Indelible Memory

Data Dissemination Designed to Optimize Memory

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INDELIBLE MEMORY

Data Dissemination Designed to Optimize Memory

By

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Abstract

The Information Age (a.k.a. the Computer or Digital Age) is characterized by the rapid shift from traditional industry to an economy based on information technology. Mankind is redesigning, improving, and advancing all that has come before. The major impediment to this advancement is man's inability to deal with the volume of data. We learned to learn via methods designed prior to this reality. The conscious acceptance of data initiates a process in the human brain to retain and utilize information, defining the creation of personal knowledge. This process along with compounding blocks of knowledge builds intelligence. The purpose of this thesis is to analyze the information collected and use it to design an optimal method of information dissemination.

The four pillars of research on which this thesis is based are neurobiology, psychology, educational science, and human-centered experimentation.

Neurobiology helps define the nature of a single thought, the process of thought creation, storage, and utilization - the process by which thoughts combine to form knowledge.

Psychology helps define human will. Conscious acceptance or rejection of data requires the engagement of the will. I hope to discover the triggers that prompt the mind to actively accept or reject data.

Educational science, the third pillar, helps examine methods used to impart information. Both successful and failed methods of information transfer were analyzed, tested, and explained. Research relevant to media and digital platforms, classroom procedures, and other methods by which a learner is exposed to data is examined, to determine the relative efficacy of teaching methods and platforms. The research provided key elements of biology, psychology and methodology that were included in an experimentally designed method of teaching, administered

to a group of volunteers. The collected research material was combined with data obtained by human-centered experimentation to provide a fulsome and holistic pool of data from which an optimal method of information dissemination was formulated.

Human-centered experimentation featured a workshop designed to collect data about educational experiences, using classroom sessions to compare the results of teaching and testing the same data delivered in two distinct ways. This research provided relevant information to under- standing learning processes and the factors that drive and inhibit it. Results of the classroom sessions suggest that information delivered with psychological triggers and emotional content add the value needed to prompt an individual's choice to accept and process data.

This work sincerely intends to provide findings leading to an optimized paradigm of teaching and learning.

Acknowledgements

The efforts of a group of intelligent, dedicated, and patient individuals made this late-life quest possible and supported one Quixotic student who tried one more time to reach an impossible dream. My heartfelt thanks are dedicated to the following:

The distinguished thesis committee: Dr. Joan Dickinson, Dr. Holly Cline, Dr. Bruce Parsons, and Dr. Kathleen Sullivan, for their guidance, instruction, and dedication.

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Chapter 1 Introduction

> Wisdom is not a product of schooling but of the lifelong attempt to acquire it.
>
> — Albert Einstein

The purpose of this study is to examine how knowledge is acquired, stored, and used by the human mind and to design methods to optimize the mind's ability to utilize knowledge. More information is readily available today than at any other point in history. Despite this ever-increasing and precious resource, humanity continues to utilize methods of learning developed prior to the current flood of data. This paper seeks to inform the development of a new method of teaching and learning based upon science and design that can better process and benefit from the bounty of available data. It identifies factors based in biology and psychology that either optimize or inhibit the mind's collection, retention, and utilization of information. Upon examination and testing, these factors will suggest the design of a new, more effective method to acquire, store, and use knowledge.

Areas of Research

Neuroscience

Neuroscience defined the anatomy of the brain and of thought and explains the physical changes that occur within the brain to manufacture "thought-webs." It details the biological processes that take place in the human brain pertaining to the perception, acceptance, and storage of engrams, or bits of information, and the formation of memory.

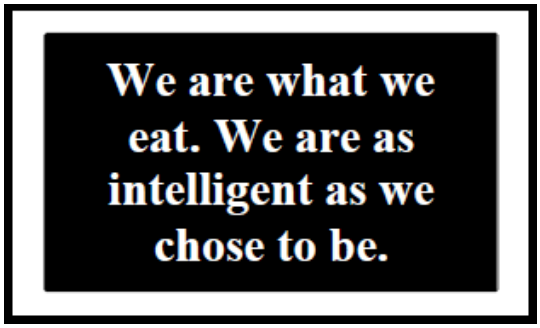
Psychology

The four main goals of psychology are to describe, explain, predict, and change the behavior and mental processes of others (McLeod, 2019). "Acceptance…is a person's assent to the reality of a situation, recognizing a process or condition (often a negative or uncomfortable

situation) without attempting to change it, protest, or exit" (Fish, 2014, p. 1).

The research focused on the psychological processes and triggers associated with the acceptance of data. People in the United States are inundated with the equivalent amount of 34 gigabytes of information every day. Bohn and Short (2012, p. 980) estimated that in 2008, Americans consumed about 1.3 trillion hours of information outside of work, an average of almost 12 hours per person per day. The mind exists in a virtual ocean of consumable information.

Nutritious food results in greater overall bodily health. Valuable information results in knowledge. When knowledge is utilized, it is refined into intelligence. We are what we eat. We are as intelligent as we choose to be.



Thinking Fast and Slow (Kahneman, 2011) reveals a paradigm central to this study, stating that the human mind functions in two basic modes called *System 1* and *System 2*. System 1 is described as operating "automatically and quickly, with little or no effort and no sense of voluntary control." By contrast, "System 2 allocates attention to the effortful mental activities that demand it, including complex computations. The operations of System 2 are often associated with the subjective experience of agency, choice and concentration" (Kahneman, 2011, p. 20- 21). Understanding acceptance is essential to the design of a new teaching/learning method. System 2 thinking must be activated to facilitate the learning process.

Pedagogy/Education Science

The field of education science includes the examination of various teaching methods and students' reaction to them, as well as insights as to their improvement. This study requires a practical understanding of the existing teaching methodologies and their relative efficacy. This research provided access to the most effective methods of teaching to facilitate the design and compilation of a new teaching/learning method.

Human-centered Design

The fourth pillar of research is human-centered design. The process of designing a new method utilized several human-centered design methods found in *Innovating for People* (LUMA Institute, 2012). These methods are designed to develop solutions in the service of people.

This area of research provides the human perspectives essential to the design of a new teaching/learning method. The methods as used in this process produced the necessary data for the actual formation of a new paradigm of teaching and learning.

Purpose of Study

The purpose of this study is to design a new teaching/learning method based upon bio-scientific fact and psychological principles. It examines both the positive and negative elements of the existing methods of teaching and learning. It adds elements of science, psychology, and human nature that can be used to design a more efficient method of teaching and learning.

Definition of Terms

All definitions are as used or as relates to this thesis. Dictionary definitions are noted as such.

Amygdala. Dictionary definition: noun; ah-MIGdah-la; a. Either of two small almond-shaped masses of gray matter that are part of the limbic system and are located in the temporal

lobes of the cerebral hemispheres (American Heritage Dictionaries, 2016) b. one of two parts of the brain that affect how people feel emotions, especially fear and pleasure (Cambridge Dictionary, 2018) (see Figure 1).

