Assurance of Learning and Knowledge Retention: Do AOL Practices Measure Long-Term Knowledge Retention or Short-term Memory Recall?

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In response to greater emphasis on quantitative measures of assurance of learning the authors propose that while useful, the assessment tools currently being utilized, and the desired outcomes that they measure, may not be well aligned with how the brain acquires and stores knowledge over the long-term. The following paper considers current approaches to teaching, assessment and long-term knowledge retention and makes a call for additional assessment measures that can assist in establishing teaching strategies that support the neurological functions that occur in the brain to allow short-term memory to become long-term knowledge retention.

INTRODUCTION

Over the past twenty-five years colleges and accreditation organizations such as the Association to Advance Collegiate Schools of Business (AACSB) have strived to use quantitative and qualitative measures to assess the knowledge and skills that students have learned in the classroom. Concurrent with the increased focus on learning assessments has been developments in neuro-science that have increased our understanding of how the brain stores and retrieves information.

The following paper addresses teaching and assurance of learning (AOL) as well as how the brain stores knowledge. It attempts to answer whether current approaches to AOL are aligned with short-term memory recall or long-term knowledge retention. It will offer suggestions for enhancing assessment and teaching methods to strengthen pathways in the brain that shift memories from short-term learning into long-term retention.

HISTORY AND PURPOSE OF ASSURANCE OF LEARNING (AOL)

In 1991, AASCB introduced in its standards the implementation of "outcomes assessment" for its accredited institutions. In 2003, the standards were changed to allow for a move away from indirect to direct measures of student learning. The purpose of the outcomes assessment was to provide "...Measures of learning (that) can assure external constituents such as potential students, trustees, public officials, supporters, and accreditors, that the organization meets its goals" (AACSB Assurance of learning interpretation, 2013).

Palomba and Banta (1999) defined AOL as "The systematic collection, review, and use of information about educational programs undertaken for the purpose of improving student learning and development." The challenge for institutions has always been to establish assessment criteria that are aligned with outcome goals and objectives of the institution, that are objective in nature, and do not create an excessive burden to faculty and administrators.

Over the years there has been extensive discussion about the best approaches to ensure AOL activities allow for accurate evaluation of the extent to which the learning goals and objectives of the institution are being met. In a recent white paper by AACSB (AACSB Assurance, 2013) the original outcomes assessment process, as described by the AACSB Assessment Resource Center, were converted into a collection of questions that institutions and faculty could address in developing a comprehensive assessment process. These questions are:

1. What will our students learn in our program? What are our expectations?
2. How will they learn it?
3. How will we know if they have learned it or not?
4. What will we do if they have not learned it?

While these questions may provide guidance in establishing assessment processes and activities, they do not necessarily address the critical concern that information is being taught in a way that the knowledge will be retained and available to students after they have left school. From this perspective, an additional question must be asked.

