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Human Learning, Memory, and Student Development

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My educational interests have largely been informed by my career in the sciences and medicine. My professional education has been both formative and transformative, opening doors to the joy of learning and a realization in the importance of memory. As an educator, clinician, and student, I have been greatly impacted by issues of curricular design, curricular development, learning and memory. My current responsibilities in student affairs also have exposed me to the delicate balance between student development, curricular design, learning and memory. Patton, Renn, Guido, and Quayle (2016) noted the importance of educators being able to use different literature sources and concepts in their daily interactions with students. In addition, Patton et al. (2016) further emphasized the importance of literature in guiding professionals in the development of curricular and related policy changes.

Underpinning student development issues is the notion that the goals of education are ultimately tied to memory and learning. Atkinson and Shiffrin (2016) noted that “it is hard to imagine how understanding memory could not be important....memory is what we are, and what defines us as individuals” (p. 115). Atkinson and Shiffrin (2016) further noted how our memory system is divided into structural components and processing components that work together to create a retrievable memory. This simple fact has played out in my professional life as I have provided care for patients with

dementia or other memory destroying processes; witnessing the person, father, mother, brother, sister, son, daughter, and friend literally become unrecognizable cognitively.

In higher education we understand that learning and memory are symbiotic but not synonymous. Illeris (2018) noted that learning can be defined broadly as any process that leads to “change” and is not solely related to maturation or aging (p. 7). In higher education however, we are more interested in managing student education through the manipulation of learning acquisition and student-environment interactions (Illeris, 2018). Memory is an ill-defined event, which happens in our brain, and is impacted by many external factors (Roediger & Wertsch, 2008).

In this paper I will explore issues of student development, human learning, human memory, and how these concepts should inform higher education’s approach to curricular issues and design. I will explore unique learning and memory concepts to provide a better understanding of the many facets of memory and learning. Additionally, I will survey ideas on curricular design that could incorporate important learning and memory concepts.

Student Development

Patton et al. (2016) noted, “student development theory now incorporates a half-century of research and professional practice with college students (p. 17). Student development categories of interest include social identity, psychosocial development, moral development and cognitive development, which I would argue would encompass learning, memory and ultimately student success (Patton, Renn, Guido, & Quaye, 2016). Arum and Roksa noted a concern of whether undergraduate students are “learning enough in college and whether institutions of higher education are teaching foundational skills effectively” (as cited in Kilgo, Sheets, & Pascarella, 2015, p. 509). Kilgo et al. (2015) demonstrated that “active and collaborative learning and undergraduate research were consistently significant, positive predictors for nearly all of the liberal arts educational outcomes” (p. 521). Kilgo et al. (2015) closed their research with the observation that “future studies must continue to research these practices to uncover additional empirical evidence to compare to the plethora of anecdotal assertions that these practices have vast benefits for student learning” (p. 523). What I found interesting is that little mention was made of how these innovative teaching practices

and activities may be superior vehicles in promoting enhanced memory and learning processes.

The goal of student development theory is to help the educator “provide the necessary scaffolding supports for students as they move through higher education” (Patton et al., 2016, p. 383). Understanding our personal student developmental experiences and how these experiences have shaped our vision of higher education will allow us to gain insight on our strengths and weaknesses (Patton et al., 2016). It is through our own personal understandings that we can hope to see the utility in change and growth along with the use of alternative teaching modalities. In the end, our commitment helps us to engage our students in the challenges related to learning and student development, and allows us to evaluate new technology using the academic lenses of student development, learning and memory (Patton et al., 2016).

Digital Technologies

Digital technologies have become important to the higher education experience. Students and faculty may argue that digital technology is important for both student development and learning. Henderson, Selwyn and Aston (2015) evaluated if paying attention to the digital needs of students holistically enhanced student’s memory and learning. Henderson et al. found that students “most often framed learning as externally imposed and involving the routine acquisition and/or reproduction of transmitted knowledge” (p. 10). Henderson et al. (2015) further noted that digital technology was important in higher education, but that it was best viewed as an external force that impacts learning, and not necessarily a transformative tool that impacts the actual processes important for memory. Henderson et al. (2015) reported that they felt that digital technology could be a useful tool to enhance a student’s own learning and memory, but that unique uses would need to be developed and tested to reach this goal. I believe that digital technologies are tools for the enhancement of student development, but they are not the true agents of change.