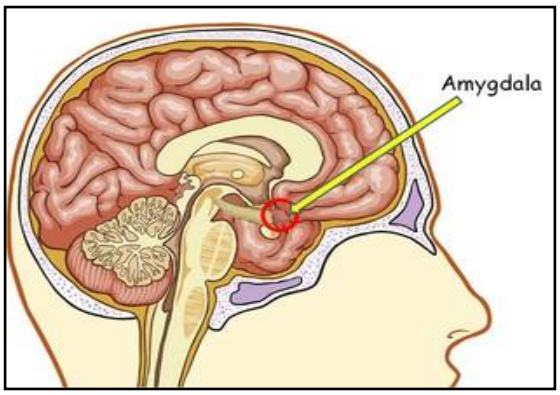


Figure 1. Illustration of the Amygdala (Brain Made Simple, 2019)

Attachment. A deep and enduring emotional bond that connects one person to another across time and space. A biological instinct in which proximity to an attachment figure is sought when the individual senses or perceives threat or discomfort. This instinct is predominantly expressed in juveniles but remains part of the life-long psychological make-up of most individuals in varying degree of prominence (see Figure 2).

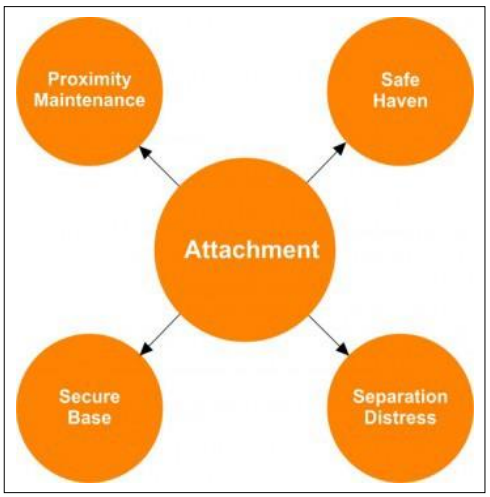


Figure 2. Illustration of Attachment (Mansukhani, 2019)

Axon. Dictionary definition: noun; ak´son; the process of a nerve cell along which impulses travel away from the cell body. It branches at its termination, forming synapses at other nerve cells or effector organs (Miller-Keane, 2007) (see Figure 3).

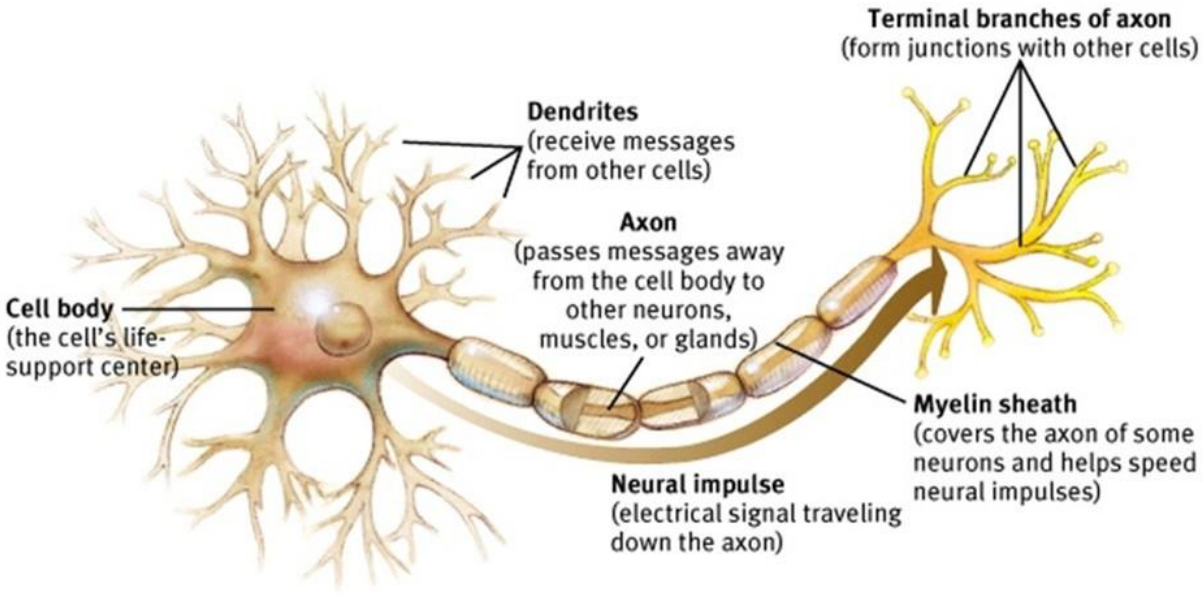


Figure 3. The Axon (Kochunni & Haneef, 2013)

Axodendritic. Dictionary definition: adjective; ak'sō-den-drit'ik; Pertaining to the synaptic relationship of an axon with a dendrite of another neuron (Stedman, 2012).

Bayley scales. (BSID). Measure the mental and motor development and test the behavior of infants from one to 42 months of age (see Figure 4).

Sample Items From the Bayley Scales of Infant Development

Age	Mental Scale	Motor Scale
2 months	Turns head to sound Reacts to disappearance of face	Holds head erect/steady for 15 seconds Sits with support
6 months	Lifts cup by handle Looks at pictures in book	Sits alone for 30 seconds Grasps foot with hands
12 months	Builds tower of 2 cubes Turns pages of book	Walks with help Grasps pencil in middle
17–19 months	Imitates crayon stroke Identifies objects in photo	Stands alone on right foot Walks up stairs with help
23–25 months	Matches pictures Imitates a 2-word sentence	Laces 3 beads Jumps distance of 4 inches
38–42 months	Names 4 colors Uses past tense Identifies gender	Copies circle Hops twice on 1 foot Walks down stairs, alternating feet

Figure 4. Bayley Scales of Infant Development (Bayley, 1993)

Cerebral cortex. Dictionary definition: noun; the convoluted surface layer of gray matter of the cerebrum that functions chiefly in coordination of sensory and motor information (Merriam-Webster, 2019).

Dictionary definition: noun; The extensive outer layer of gray matter of the cerebral hemispheres, largely responsible for higher brain functions, including sensation, voluntary muscle movement, thought, reasoning, and memory (American Heritage, 2016).

The cerebral cortex is the part of the brain that functions to make human beings unique. Distinctly human traits including higher thought, language, and human consciousness as well as the ability to think, reason, and imagine all originate in the cerebral cortex. It is the outermost portion of the brain and is divided into four lobes. It integrates higher mental functions, general movement, visceral functions, perception, and behavioral reactions. It has been classified in many different ways.

Research has described more than 200 areas on the basis of differences in myelinated fiber patterns and has defined 47 separate function areas with different cell designs. For example, stimulation of the precentral cortex or motor area with electrodes causes contractions of voluntary muscles. Destruction of a motor speech area in the frontal operculum causes motor aphasia or speech defects despite healthy, intact vocal organs (see Figure 5).