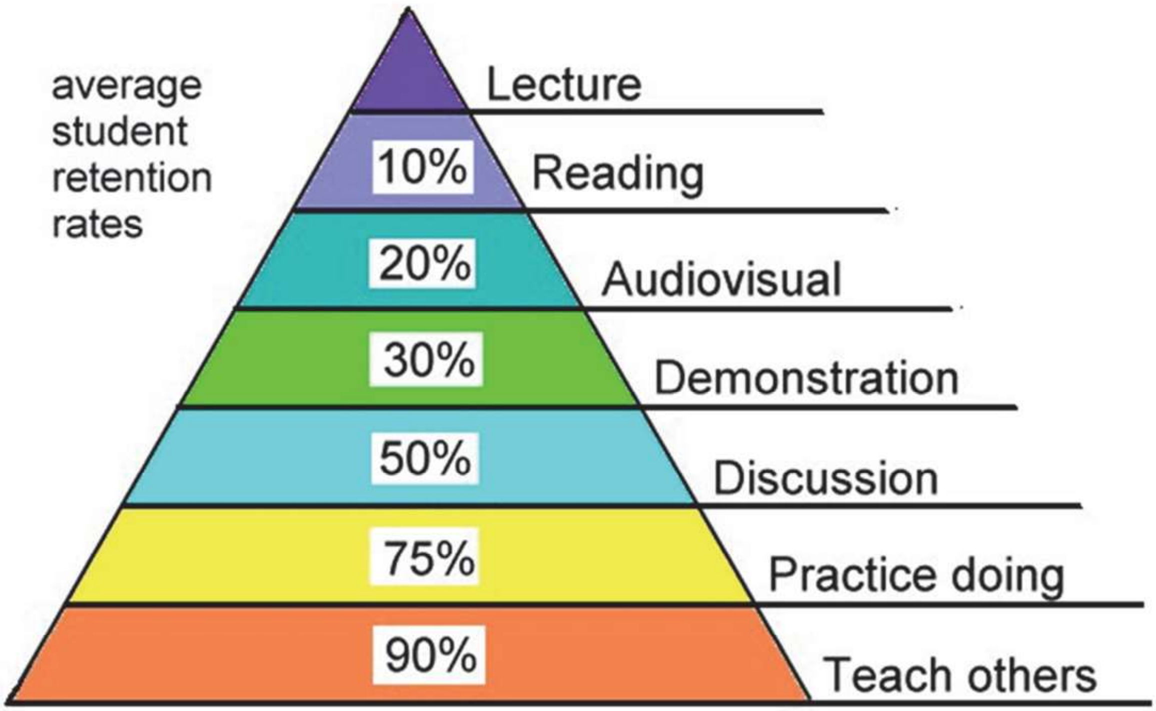
5. Will our students retain this knowledge after they leave the program?

For this question to be answered institutions must consider the inherent challenges regarding how people learn and retain information, how the educational delivery process enhances or impedes the long-term retention of knowledge, and whether current assessment tools capture or measure retention after graduation.

LEARNING AND RETENTION ISSUES

Research conducted by the National Training Laboratory of Bethel, Maine in their work on the "Learning Pyramid" (See Figure 1) attempted to describe what the average retention rate was of adult students for various teaching modalities.

FIGURE 1
LEARNING PYRAMID



Source: National Training Laboratories, Bethel, Maine

Perhaps not surprisingly, traditional lecturing and reading of materials were considered the least effective in providing students with information that would be retained. In comparison modalities that required students to be highly interactive (e.g. "practicing and doing" as well as "teaching others") were identified as having the highest level of learning retention rates.

Critics (Willinghan, 2013: Strauss, 2013) argue that learning and retention are too complex to be categorized in a pyramid. Willingham (2013) identified several factors that will impact retention including:

1. What the material is.
2. The age of the subjects.
3. The delay between study and test.
4. What were subjects instructed to do.
5. How was memory tested.
6. What subjects know about the to-be-remembered material.

Dunlosky, Rawson, Marsh, Nathan and Willingham (2013) reviewed ten teaching techniques and analyzed quantitative research that had been conducted to establish the efficacy of each technique. The authors found two moderating effects on how information was processed and retained. The first was the level of prior knowledge of the subject that students had while the second was the amount of time between when the material was studied and when the material was tested. In most instances, knowledge retention was measured through a test either during the course or at its end. These authors found that most measurements of learning occur as part of scheduled testing that allow students ample time to prepare. What much of this research fails to show is whether this knowledge is available to students after they have left the institution, or even the class where the assessment was given.

