities multiple times over, offering either mandatory or voluntary practice activities where students are engaged in completing tasks. Repeated encoding of course material (through studying or repeated practice), has a measurable benefit to the students' ability to retrieve/recall the information later (Long, Kuhl, & Chun 2018).

Strategy 3: Assess Cognitive Load. Miller (2014) opens discussion on this strategy with a definition of Cognitive Load Theory: "How learners allocate working memory and attention resources during learning". Cognitive Load Theory is split into three subparts, each used to define the origin of a particular addition to cognitive load – intrinsic, extraneous, and germane.

Intrinsic cognitive load is defined as the amount of working memory required to juggle the various aspects of your learning experience. Extraneous cognitive load is the cognitive load imposed upon the learner by the methods in which the learning is being delivered. Germane cognitive load refers to the working memory required to encode new information. Extraneous cognitive load is seen as the only one of the three that can be impacted by educators, with a goal of net zero cognitive load coming from the educational design. Miller offers an example in completing a low-stakes introductory module in an LMS to familiarize students with the system itself, so difficulties learning the LMS will not take cognitive resources away from the lessons later on.

Strategy 4: Discourage Divided Attention. Miller (2014) begins the discussion of this strategy by reiterating her statements from this chapter that attention and memory are interconnected., She summarizes that "attention is the foundation for all the cognitive processes we want to promote as educators, especially memory." She states that as educators, we need to design our digital education to be seamless, fast-paced, and we need to focus on methods and practice that removes any extraneous cognitive load from the students to encourage as much attention as possible to the taught content. Fisch (2017) also offers suggestions to streamline children's education when designing educational media. He discusses how to arrange narratives and educational content to limit cognitive load, as well as the effectiveness of gamification in a digital medium.

Miller on Memory

In Chapter 5 of *Minds Online* (2014), Miller builds on the cognitive science of Chapter 4 and moves right in to how these theories and techniques are applicable to learning design. She

introduces the chapter by saying that memory theory is essential background to have because "technological tools open up ways to take advantage of memory principles in ways we never could before." These theories are applicable not only to the content, but also the user interface and how technology is leveraged to deliver the most efficient learning experience (Owen 2019).

Memory principles have gone through many definitions and conceptual models across the industry and throughout the years (Engle and Cane 2004; Oberauer 2019; Miller 2014), but on a high level there seems to be consensus on a constant relationship between attention and working memory, though how they interact with one another and inform long-term memory is highly unique to the individual and how the learning was performed (Long, Kuhl & Chun 2018; Engle & Kane 2004; Miller 2014). In all research reviewed for this paper, the concepts of *encoding*, *storing*, and *retrieving* memory representations are utilized and form the basic framework of how memory functions and is strengthened through intentional choices in education design.

As in Chapter 4, Miller uses a list of strategies for educators to apply the knowledge gleaned from this chapter to their educator roles.

Strategy 1: Include Frequent Tests and Test-Like Activities. The Testing Effect has found that the mere act of answering test questions improves the likelihood of remembering that information later (Miller 2014).

Strategy 2: Structure for Spaced Study. The Spacing Effect (also called distributed practice) is a supported theory that multiple study sessions with breaks in between are more effective than an

extended review session or cramming when it comes to long-term memory and learning. Cramming or designing an educational experience that encourages high-stakes or infrequent engagements with the material may not impact immediate test results as this material is still encoded into short term memory, but will negatively impact long-term learning (Miller 2014; Engle & Kane 2004). Technology can also be utilized to provide easy and immediate access to study tools from any location or device to make it easy to repeat study (Walsh 2019).

Strategy 3: Involve Emotions. Including emotions in learning enhances the student ability to understand and connect with the learning material. Though negative emotions are a stronger programmer of memory than positive ones, eliciting a stress response from students is likely not the most ethical way to connect the learner with the material. Miller (2014) summarizes these points in a high-level overview, and Wolfe (2006) explains that there are measurable biological responses in how emotions interact with brain chemistry to promote learning. Miller encourages a careful attention to inspiring an emotional connection from students by using technology to connect the students with real-life experiences and collaborative interactions.

Strategy 4: Steer Students Into Deep Processing. Miller (2014) writes that students will default to shallow processing without truly making meaning from the material unless the instructor designs educational activities to push the students towards deeper processing and analysis. This can also be done by connecting the material to the real world, to personal experience (emotion) or prior knowledge, or by providing activities that apply new material to concrete experiences or problem-solving (Wolfe 2006). Miller breaks Wolfe's concept of application to prior knowledge out into its own strategy, listed next.

Strategy 5: Base New Knowledge on Old Knowledge. Miller's last strategy ties into Wolfe's 2006 article and Strategy 4, with both authors stating that memory won't fully engage in the absence of meaning and relevance. Wolfe (2006) writes that "the brain searches its existing networks to find a place where the new information 'fits.' If there is a match, we say the information makes sense, or is meaningful. If there is no match, then the information is, from the brain's perspective, nonsense." This is a constructivist perspective and is often called "scaffolding of knowledge" and has the potential to be highly personalized to each student and learning experience (Miller 2014).