Human Learning

Learning is a practice that can best be understood as a theory and process that is influenced by many external interactions between the learner and their environment, which ultimately leads to “an internal psychological

process of elaboration and acquisition (Illeris, 2018, p. 8). Illeris (2018) noted that learning has a content dimension that describes what is learned, and an incentive dimension that depicts “whether the learning is driven by desire, interest, necessity, or compulsion” (p. 10). Roediger and Wertsch (2008) described some of the external forces that impact learning to include politics, law, social media, anthropology, and neuroscience.

Learning Types

Illeris (2018) described four types of learning to include cumulative, assimilative, accommodative, and transformative; each more complex than the former. Cumulative learning is “isolated formation” where one “must learn something with no context of meaning or personal significance” (Illeris, 2018, p. 13). Assimilative learning is “learning by addition, meaning that the new element is linked as an addition to a scheme or pattern that is already established” (Illeris, 2018, p. 13). Accommodative learning implies a type of learning where an individual breaks down an “existing scheme and transforms it so that a new situation can be linked” to the original scheme (Illeris, 2018, p. 13). Transformative learning results from a “crisis-like situation” leading to a “restructuring of a whole cluster of schemes and patterns” “making it necessary to change oneself” (Illeris, 2018, p. 14). Huitt and Hummel (2003) observed that Piaget’s Theory of Cognitive Development noted that assimilation and accommodation are an individual’s attempt to adapt to their environment, an activity described as intelligence that is established during the process of cognitive development.

The process of assimilation is important in both learning and cognitive development, but the question is whether this is the form of learning that is most effective to create memory in higher education. Illeris (2018) noted that young learners primarily use cumulative learning in the first years of life, and that assimilative learning is often used in our education systems. Interestingly, however, assimilative learners find it difficult to integrate knowledge from one subject to another (Illeris, 2009). Illeris (2018) noted that accommodative learning is more difficult and requires more energy, but it also seems to create memory that “can be recalled and applied in many different, relevant contexts;” leading to “something which one really has internalized” (p. 13).

Illeris (2015) further discussed issues surrounding learning in general, noting that learners need to be able to choose their own appropriate learning style based on both internal and external factors discussed. Illeris (2015)

emphasized that these learning types are progressively more complex but that curriculum cannot, and should not, be focused on one style over another. I find this point very important. As educators it should be our goal to meet our students where they are in their learning progression, not where we wish them to exist. Our curricular development needs to reflect the complexities of learning and memory creation, and curricular content and structure should be designed to maximize these complexities. However, I do feel that we need to push our students to be able to become accommodative and transformative learners. I would argue that the ability to integrate unrelated information has life-long value and is ultimately transformative. As a health care professional, my ability to integrate information is what makes me relevant; remembering that everything that I have learned is available to everyone on the Internet. What is not available on the Internet is my ability to integrate unrelated information to solve a new and complex problem. I stress to students that an ability to take unrelated bits of information and create a pathway to problem solving is the essence of the learning process.

Memory and Memory Studies

The concepts of memory seem to be easier to identify than to define. Some of our observations of memory are impacted by personal observations of people who have experienced learning disabilities, traumatic brain injuries, birth injuries, or dementia. Tonegawa, Pignatelli, Roy, and Ryan (2015) noted that “memory refers to storage of learned information in the brain, and is crucial for adaptive behavior,” a concept that would likely be supported by the teachings of Illeris and Piaget (p. 101; Illeris, 2018; Huitt & Hummel, 2003). Tonegawa et al. (2015) further postulated how “lasting memories have long been hypothesized to be encoded as structural changes at synaptic junctions of sparse neuronal assemblies,” a concept we will explore further (p. 101). The end result is varying types of memory that are used regularly, namely declarative and non-declarative memory types (Strickgold, 2005). Strickgold (2005) described declarative memories as those “that a person can call to mind (for example, the capital of France or last night’s dinner), and non-declarative memories, which are those that are normally used without conscious recollection (for example, how to ride a bicycle or how to talk your way out of a parking ticket)” (p. 1272).

My medical background finds the science behind memory very fascinating. As we already observed, memory often defines who we are and how

we interact with our environment. Interestingly though, we understand very little about the process of learning, memory, and memory retrieval; and what we do understand is largely based on animal models and observations of human memory pathology (Clem & Schiller, 2016). In humans, the portion of the brain that appears to be most important for memory is the medial temporal lobe, and in particular the hippocampus, and the memory unit created is referred to as a memory engram (Tonegawa, Pignatelli, Roy, & Ryan, 2015). In 1949, Donald Hebb published his theoretical observations on memory research that has led to various versions of memory storage and retrieval theory (as cited in Tonegawa et al., 2015). “Until 2000, majority opinion held that memories are formed through a one-time process of consolidation, a form of synaptic plasticity requiring new protein synthesis and long term molecular changes” (Clem & Schiller, 2016, p. 340). Clem and Schiller (2016) further observed that under this model, formed memories are stored in an inactive state and then passively recalled. More recent opinion would suggest that memories are formed and retrieved actively, requiring the “synthesis of new proteins and molecular changes to confer long-term memory persistence” (Clem & Schiller, 2016, p. 340).