NEUROSCIENCE OF THE BRAIN AND WHAT IT CONTRIBUTES TO LEARNING AND KNOWLEDGE RETENTION

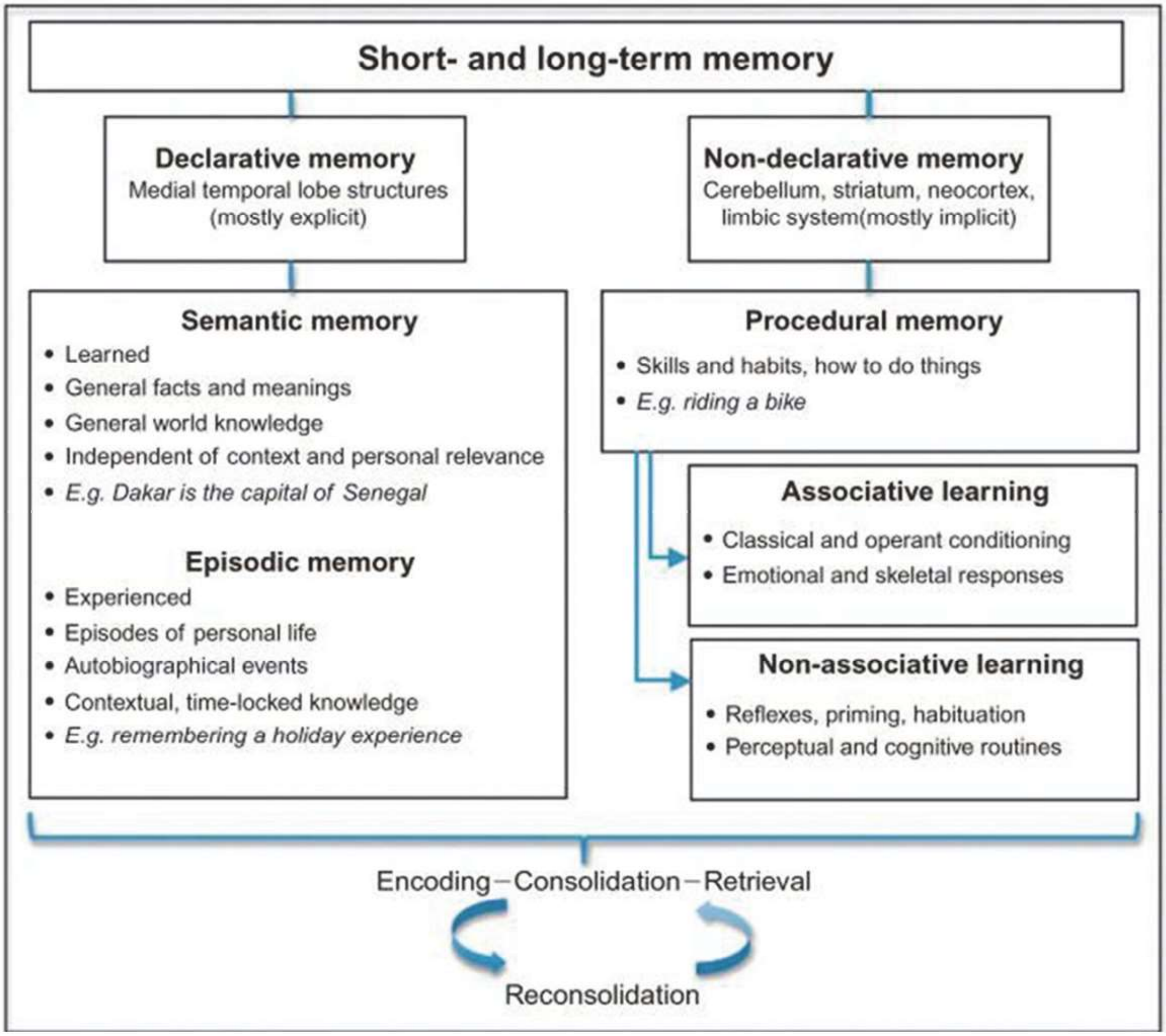
Neuroscience is the study by any of the sciences, such as neuroanatomy or neurobiology, that deal with the nervous system (The American Heritage Medical Dictionary, 2007). Advances in neurobiology science have developed a better understanding of how the brain functions, interprets, and stores information. With that understanding, cross-disciplinary research began first in the domain of psychology, which investigated the structure and organization of cognition in the brain (The Science Behind the Learning Process, 2011; Squire, Knowlton and Musen, 1993). Today, neuroscience plays a role in cross-disciplinary studies across many domains including economics, decision making, and theories of action (Shane, Locke, and Collins, 2003), as well as entrepreneurial opportunity evaluation and entrepreneurial decision making (Krueger, 2011). In practice our understanding of how the brain acquires, stores and retrieves information is being used in many training and development programs to improve corporate training, talent development, and coaching (Andreatta, 2015; Bossons, 2016; Harburg, 2009; Hassel, 2017; Rock, 2014). Neuroscience is also influencing higher education pedagogy (Bescani-Ludvik, 2016) and may allow for a broader perspective of what constitutes evidence-based management in response to recent criticism of EBM in management learning (Morrell and Learmonth, 2015).