Miller on Thinking

Miller (2014) defines "Thinking" as engaging in higher-order thought processes, also explained as "extending what [students have] learned to new situations." Traditional research has broken thinking down into the categories of formal reasoning, judgement/decision making, and problem solving. Digging deeper into those areas, the core of higher thinking is often discussed and analyzed through examples of *transfer*, *critical thinking*, and *metacognition* (Halpern 1998).

Miller (2014) defines transfer as "how we get students to take what they've learned and apply that knowledge to new domains, problems, and situations" while defining metacognition as "one's own insight about learning and ability to self-manage the learning process." Critical Thinking involve a number of cognitive processes and requires the student to not only dissect the underlying structure and principles of a new problem they encounter, but apply prior knowledge to the current problem to determine the correct course of action – reflective of transfer and also

the memory strategies discussed earlier. This is seen as a necessary skill for students and adults in every context (Marczak 2019). It is also theorized that the student must *choose* to use critical thinking as well as be able to use it in the first place (Miller 2014; Halpern 1998).

Strategy 1: Assign Students to Practice the Thinking Skills You Want. Miller (2014) discusses a number of digital resources designed to facilitate critical thinking activities and promote the development of critical thinking skills. Interactive activities using software designed to promote critical thinking include a multifaceted approach that includes media in all its forms (images, audio, interactivity) to attend to varied student needs and promote learning and critical thinking (Fisch 2017; Marczak 2019). These technologies play into the next strategy as well.

Strategy 2: Set up Varied, Realistic Scenarios for Reasoning. Miller (2014) encourages the application of real-world scenarios to promote student learning. We already know that adding meaning to educational activities promotes learning (Wolfe 2006), so problem-based learning is a logical extension of making meaning. Problem-Based Learning involves "assigning students an open-ended, ill-defined problem situated in a realistic context" (Miller 2014). The students collaborate in small groups, facilitated by the instructor, to follow an organized path to analyze and determine the best way to address the problem. Case Studies are another way to bring students through a similar process, but the format for analysis is a bit more freeform and dependent on the instructor (Miller 2014). These collaborative concepts translate well to online learning with the number of collaborative technologies available for students to use in real time.

Strategy 3: Use Analogies. Analogies are a great way to connect educational material with preexisting knowledge to encourage learning (Miller 2014; Wolfe 2006), and an online environment provides a surplus of multimedia and replayability. Miller (2014) warns that using analogies requires an intentional mapping of how the information translates to account for any discrepancies in student experiences that might not draw the connections as intended,

Strategy 4: Use Discussion to Build Thinking Skills. Discussion is a core aspect of online education environments as it plays into so many of the topics discussed in this paper. Online learning builds a human connection between students, and between students and material. Learned information is extended to critical thinking discussions and responses to classmates, and new perspectives are exposed. This may even be the most important aspect of online education as it ties so many concepts together under one practice and can be easily moderated by the instructor (Miller 2014).

Reflection

In the Healthcare education profession, education tends to fall under two major categories or methodologies. The first is what most people think of when they think of medical education – training and clinical degree programs for Nurses and Doctors marked by a hybrid learning program composed of classroom studies, multimedia simulations, and patient-facing internships and residencies. The lesser-known side of medical education is the significant number of Allied Health positions that encompass various certification programs that prepare a healthcare worker (HCW) for a certification exam. Once the exam is passed, the HCW usually receives a title that includes "Technician" and is eligible for employment in a certified healthcare position. Think of

the Phlebotomist who draws your blood for testing, the Radiologic Technician who conducts your xrays, the Pharmacy Technician who retrieves your prescriptions and offers you consultations on how to take them, or the Medical Assistant who checks you in at your primary care office and takes your vitals. These are all certified Allied Health professionals. In many states, such as Massachusetts, achieving this certification is required before you can even be hired into the Technician position. Certification generally requires completion of a Technician training program which varies widely based on the certification you are going for and the industry requirements for working in that capacity. If you will have direct patient contact, for example, you will likely be required to complete an internship before you are eligible to sit for the certification exam.

The defining factor of all these health professions, no matter how complex the initial certification or degree was, is the industry expectation that you must complete continued education (CE) credits to maintain your certification. This is not always the case with other industries, such as IT or Business, where you may pass a certification exam and then you keep the certification indefinitely. This is where my role comes in.

I work as a healthcare educator. I have worked within a hospital and been responsible for developing training for hundreds of staff members, and now I work for a medical device manufacturer and educate HCWs on appropriate use of our medical devices. There are two methods which I have delivered CE training: In-person classroom/hands-on training and competency assessments, and by creating digital education modules that are delivered to staff using a corporate LMS. Much of my education is for CE training, but I have also developed

policy and procedure training or similar education programs that are informational in nature and may only require notice of completion or a trackable acknowledgement that the staff member has viewed and understood the education material.