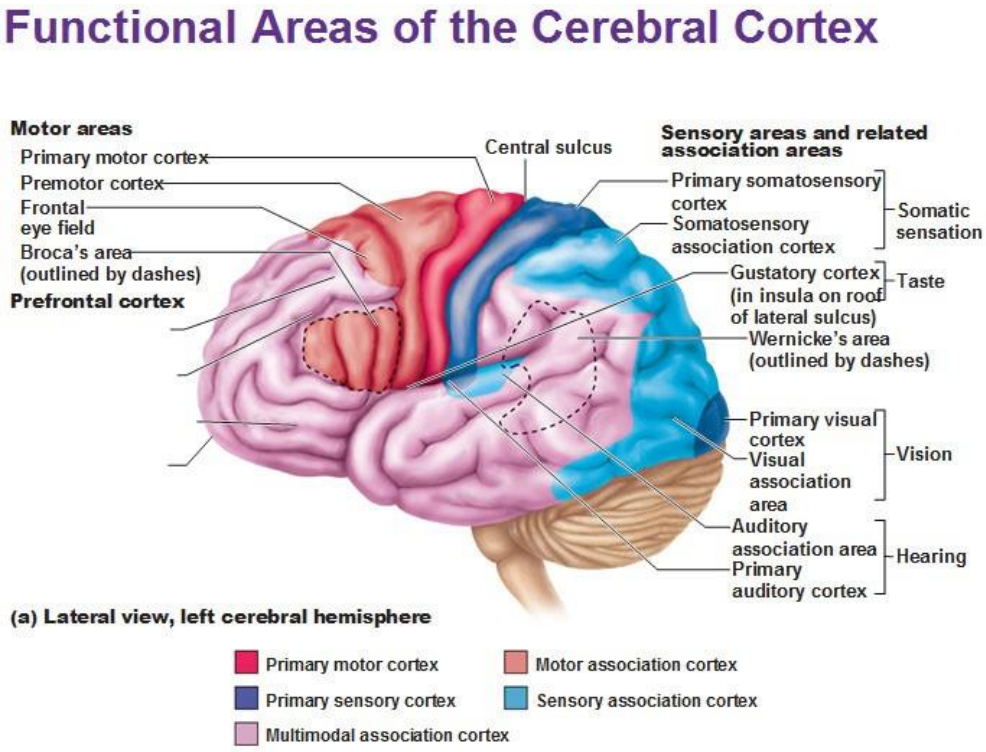


Figure 5. Functional Areas of the Cerebral Cortex (Kizarian, 2019)

Chunking. Refers to organizing or grouping separate pieces of information together.

When information is "chunked" into groups, memorizing information becomes easier by remembering the groups as opposed to each piece of information separately. Chunking is used most commonly to organize or classify large amounts of information, even when there are no obvious patterns.

Occurrences of chunking as a memory devise can be seen in the way information is grouped in our daily lives. The basic process of information chunking follows four steps:

1. Breaking large amounts of information into smaller units
2. Identifying similarities or patterns,
3. Organizing the information, and
4. Grouping information into manageable units (see Figure 6)

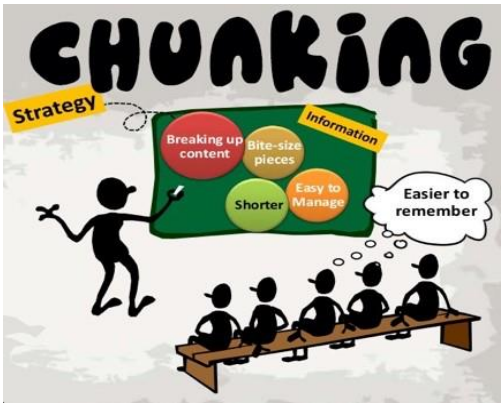


Figure 6. Chunking Explained (Marican, 2014)

Dendritic spine. Dictionary definition: noun; Any of various outgrowths of certain nerve-cell dendrites, ranging in shape from small knobs to thorn-like or filamentous processes, that are preferential sites of synaptic axodendritic contact (American Heritage, 2007).

Dendrite. Dictionary definition: noun; den´drīt; any of the threadlike extensions of the cytoplasm of a neuron; they typically branch into tree-like processes and compose most of the receptive surface of a neuron (see Figure 7).

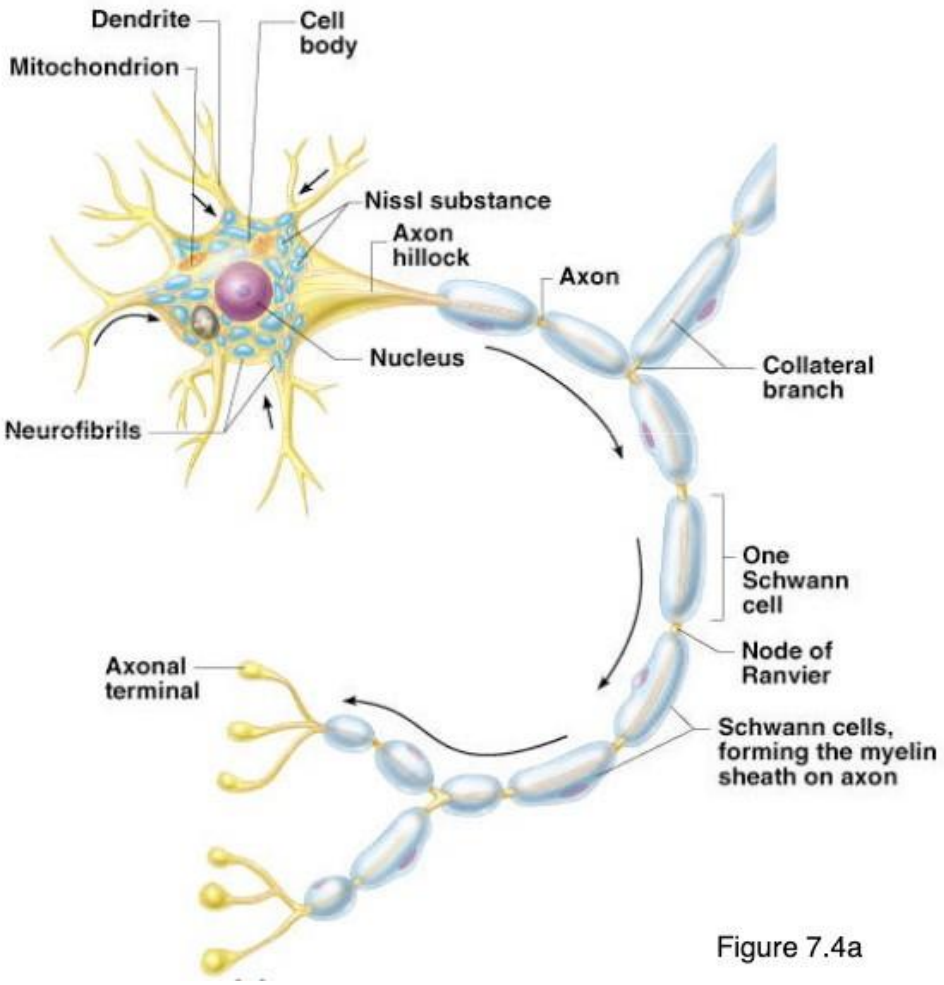


Figure 7. Illustration of Dendrite (Marieb, 2003)

Disseminate knowledge/data. Any point at which a person/presentation or a written source presents information to another person or persons. Dissemination of knowledge can occur in either an educational or a commercial paradigm. This is to say, information provided for human processing.