Neuroscience can provide insights into knowledge acquisition and retention with its explanations of how the human brain and memory work. Yet the term "memory" is not a single activity held in a single repository in the brain. According to the field of neuroscience the term "memory" consists of several types of memory housed in several locations in the brain.

Memory is best understood as an outcome of the cognitive process of responding to life events. This cognitive process is short-term in nature and often will start to erode immediately unless active maintenance continues. This maintenance can consist of continued cognitive activity or the transfer of the knowledge acquired from short term recall into long-term memory retention. This transfer is not done by accident and requires a direct or indirect "tagging" of the information by the brain for it to begin (Brem and Pascual-Leone, 2013). The neurological processes required to make this transfer from short-term to long-term are biologically not well-designed for "multi-tasking". For this reason, most knowledge is lost as the brain shifts from one completed cognitive task to the next (Andreatta, 2015).

Memories have been classified into several distinct categories (See Figure 2). The two broadest categories are declarative, which deals with facts and events, and non-declarative which deals with skills and habits (Brem A-K and Pascual-Leone, (2013). Declarative memory are mostly explicit memories that can be broken into two sub-categories, semantic and episodic. Semantic memories are learned and deal with general facts and knowledge that are independent of context and personal relevance. Episodic memories are related to experience that the individual has and is extremely contextual to the event (Brem A-K and Pascual-Leone, 2013). Non-declarative memory, which is better known as procedural memory, is mostly implicit in nature. These memories deal with skills such as riding a bike and are learned through associative learning such as through classical conditioning or by non-associative learning such as reflexive responses (Brem A-K and Pascual-Leone, 2013; Robertson, 2009). Procedural memory is also considered when describing those skills and abilities that are practiced at a sub-conscious level. Memories are also classified as to whether they exist for a short-term or a long-term in nature (Moscovitch, Nadel, Wincour, Gilboa & Rodenbaum, 2006).

FIGURE 2
SHORT- AND LONG-TERM MEMORY



Source:Brem A-K, Ran, K., Pascual-Leone, A. (2013)

Short-term memory (STM), often called primary memory, has been described as an essential component in cognition and is utilized over a very short time period ranging from just a few seconds to a few hours. STM requires a conscious maintenance on the part of the individual and once this maintenance is gone these memories will quickly erode (Brem A-K and Pascual-Leone, 2013; Kon, 2015; Squire, Knowlton, & Musen, 1993). Long-term/long-lasting memory (LTM), often called secondary memory, involves the reactivation of past experiences, including learning experiences. LTM normally accesses different parts of the brain and is the mechanism where memories gain stability and strength and therefore become resistant to interference (McGaugh, 2000; Squire, Knowlton, & Musen, 1993). The question then is how do memories that require conscious maintenance to exist evolve into memories that are free of conscious maintenance and yet are stable, strong and consistent. This is accomplished through another neurological process called memory consolidation.