I think that Miller's strategies under Attention are probably the most applicable to my work, as I am often giving education in the middle of the workday with the learners coming in and out between patient care and work duties. In many cases, when I am doing in-person education I am there to review a practice that all the staff have already been trained on. Industry-wise, the expectation is that competency assessments or review education will be performed every 1-3 years to ensure staff are up to date with the technology and equipment. There are no "targets" or "goals" for the education aside from making sure folks remember how to perform the tasks correctly. The staff interact with the equipment and processes on a near-daily basis, meaning their working memory is generally in place through repetition, but their attention is not.

Miller's (2014) first strategy of Attention is "ask students to respond" which is the most heavily-used technique in my arsenal for these in-person sessions. It coincides with her strategy of discouraging divided attention in that I set up my learning environment with as little distractions as possible and actively engage with the learners. The staff should be familiar with the process as it is written, but there are minor changes in ancillary equipment and alternative processes that vary by facility – so I tend to ask "what's the next step" or "what do you do when x situation happens" as part of my education. It keeps student attention and also engages them when I ask directly. Miller's second strategy involves automaticity, which is harder for me to do in these review education sessions. When I am doing hands-on training, I will have the learners repeat the

physical actions after I have shown them the proper way to do it, and also engage them on how they do it themselves to make connections between the repetitive history of performing the task and the material I am presenting. Miller's strategy addressing cognitive load is less applicable to in-person education since I am normally reviewing material for the staff and only occasionally build upon their existing knowledge, but the information is rarely new or without context for staff members. If the information is new, I will change the delivery method to a hands-on one-on-one interaction where I work with the staff member to go through the material without the additional distractions or pressures from experienced staff looking to get their signoffs and go back to work.

When I am designing online education for staff, the approach is somewhat similar, but I have to use technology to encourage interactions with the education since I am not there in person to encourage interactivity through questions and reading the temperature of the group. I still integrate questions or knowledge checks throughout the module to promote active engagement, but I do need to include an assessment method within the education that can be recorded and graded for CE approvals. This is generally in the form of a quiz at the end of the lesson, since the healthcare industry requires an explicitly quantitative measure of learning that are approved by the certification agencies to attach CE credit. The class discussions on LMS were helpful in discussion the methods an LMS can assist with promoting student engagement, and I am looking forward to exploring screencasting as a more personal method of connecting with my student base across a digital format – especially with the explosion of Covid-19 distance learning,

Miller's discussion of Memory applies more strongly to the digital education that I create, since that is often used for training staff on new processes or familiarizing staff with procedures they do not complete regularly. Including regular knowledge check questions interspersed within the education strongly supports Miller's first strategy and the testing effect. Spacing is a bit harder to implement in a self-contained learning module since staff will not go back to the module after they complete it. This means information has to be regularly revisited within the education itself and the focus shifts more towards scaffolding. Linking out to a resource collection site such as Diigo or a collaborative community like a Wiki might be a great way to give the staff a way to reconnect with the education content after completing the module – a single location for resources and references is the kind of thing they may remember and look for when searching for answers to problems or scenarios experienced in the workplace. It's far easier to remember to go to a website and look for an answer to your problem when you know the website contains relevant materials for the topic at hand. Emotions and Deep Processing are integrated into the education thorough critical thinking problems designed to reflect the types of situation a learner will encounter in their professional role, which is a learning design area that I am weak in and enjoyed reading further into. Most of my education tends to build on prior knowledge, so Miller's last strategy under Memory is another that I heavily use.

All the strategies in Miller's Thinking category are easily utilized in my in-person education sessions, but discussion is much harder to include in the online delivery systems. Unfortunately, with these self-contained education modules, there is no discussion component since they are entirely asynchronous. When I am running an in-person training, the staff can discuss what I say among themselves and also seek clarification from me. I use analogies frequently to connect

complex concepts in the education to a more familiar everyday experience. It's very common for staff members to ask me a question and have the other staff members answer, or express that there is some component of the education that they do not complete or are not familiar with. In these situations, I can bring the staff together and also cover how things should be done across the board. I would like to include discussion more heavily in my elearning modules but am not entirely sure how to include that in my profession.

Closing

Miller's format of offering actionable strategies for educators is a fantastic way to apply theories and research to our own education design. When completing a degree program at Northeastern, students are usually enrolled in the program while working fulltime and attempting to learn new practices and apply them to their work in real time. A resource that aggregates research and theory into a checklist, like Miller does, is extremely helpful for busy people. In the same vein, Diigo was very helpful for this paper because it allowed me to go to one single site and procure references that applied to my content and only look outside Diigo when I could not find a reference that fulfilled my needs. With so much information available online, organization and single-source references streamlines our ability as professionals to collect information and learn ourselves, which in turn expands our skills as educators.

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