Design thinking. An interdisciplinary methodology that develops solutions in the service of people by utilizing human-centered design. Design thinking uses methods of three design skills - looking, understanding, and making, to bring new and lasting value to the world. This

discipline empathizes with the human end-user/participant as a basis for all design.

Flashbulb memory. Dictionary definition: the term that is given to any memory that is associated with a personally significant or emotional event. These memories have a photographic quality of the moment (Psychology Dictionary, n.d.) (see Figure 8).

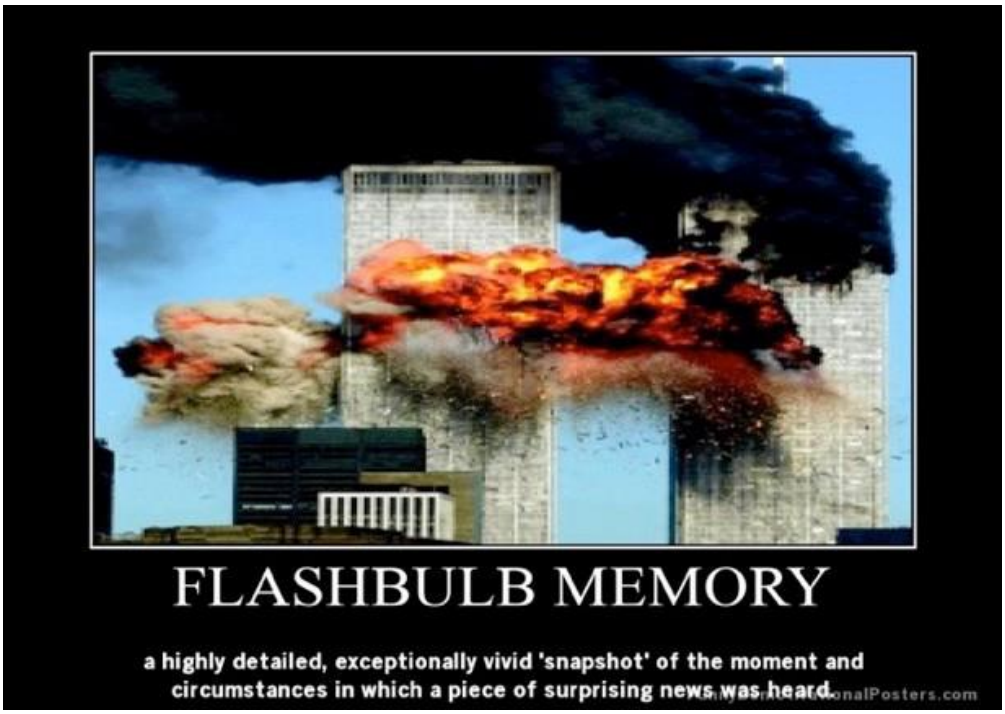


Figure 8. Definition of Flashbulb Memory (Berends, 2013)

Functional Magnetic Resonance Imaging (fMRI). A technique for measuring brain activity. It works by detecting the changes in blood oxygenation and flow that occur in response to neural activity; when a brain area is more active it consumes more oxygen and to meet this increased demand blood flow increases to the active area. fMRI can be used to produce activation maps showing which parts of the brain are involved in a particular mental process. fMRI looks at blood flow in the brain to detect areas of activity. These changes in blood flow, which are captured on a computer, help doctors understand more about how the brain works (see Figure 9).

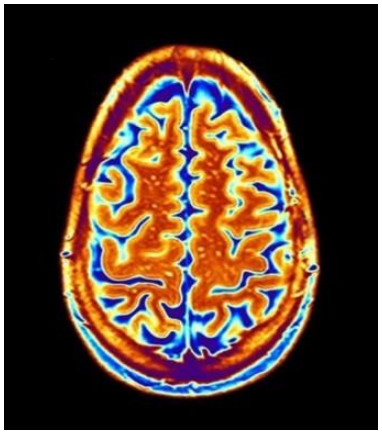


Figure 9. fMRI Brain Scan (Oaklander, 2019)

Hippocampus. Dictionary definition: noun; hip″o-kam´pus; a curved elevation of gray matter on the floor of the inferior horn of the lateral ventricle; it is an important functional component of the limbic system. As pertains to this thesis, the part of the brain wherein memory resides (Miller-Keane, 2007) (see Figure 10).

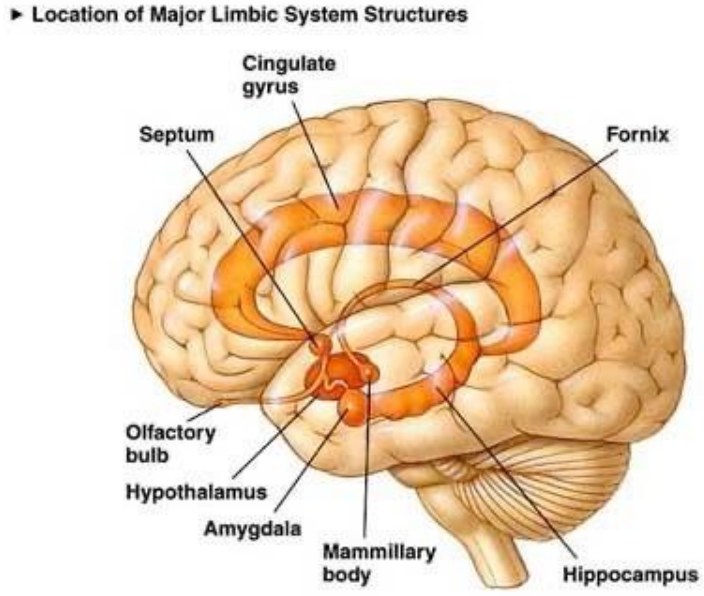
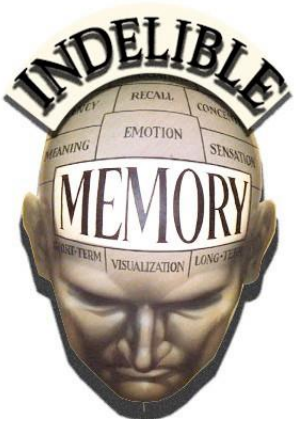


Figure 10. Location of Major Limbic Structures (Becker, 2012)



Indelible memory. The memory or memories permanently retained and able to be recalled by a person. These memories are imprinted into long-term memory as a result of being voluntarily accepted, assigned a value, attached to emotional stimuli, and retained intact, often tied to an extended collection of other related memories. The goal of this paper is to design a methodology to optimize the long-term potentiation of memory and the quest for memory permanence.

Intelligence. Dictionary definition: (ĭn-tĕl′ə-jəns) n. 1. The ability to acquire, understand, and use knowledge (Farlex, n.d.). In con- text of this thesis, intelligence refers to information retained, recalled, and added to the entirety of an individual's knowledge. In this context, intelligence is the totality of useable knowledge, and the growth of that totality through the laddering and utilization of additional knowledge, or knowledge as an entity, capable of quantitative and qualitative growth.