Memory consolidation is a process that consists of three milestones described as encoding, consolidation, and retrieval (Karni, Meyer, Rey-Hipolito, 1998). This process is influenced by hormonal and neural processes as well as molecular and cellular mechanisms and may take hours or even days to complete in the brain. The process requires many “offline” activities that allows for the release of certain neuro-transmitters and other chemicals in the brain and even a sleep state which reduces the amount of noise in the brain and allows the formation of LTM (McGaugh, 2000).

While STM and LTM appear to reside in different locations in the brain they do not act independently of each other, Jonides et. al. (Jonides, Lewis and Nee, 2008). concluded that STM may consist of temporarily activated LTM representations. Other studies, using brain imaging techniques, have confirmed this assumption that regions of the brain normally associated with LTM are activated during processes utilizing STM (Wheeler, Petersen, & Buckner, 2000).

From the perspective of learning and assessment it appears that the types of memories that are being assessed would be classified as declarative and semantic in nature (memories that are explicitly learned). However, what may not be considered is whether these assessments are measuring memories that are short-term in nature, and thus require constant maintenance by the student, or are long-term in nature which would allow the student to access the knowledge on demand long after they have left their academic institution. Why this is important can be described in two other descriptions of memories “working memory” and “prospective memory”. Both processes describe the use of memories in cognitive functions and decision-making.

Working memory (WM) is a temporary active manipulation of information necessary for complex tasks. It draws from both external stimuli that is being experienced as well as internal stimuli retrieved from the brain. Baddeley (2000) described WM as an executive activity that draws from visual semantics, language and episodic LTM to help define and solve complex operations. WM allows individuals to focus on relevant stimuli while ignoring irrelevant noise and is considered necessary to successfully complete higher cognitive functions such as decision-making, mental imagery, or language functions (Gazzaley & Noble, 2012; Brem A-K & Pascual-Leone, 2013).

Prospective memory (PM) involves an intention to carry out an action in the future. The future orientation of the action requires that the memory be tagged and retained until it can be activated at the right time or in the appropriate context. PM involves both WM and LTM processes and it has been proposed that as the memory is being encoded by the brain it achieves a special status in part due to its future orientation and activation requirements (Wittmann, 2009; Reynolds, West, and Braver, 2009; Burgess, Gonen-Yaacovi and Volle, 2011). According to Brem et al (2013) working and prospective memory have a special place in the memory domain as they rely strongly on executive cognitive processes. As in many cases these two types of memories are in different parts of the brain anatomy and seem to be activated differently and for different purposes.

Jonides et al (2008) concluded that STM and LTM are not inseparable. Rather these various types of memory structures overlap and influence both their formation and activation. It also appears that the development of these types of memories are closely connected to time perception, attention, and the emotional valence of the memory contents (Jonides et al, 2008).

This appears to be the great challenge in teaching and learning - to not just provide students with information to prepare them for a test but rather to provide them with knowledge that they can draw upon throughout their adult lives. This knowledge must be delivered to students in a way that allows them to cognitively prepare the knowledge to become a prospective long-term/long-lasting memory as well as the time to process and transition from short-term memory structures into long-term ones. To enhance this transition from STM to LTM the teaching of this knowledge must allow students to connect it to some aspect of their future.

ASSURANCE OF LEARNING ASSESSMENT TOOLS

As described earlier, AACSB describes assessment as “...measures of learning (that) can assure external constituents such as potential students, trustees, public officials, supporters, and accreditors, that the organization meets its goals” (Assurance of learning interpretation, 2013). Often these goals are articulated as aspects of learning and future preparation for success in a student’s career and other life endeavors. The future orientation of these goals logically assumes that what is learned by a student in a higher education institution will therefore be retained and available to the future graduate sometime in the future. The question, however, is whether the current approach to teaching and learning assessment supports the development of critical long-term memories that students can access and bring into working memory to assist them in future decision-making.