The importance of understanding how memory is created, stored, and retrieved could have significant ramifications for understanding the learning process (Atkinson & Shiffin, 2016). Roediger and Wertsch (2008) observed that Atkinson and Shiffrin’s (2016) propositions support the need for the creation of a new discipline called memory studies. Roediger and Wertsch (2008) not only discussed the science of memory studies, but also the history and breadth of memory studies, including the numerous external events that impact both learning and memory. Clem and Schiller (2016) further argued that their research supported that “memory can be maintained by secondary substrates in an occult state, where its recovery may be subject to particular behavioral conditions” (p. 344). Interestingly, Clem and Schiller (2016) also postulated that these external behavioral events could impact both memory creation and memory retrieval.

External Impacts on Memory

Sleep deprivation

Scientifically, how behavior affects memory may be impacted by how our environment affects learning. This notion is supported by the observation

that sleep deprivation may impact neuronal engram production during memory formation (Graves, Heller, Pack, & Abel, 2003). Strickgold (2005) reminded readers of his research of the old adage “sleeping on a problem,” as he further studied the connection between sleep and memory (p. 1272). Strickgold (2005) observed that sleep deprivation potentially impacted memory consolidation, which is the ability to produce memory that is resistant to interference, but still able to be enhanced or reorganized. A corollary to this observation is that this process of sleep and memory consolidation may be bi-directional (Strickgold, 2005). Strickgold (2005) observed, “In one major psychiatric illness, at least, one process of sleep dependent memory consolidation seems to be totally dysfunctional;” arguing that the illness’s impact on sleep could be the cause of memory difficulties, which further exacerbated the mental illness (p. 1275).

Prescription stimulant use

Ilieva, Hook, and Farah (2015) researched the impact of prescription stimulant use (methylphenidate and amphetamine) on cognitive function to include several aspects of memory. The authors found evidence for small but significant stimulant enhancement effects on inhibitory control and short-term episodic memory” along with a “small effect on working memory,” all of which was significant (Ilieva, Hook, & Farah, 2015, p. 1070). Ilieva et al. (2015) further observed that the stimulant impact on memory might have been the result of enhanced energy and motivation (external factors) more than improved cognition. In a related research project, Franca, Takahashi, Cunha, and Prediger (2018) found that in patients with attention-deficit/hyperactivity disorder, caffeine might be a therapeutic to improve both emotional and cognitive difficulties. Importantly, Ferré, Díaz-Río, Salamone, and Prediger (2018) observed that the effects of caffeine on cognition might have a biochemical basis and not just a motivation component.

Kuhn’s (2010) research reminded us, “memory is a process, an activity, a construct; and that memory has a social and cultural, as well as personal, resonance” (p. 298). These external impacts on learning and memory should be considered when we develop learning environments and skills, and should also act in informing us on curricular development. I would argue that we should be sensitive to study habits that we either overtly or covertly encourage our students to adopt such as the use of drugs and sleep deprivation.

Curricular Development

My personal medical educational experiences have heavily influenced my attitudes toward higher education and the medical training that U. S. medical students are currently receiving. The University of Nebraska recently implemented a new curricular design, slowly moving away from the traditional teaching environment of lectures in large classrooms to large numbers of students, and toward a student-centered learning environment where the responsibility of learning is placed on the learner. This student-centered learning theory has been sweeping across medical schools throughout the U. S. (Luscombe & Montgomery, 2016). The crux of the student-centered learning theory model is that students must do more than listen to learn, leading to new learning techniques such as flipped classrooms and audience response systems (Luscombe & Montgomery, 2016). Luscombe and Montgomery (2016) noted that movement toward a student-centered learning curriculum assumes that students will embrace these teaching techniques if the students find the material relevant; a problematic notion I would argue. Additionally, Luscombe and Montgomery (2016) demonstrated that students were still highly motivated by tests and assessments, bringing into question whether the students' motivations were internal or externally driven. In the end, Luscombe and Montgomery's (2016) observation were more about student satisfaction than student learning, and little or no mention was made of how adult learners gain useable memory. It is this point that I feel deserves more attention. We know as educators we are able to teach our students to pass a test, but the equally important question is, are we teaching our students to synthesize and integrate relatively unrelated experiences and information to create new learning experiences and memory; an important skill needed for future success.