Laddering. Dictionary definition: Process of enhancing overall intelligence by systematically adding new knowledge to retained knowledge, building detail, concept, understanding, and complexity of that knowledge. Laddering therefore is dependent upon the quality and quantity of retained and recalled information (see Figure 11).

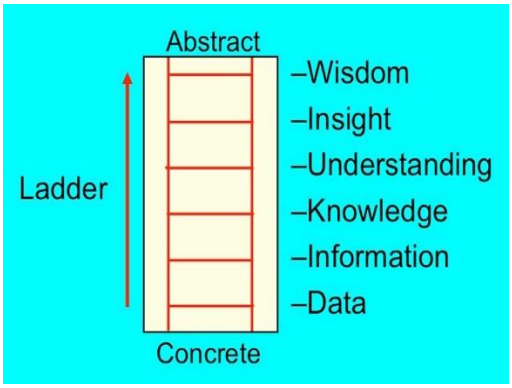


Figure 11. Different Types of Information (Garber, 2013)

Learning: Declarative learning. What is known, as opposed to motor learning and procedural learning, which are about what can be physically actuated. The means through which new information is acquired. Example: One's knowledge about common things like facts and data.

Learning: Nondeclarative learning. Stored information that can be physically actuated by the body, as opposed to information that is known and stored. Example: Skills like riding a bicycle, driving, and swimming (see Figure 12).

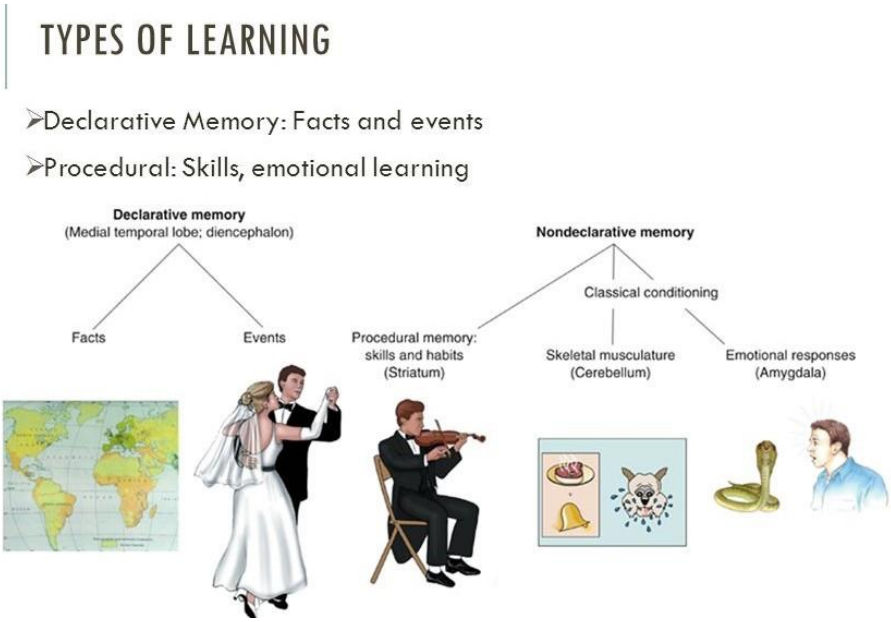


Figure 12. Types of Learning (Stedman, 2012)

Learner. Any person receiving and processing information from any source. By this definition, a "learner" refers to a student, a consumer, a staff member, or any individual in receipt of data.

Long-term potentiation (LTP). Dictionary definition: A long-lasting strengthening of the response of a postsynaptic nerve cell to stimulation across the synapse that occurs with repeated stimulation and is thought to be related to learning and long-term memory (Merriam-Webster, 2019, p. 734). Used to aid in the explanation of the formation of hypothetical thought webs (see Figure 13).

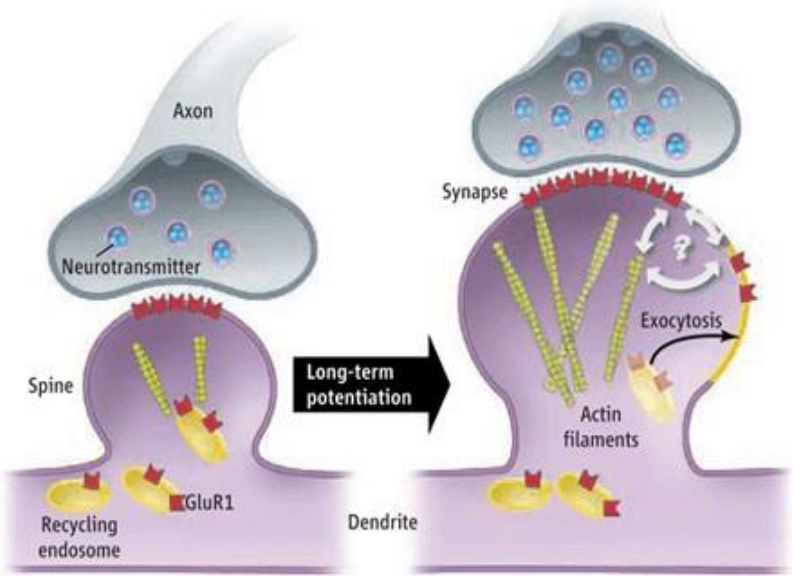


Figure 13. Neuroplasticity Mechanisms (Lieff, 2012)

Montessori method. A revolutionary method of observing and supporting the natural development of children. Authentic Montessori educational practice helps children develop creativity, problem solving, critical thinking, time-management skills, care of the environment, and each other. It can prepare them to contribute to society and to become fulfilled persons.

The basis of Montessori practice in the classroom is mixed age group (3-6 ages in one class), individual choice of research and work, and uninterrupted concentration. Group lessons or lectures by an adult are seldom found in a Montessori classroom, and learning abounds. Children remember what they learn. Montessori is the fastest growing and most successful method of education today (International Montessori Council, n.d.).

Neuron. Dictionary definition: noun; noo r-on; a specialized, impulse-conducting cell that is the functional unit of the nervous system, consisting of the cell body and its processes, the axon and dendrites (see Figure 14).