According to neurologists most learning becomes memories that are short-term, declarative (explicit) and semantic (dealing with facts) in nature (Brem A-K & Pascual-Leone, 2013). Being short-term, these memories require constant maintenance by the student (i.e. cramming) to keep them from eroding, which they will do as soon as the maintenance by the student is discontinued. For these memories to be consolidated into LTM they need to activate memory consolidation processes that can convert the memory from short-term "semantic" into long-term "procedural" memories. It seems however that the need for quantitative assessment of learning may be driving educators away from long-term memory development (e.g. knowledge retention) and towards short-term memory recall to satisfy quantitative assessment measures.

Assessment of Learning at the Undergraduate Level

In many instances, AOL takes place at the class level through a collection of questions (usually multiple choice) that are embedded in semester and end-of-semester tests. In some instances, a capstone class such as strategic management in business is utilized to assess learning throughout the student's baccalaureate career. In other instances, a standardized test such as the ETS is utilized after the completion of the undergraduate program to provide learning assessment.

Students will respond to these AOL test questions in one of two ways. If the questions do not impact the class grade, or the test is administered outside of class, the chances are that they will not study and instead make "educated guesses". These "educated guesses" are weakly linked past experiences that students use to discern a correct answer. In response to these poor assessment outcomes, questions are often embedded into tests that impact student course grades, with the hope that students will better prepare for (i.e., learn) the material.

When these questions are embedded into a class test, however, students will likely prepare for the test as they normally by "cramming" up to the moment that the test is taken. From a neurological prospective this knowledge is incorporated into the brain's "working memory" which is short-term in nature and is maintained only through the conscious maintenance of the information (e.g. constantly reviewing class notes and study guides).

However, when the test is complete and the conscious maintenance of the knowledge by the student stops, the memory that is created will almost immediately begin to erode and disappear. This is especially true if the knowledge recalled for the past test is competing with different knowledge that needs to be recalled for other, future tests. This erosion of knowledge retention may have an even more dramatic impact on student's performance on end of academic career field tests such as the ETS.

Given what neuroscience is beginning to know about the neurological processes related to memory and knowledge retention, it is quite possible that end of academic career assessments like an ETS, or a multi-disciplinary test at the senior level, are not assessing what was learned throughout a student's academic career. Instead what these assessments measure is another upload by the students of knowledge into working memory that will also begin to erode once the assessment is completed.

If this is typical of how assessments are conducted and how students prepare for these assessments then institutions may be misinterpreting short-term memory recall as long-term learning. In that case institutions may inaccurately identify poor performance as a lack of learning instead of a lack of knowledge retention. Faced with these assessment results colleges and departments may choose to consider modifications of course content and approaches to testing rather than consider how the brain acquires and stores knowledge and how well teaching and assessment modalities are aligned with these biological processes.

Enhancing AOL for Long-term Knowledge Retention

If long-term memory and knowledge retention describe a similar, or the same, neurological process then enhancements to current AOL processes must occur to align teaching to these processes. These enhancements not only need to identify what approaches to teaching enhance long-term knowledge retention but also identify what types of measures must be added.

Dunlosky et al (2013), in assessing the efficacy of various teaching techniques, found that prior knowledge and time between review of material and testing had moderating effects on retention. From a neurological perspective, these findings imply that traditional, "passive" learning techniques create memories that are declarative and semantic in nature. As students prepare for the assessment, knowledge is placed into working memory, and quickly erodes once the assessment is completed. For knowledge to be retained in prospective memory, several moderating factors must be recognized and ultimately embedded into teaching methods. The following are some possible suggestions for improving pedagogical delivery to enhance learning and long-term retention.

Overlap Course Material to Move Memories from Short-term to Long-term

Jonides et al (2008) concluded that short-term and long-term memories are not independent of each other but rather overlap. Prior knowledge is a mitigating factor that can enhance retention and may assist in consolidating STM into LTM, especially if this knowledge is "tagged" by the brain as having future value and relevance to the student (Dunlosky et al, 2013).