Spaced Repetition

Kang (2016) asked the question of how we are delivering information to our students, and proposed that we adopt teaching techniques that uphold the old adage that "practice makes perfect" (p. 13). The spacing effect has been described in the literature for more than 100 years, and describes a repetition of similar material spaced apart in time (Kang, 2016). Kang (2016) noted, "hundreds of studies in cognitive and educational psychology have demonstrated that spacing out repeated encounters with the material over time produces superior long-term learning, compared with repetitions

that are massed together” (p. 12). Kapler, Weston, and Wisheart (2015) noted also that students using spaced educational techniques were able to perform better on both factual level questions and higher-level questions. Kapler et al. (2015) evaluated the benefits of the spacing learning process on questions not specifically reviewed and found that their results highlighted “the integrative and holistic nature of the (spaced repetition) learning process” (p. 42).

Previously we observed educator’s desire for students to be able to synthesize and integrate educational experiences and materials. Kang (2016) observed, “spaced review or practice enhances diverse forms of learning, including memory, problem solving, and generalization to new situations” (p. 12). Kang (2016) also explored the issue of transfer of learning which is “the ability to utilize what was learned to answer new questions or solve new problems;” an important real-life skill since seldom is the same information presented to us in identical aliquots (p. 14). Kang (2016) was able to demonstrate the benefits of spaced repetition in the transfer of learning as well. Kang (2016) further stressed, “Testing or spaced practice, each on its own, confers considerable advantages for learning. But, even better, the two strategies can be combined to amplify the benefit” (p. 14).

We have demonstrated the advantages of spaced repetition as a teaching tool to enhance curricular development; another important question is if there is an interval of repetition and testing that works best. This is particularly important for many students, like myself, attending professional schools that are expected to pass a standardized national examination for career advancement. Kang (2016) noted that if you want to maximize performance on a test about 1 week away, then a lag of about 1 day would be optimal: but if you want to retain information for 1 year, then a lag of 2 months would be ideal (p. 14).

Interleaved Practice

Thus far, we have focused on curricular development for information that is presented primarily in a classroom setting. However, many professions require the acquisition of certain motor skills, such as a surgeon or musician. Blocked practice is a process of focused repetition in an effort to master a given skill (Carter & Grahn, 2016). Musicians often use blocked practice routines in an effort to make a given task feel like second nature through increased fluency, however issues of memory retention seem to exist (Carter & Grahn, 2016). Carter and Grahn (2016) described an alternative to blocked

practice called interleaved practice, “which involves practicing multiple tasks concurrently by alternating between them” (p. 1251). This approach to motor skill acquisition uses a technique called contextual interference (CI) (Wright, Verwey, Buchanen, Chen, Rhee & Immink, 2015). Interestingly, CI disrupts performances during the practice routine because of its random nature, but in the long term, CI imparts changes to the brain, in the motor network memory regions, which promotes improved long-term memory storage (Wright et al., 2015). This improved retention also leads to improved transfer benefit, similar to the benefits discussed with spaced repetition (Wright et al., 2015).

It would appear that interleaving practice routine’s use of CI seems to enhance cognitive processing, which ultimately benefits retention in the acquisition of important motor skills (Carter & Grahn, 2016). In the context of curricular development, an interleaved schedule may more closely simulate a real world experience, for instance in an operating suite or in a concert hall where starting over is not an option (Carter & Grahn, 2016). Disturbing for the teacher is the loss of immediate positive feedback when your learner shows immediate motor skill improvement or acquisition as one may see in a blocked practice routine (Carter & Grahn, 2016). CI is not comfortable for the learner, and Carter and Grahn (2016) demonstrated that many students were more comfortable with the blocked practice routine over the more challenging interleaved practice routine. This false sense of motor skill proficiency and fluency noted in the blocked practice routine underscores the need of understanding the goals of curricular development and associated student learning and memory. Although student satisfaction is important, I believe that goals for curricular design need to be clearly delineated for students in an effort to decrease student stress and anxiety.

Leadership Skills and Curricular Success

For those of us who have been involved in curricular development, leadership is paramount in the process. Bryman (2007) noted that leadership is often on a departmental level, even though the impetus for change may have originated from places higher in the administrative hierarchy. Leadership attributes important in leaders of curricular change include a clear sense of direction, communication skills, and trustworthiness (Bryman, 2007). Many of these listed leadership qualities are found in transformational leaders (Braun, Peus, Weisweiler, & Frey, 2013). This is not to say that only transformational leadership styles will suffice to create effective curriculum, but,

it does emphasize that certain leadership qualities are important for a successful process (Bryman, 2007). Important is that leadership provides a clear strategic plan and goals (Bryman, 2007). I would argue that leadership must have a clear understanding of many of the learning and memory issues we have discussed. Van Ameijde, Nelson, Billsberry, and Van Meurs (2009) argued that the best approach to leadership is through “taking a qualitative approach aimed at identifying the factors that influence the success or failure of projects” (p. 776). One of the challenges in identifying curricular success is developing tools to measure curricular outcomes.