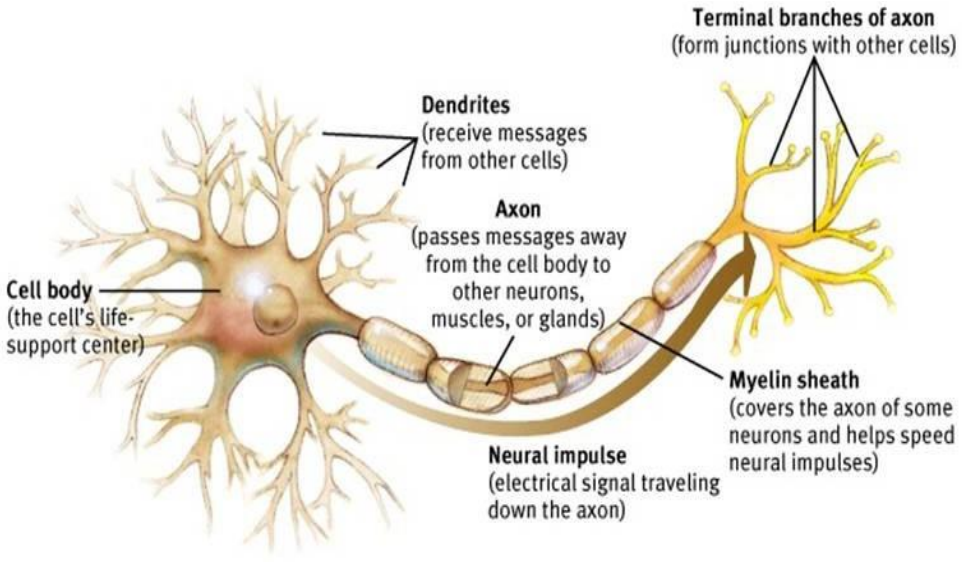


Figure 14. The Neuron and Its Functions (APPsychology, 2018)

Neurotransmitter. Dictionary definition: noun; noor″o-trans´mit-er; a substance (e.g., norepinephrine, acetylcholine, dopamine) that is released from the axon terminal of a presynaptic neuron up-on excitation, and that travels across the synaptic cleft to either excite or inhibit the target (Miller-Keane, 2007) (see Figure 15).

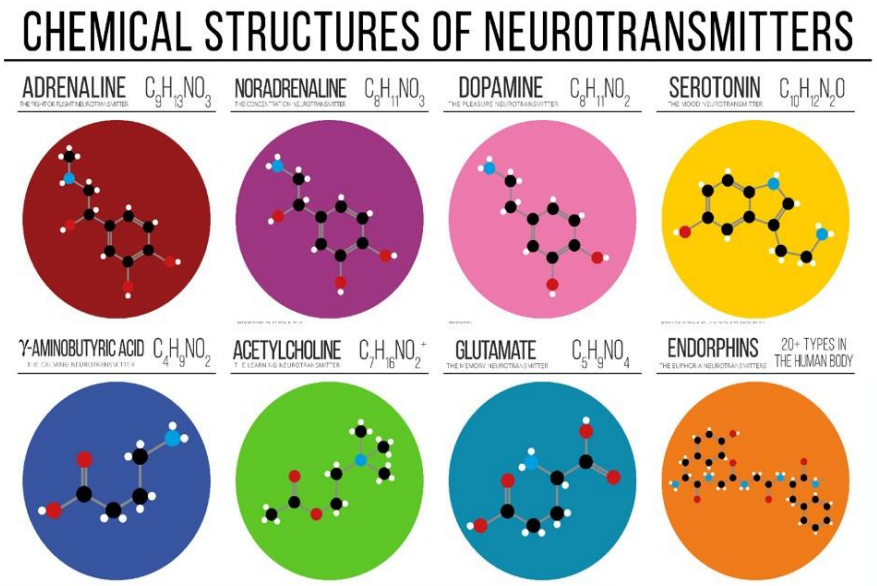


Figure 15. Chemical Structures of Neurotransmitters (Miller-Keane, 2003)

Reticular activating system (RAS). Part of the mammalian brain located in the brain stem that controls the four states of sleep and arousal: waking, asleep (resting or slow-wave sleep), asleep and dreaming paradoxical/active (rapid eye movement sleep), and behavioral motivation (breathing, and the beating of the heart) (see Figure 16).

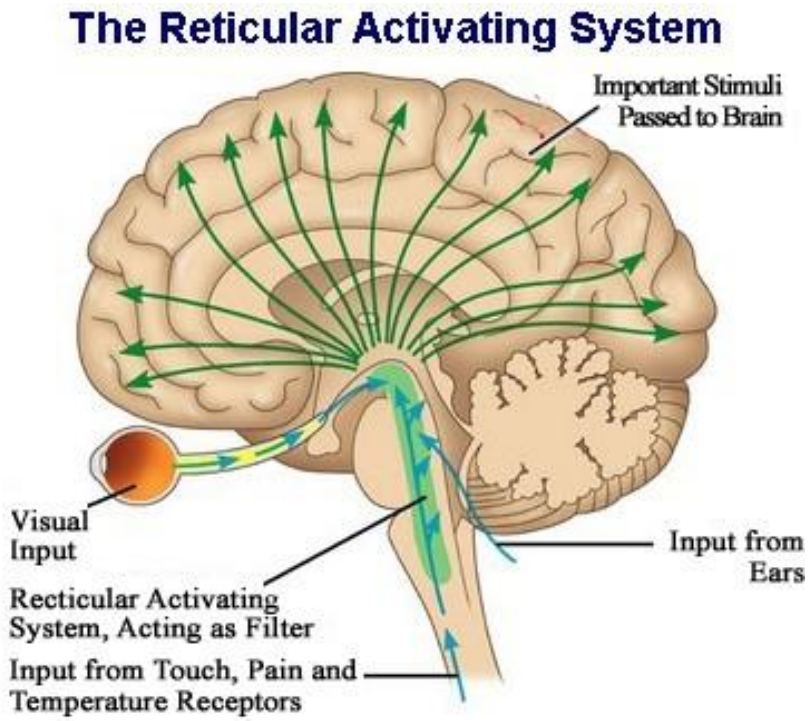


Figure 16. RAS Reticular Activating System (Marieb, 2003)

Synapse. Dictionary definition: noun; syn·apse|\ˈsi-ˌnaps; the point at which a nervous impulse passes from one neuron to another (Merriam-Webster, 2019). In the central nervous system, a synapse is a small gap at the end of a neuron that allows a signal to pass from one neuron to the next. Synapses are found where nerve cells connect with other nerve cells. Synapses are key to the brain's function, especially when it comes to memory (see Figure 17).

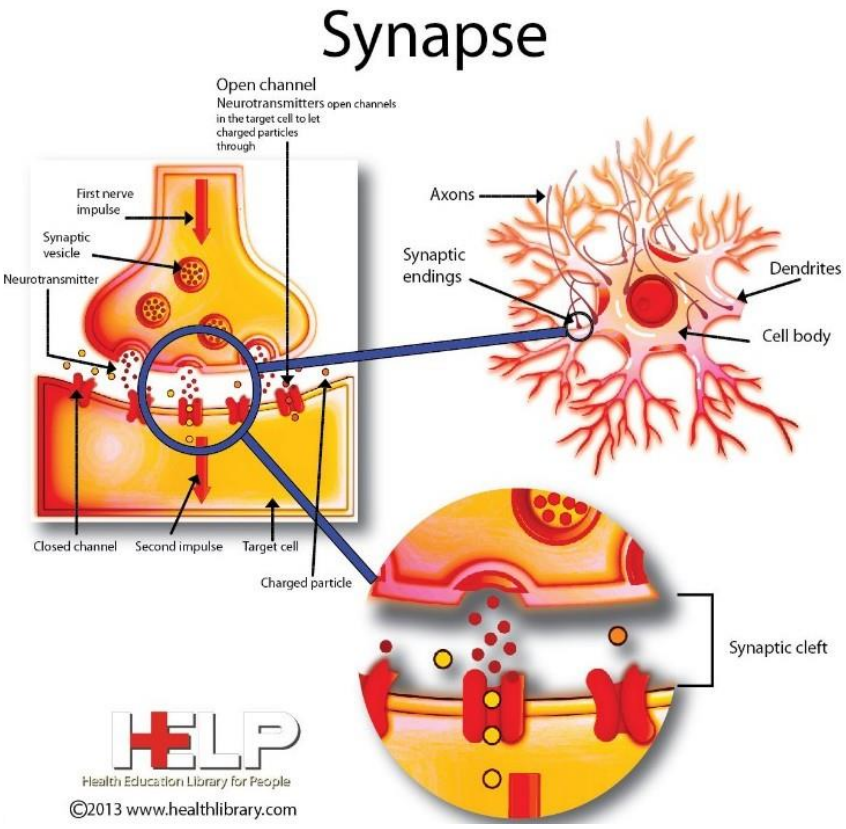


Figure 17. Synapse (Health Library, 2020)