If this is true than courses that build and overlap on prior courses as well as on students' prior experiences may help facilitate memory consolidation. While overlap between courses and student experiences may exist in certain aspects of specialization degrees it is not usual in general business degrees such as management, especially at the undergraduate level. In these instances, programs are often a collection of survey classes on topic issues that are relevant to the practice of management. Once these courses are completed they are rarely, if ever, referred to in other courses until, possibly, a senior level capstone course. Without motivation to retain these short-term memories externally through course overlap and/or by the student internally through recall, prior experience, and/or reflection, these memories will quickly erode with the ultimate effect being that what is being tested in these capstone classes, or general learning exams like the ETS, is current short-term memory recall rather than knowledge retention of past knowledge.

Make the Connection between Course Material and Later Career or Life Goals

The relevance of a course in the mind of the student has always been recognized as a critical pathway to knowledge retention. Unfortunately, too often the level of course relevance may be focused primarily on the grade to be earned and not on the usefulness of the knowledge to the student sometime in the future. Establishing a clear pathway in the mind of the student regarding the relevance of the knowledge to the student's career objective must occur at the beginning of their higher education career.

It is this combination of overlap and future value that can increase the possibility that the student will provide the necessary attention to the information which begins the process of memory consolidation and the development of a long-term prospective memory. One way to accomplish this is through developing teaching modalities that embed semantic (data) memories into episodic (experience) memories. The strategic use of self-reflection, application, and experiential learning through in-class exercises and/or outside work experiences create the necessary overlap of semantic and episodic memories to begin the neurological processing of prospective memory.

Recognize the Importance of Emotional Connection

Emotional connection seems to be an additional modifier in creating long-term memories (Hassel, 2017; Rock, 2014). Students must feel connected to the knowledge. This can be done in one of two ways. The first is finding the connection between data and individual experiences. This could be part of a course that answers questions or concerns that a student has developed based upon experience. Another way of establishing emotional valence is to allow students to see how the knowledge helps them improve their performance. Self-reflection allows the student the time to assess the future value of the information as well as allow the brain to process and transfer the memory into long-term prospective memory. Practice and practical experience allow students to use this knowledge to acquire a proficiency and, much like a successful athlete, will use that proficiency to enhance personal identity and self-esteem. In this instance, experiential education may be an integral part of long-term knowledge retention.

Experiential education has been a topic of education since the 1930's and is looked upon as a way for students to practice and develop proficiency in a topic area as well as reflect on what they did to acquire this proficiency. It may now also be argued that experiential learning may create episodic memories in the brain which seem to be more easily converted to LTM and prospective memory. Much of the assessments of these types of experiential education modalities are subjective or even personal to the individual student. It has been offered, at least from the perspective of learning assessment, that these teaching methods should be replaced with theory driven courses that are better suited for standardized testing and quantitative measurement (Ames, 2006). However, from the perspective of knowledge retention and how the brain operates these experiential courses may be an integral part of overall teaching and therefore can enhance necessary attention to the knowledge being taught, create a positive emotional valence to the knowledge, and provide for a period of reflection that is needed for the development of memory consolidation that creates long-term prospective memory. This is the challenge for educators as they continue to improve learning goal objectives and assessment tools.

Present and Deliver Material in a Way that Facilitates Knowledge Retention

In addition to macro approaches to enhance memory consolidation and knowledge retention Andreatta (2015) suggested that many in-class approaches can enhance connections between material being taught as well as increase student focus and therefore must be considered when building curriculum. These approaches include:

a) limiting information flow to 15-minute packets to allow the brain time to process and target information for long-term retention.
b) providing repetition of concepts and opportunities for at least three retrievals of the information through a variety of in-class activities (e.g., discussion, application, and quizzes).
c) relating the information to a student's personal experiences.
d) incorporating activities that reinforce the potential future application and relevance of what is being taught,
e) considering the student audience, including factors such as learning preference and generational differences that may impact how information is received and retained.
f) recognizing that memory consolidation is not immediate – habits need to be formed and the brain needs time and rest to consolidate.