Measuring curricular success has many facets, least of which is the variability of the learner and the influential external and internal factors that we have discussed. Some have argued for the development of “generic skills” to be measured as a marker for a successfully engaged curriculum (Murdoch & Whittle, 2012). In the field of medicine, one could understand the desire for a physician community that is competent in both academic and motor skills necessary to provide effective medical care. Assessment of these generic skills “places the onus upon medical educators to ensure that we develop doctors with skills that contribute to effective lifelong learning, and abilities to self-regulate and adapt to changing ideas and environments” (Murdoch & Whittle, 2012, p. 126). Although I agree with this proposition in principle, I believe that our ability as educators to effectively provide meaningful assessments of students in our current geopolitical environment is limited. While we wrestle with the weighty topic of improved student assessment, we also juggle issues of promotion and tenure that are often impacted by learner satisfaction; and, we have already explored curricular innovations that do not necessarily improve student satisfaction on the short term (Hornstein, 2017). However, I do believe that educators have the ability to assess minimal competency skills; but this will definitely take an enormous collaborative process that includes a serious look at the utility and function of student evaluations, along with thoughtful discussions of promotion, tenure, and graduation requirements.

Concluding Thoughts

Student development is a process whereby educators are encouraged to “connect experiences to theory and theory to practice that provides context for additional developmental experiences for students and themselves” (Patton et al., 2016, p. 395). Important in this observation is the bi-directional

nature of student development. Everyday higher education is criticized and maligned, ultimately creating an environment where educators may choose to avoid the path less traveled.

Curricular development is a path that many would consider a path to avoid. As I have discussed, the many moving parts to consider in developing a meaningful comprehensive curriculum is daunting. However, I would, and have, argued that if one takes an approach that incorporates what our own literatures advocates, the process can be rewarding. The amount of information that is available to us on student development theory is staggering, yet we often rely on our own experiences and biases to make curricular content delivery decisions (Patton et al., 2016).

Several observations on learning are worth highlighting. I was intrigued by the observation surrounding accommodative and transformative learning. As a reminder, accommodative learning is best described as the ability to break down information and then apply those facts to create a new set of observations, and transformative learning is when the individual is literally transformed by the learning process resulting in a foundational psychological change (Illeris, 2018). Although many of our students are not accommodative or transformative learners, our goals should be aligned to push our learners to these levels. However, I would argue that we should strive, as our curricular goals, to allow our students to learn accommodative techniques that, I believe, will ultimately lead to a transformative experience. I personally believe that higher education should aspire for our learners to experience transformational learning, but that these experiences should be personal and not institutionally mandated.

The research that I explored in the field of memory was fascinating. I was surprised at the breadth of memory research and at the dearth of hard-core knowledge referable to human memory. I was captivated by the many factors that potentially impact human learning and memory to include the topic of sleep deprivation (Strickgold, 2005). Issues of sleep deprivation are extremely important in medical education. Medical house staff work-hours are strictly scrutinized and impacts residency accreditation (Baldwin & Daugherty, 2016). Despite the well-described effects of sleep deprivation, I believe that all facets of higher education tacitly endorse sleep deprivation as a successful learning process in the form of “all-nighters” and finals week cramming. Medical education is slowly working to resolve this curricular problem, a problem that clearly has its roots in undergraduate education. Equally intriguing were the issues surrounding medical stimulant use (Ilieva et al., 2015). Although the research noted a potential benefit to learning and

memory, issues surrounding societal norms, fairness, morality and student developmental impacts are less defined (Ilieva et al., 2015).

The reviewed research was encouraging on both spaced repetition and interleaved practices, which incorporated the concept of contextual interference in the acquisition of motor skills (Kang, 2016; Carter & Grahn, 2016; Wright et al., 2015). In both instances, issues of enhancement of transfer benefit were noted, a concept important for accommodative learning (Kang, 2016; Carter & Grahn, 2016). While researching these topics, I thought of numerous examples where these two techniques could be immediately intercalated into a medical curriculum, including standardized board prep and practice with the acquisition of a multitude of important motor skills required for competent medical care delivery. Through a better understanding of the available literature, educators can make decisions that will advance student development along with memory procurement through enhanced learning techniques.

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