Synaptic plasticity. Change that occurs at synapses, the junctions between neurons that allow them to communicate. Synaptic plasticity controls how effectively two neurons communicate with each other. The strength of communication between two synapses can be likened to the volume of a conversation. When neurons communicate, they do so at different measures of strength. Synaptic strength is not static, but rather can change in both the short term and long term. Synaptic plasticity refers to these changes in synaptic strength (see Figure 18).

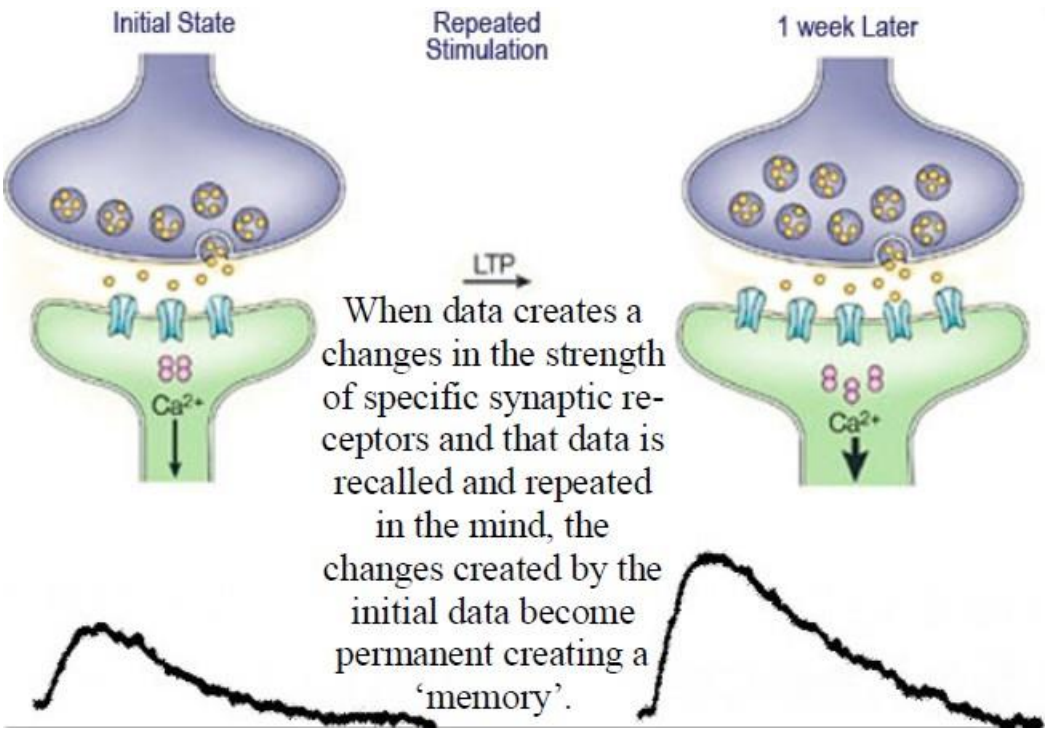


Figure 18. Synaptic Plasticity (McAuliffe, 2018)

Thought/web. Allegorical models representing the structure memories in the brain. These are imaginary structures that were designed to aid in visualization and comprehension of the various processes of learning and memorization described in the following pages (see Figure 19).

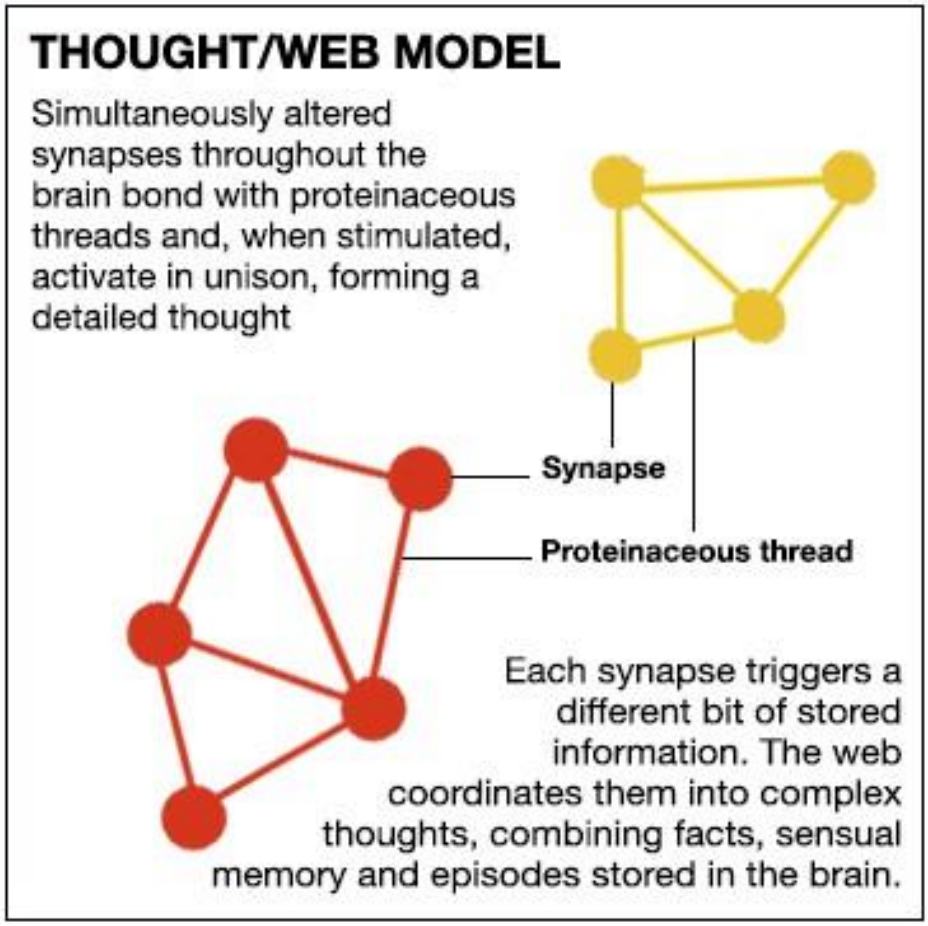


Figure 19. Thought/Web Model (Digital illustration by Wm. J. Castello)

Chapter 2 Research

The purpose of this research is to discover the basic biological, psychological, pedagogical, and human-based factors that affect an individual's ability to accept, retain, and utilize information. This research explores the biology of the human mind. It seeks to define psychological triggers that compel the learner to accept information and examines the current efficacy of teaching methods, comparing them with redesigned methods in current use. The research seeks to understand the effects of the physical environment as they pertain to the learning process. The final area of research consists of human-centered experiments with the purpose of focusing the design of an optimal method of teaching in the perspective of actual human beings. This research spans four disciplines: neuroscience, psychology, pedagogy, and human-centered design (see Figure 20).