Reinforce Concepts across the Curriculum Through Application and Practice.

In-class assessment is necessary to determine if key course concepts are being learned. However, most assessments measure short-term working memory, which means that most of what is measured will quickly be lost by the student. To increase the possibility of long-term knowledge retention, key concepts should be reinforced across multiple classes. Much like an athlete practices to develop skills and capabilities until they become embedded into "muscle memory" students must have the opportunity to practice and develop proficiency not only in the skills being taught but also the process of critically assessing new experiences with procedural memories of past experiences. Ideally, this reinforcement will not simply be a "re-learning" of material, but increased application of key concepts through discussion, experiential learning opportunities, and other activities. This overlap will help students see the connections between what is being taught today with what was taught yesterday and provide them with the practice necessary to embed knowledge into long-term episodic memory.

Develop Overarching Learning Goals

Learning goals should be aligned with and benefit student's long-term goals. At the college level, this might involve creating broad, skill-based goals such as decision making, critical thinking, or ethical behavior – all of which can apply across specific disciplines and therefore can be reinforced at multiple times during the students' education. Nested within the college level goals could be discipline related goals at the department level (e.g. sustainability, entrepreneurship, social responsibility, etc.).

Incorporate both Qualitative and Quantitative Assessment Tools

Some authors argue that educators should not use pedagogical techniques that produce quantitatively unmeasurable outcomes (Ames, 2006). However, qualitative measurement can provide valuable data that can be used to supplement existing measures. For example, many skill-based learning goals (such as critical thinking, decision making, ethical reasoning, etc.) are effectively measured through well designed rubrics that specify the criteria, standards, or expectations for performance. Another useful supplement might be to ask students and other stakeholders (e.g., internship supervisors, company leaders, etc.) to provide input on student competence – these ratings could then be compared to more objective measures of performance. Adopting a multi-faceted approach to assessment activities will better allow for true assurance of learning, including long-term retention and application of knowledge.

CONCLUSION - FUTURE DIRECTIONS

Over the last 25 years, colleges and universities have moved towards establishing higher levels of accountability and process improvement in teaching pedagogy and course development. Assurance of learning assessment in higher education has created the foundation for a better understanding of the purpose of the school as well as the development of strategies for continuous improvement in teaching delivery. It is now time to consider what needs to be done next to ensure that students not only learn information to help them pass a course but also that this information becomes embedded in a tapestry of knowledge that will be available to them long after they leave school.

Advances in the field of neuro-science have allowed educators to begin to understand not only how we learn but also how to develop and strengthen pathways to enhance knowledge retention. The next logical improvement in teaching will be to take what is known about how the brain functions in developing long-term memories and design teaching strategies that make it easier for students to optimize knowledge retention throughout their lifetime. To recognize that the key to success is not the ability to recall disconnected facts but rather to fold these facts into a collection of processes that overlap seamlessly, that are not constrained by specific context, that are pliable and responsive to internal and external change and are readily available throughout an individual's life. As part of this evolution in our understanding of how students learn, we must look beyond current approaches in assurance of learning and ask if assessment practices can be enhanced to more accurately measure whether or not what has been taught is being retained and used by students – both in their future classes as well as in their post-graduation careers. As educators, we recognize that student success is not based upon the number of facts that a student can recall, but on how those facts are applied to analyzing and solving problems and challenges our graduates face long after they leave the institution. Therefore, assessments must go beyond the measurement of short term memory recall to consider long term retention and application. We should challenge our faculty to consider and experiment with non-traditional assessment activities that may more accurately tap the application of knowledge and skill, rather than simple retention.

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