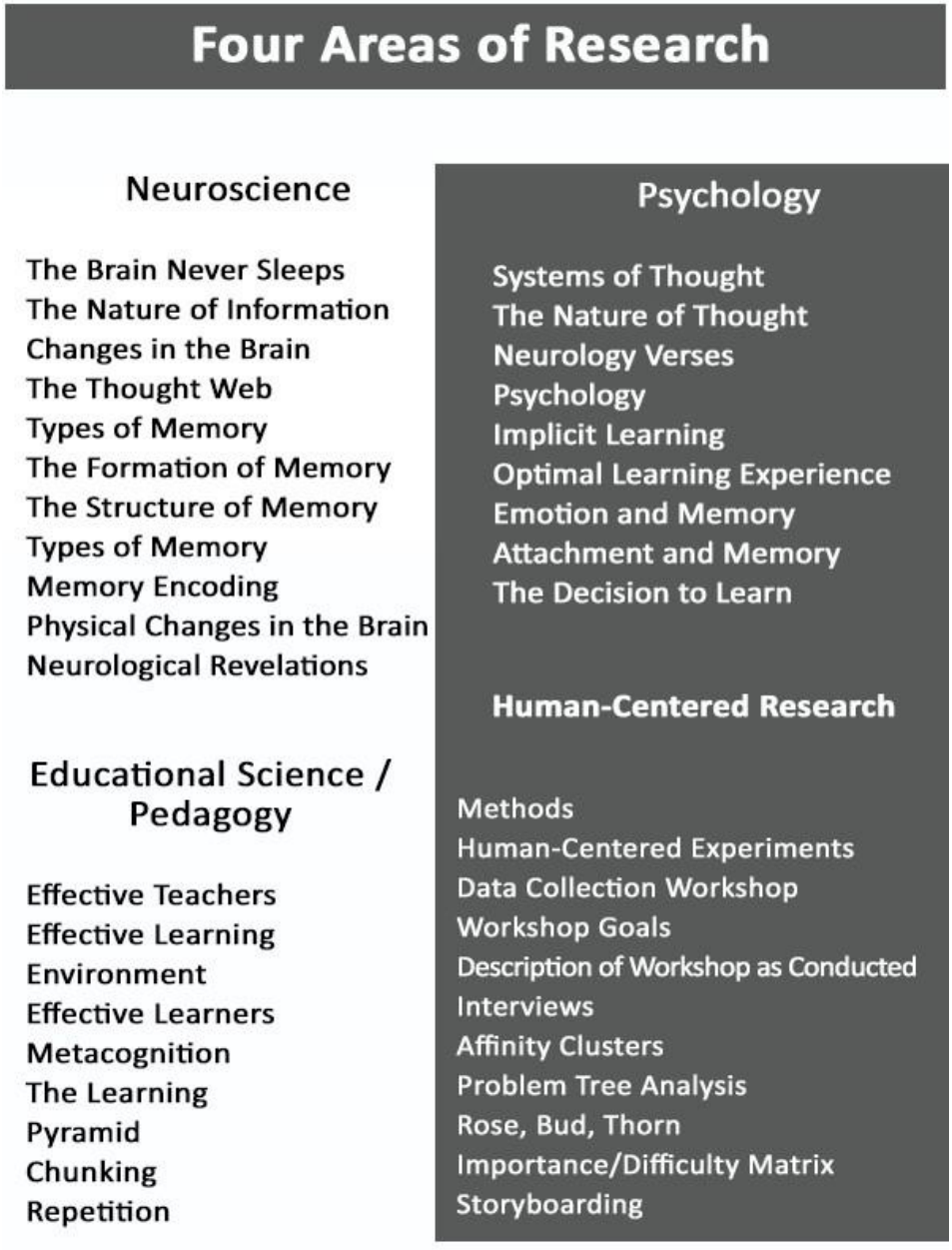


Figure 20. Four Areas of Research

Neuroscience

Neuroscience is necessary to understand the basic biology of the human mind as it relates to the process of creating thoughts, memories, knowledge, and intelligence. Intelligence is the ability to utilize and combine units of information (memories), stored in the mind to fuel the knowledge-building process. The process involves reason, relationship perception and analogies, understanding more complex concepts, problem-solving, calculating, seeking information, and learning and compounding knowledge. It allows the individual to perceive new concepts, discover new knowledge, and even imagine unique worlds. Intelligence is the driving force behind the evolution of humanity. It allows mankind to change, improve, explore, and refine every aspect of itself and the world around it.

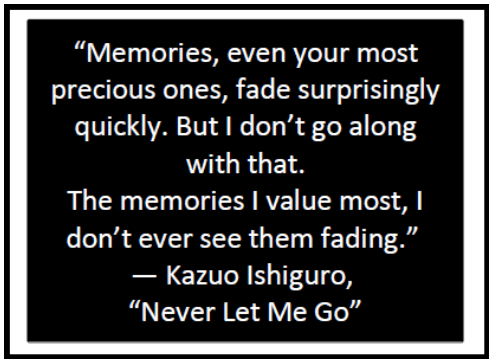
The Brain Never Sleeps

The brain is in a perpetual state of awareness. Sensory data is received and processed in both waking and sleeping states. Even when consciousness is suppressed by chemical or trauma introduced into the body, the brain continues to function.

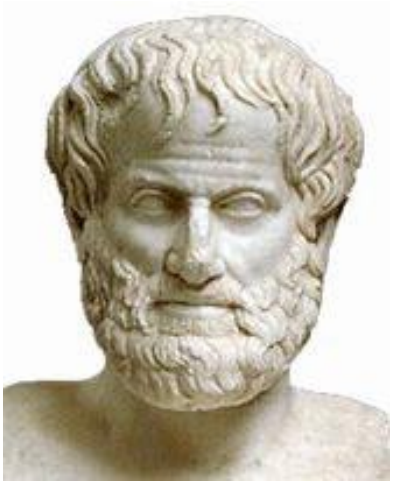
The mind's ability to receive and process information while insensate was proven in 1964, when physicians at the University of California Hospital, San Francisco

> inadvertently discussed their personal, sometimes unpleasant, interactions with individuals while operating on patients under the influence of anesthesia. Upon revival some of the patients freely recalled the doctor's discussion. When hypnotized, other patients who had denied recalling doctor's conversations were able to repeat them word-for-word. (Sweeney, 2009, pp. 171-172)

Chantal Kerssens (2010*)* stated of this that various studies conducted to deny the validity of this phenomenon were based upon theoretical models and do not account for actual patient responses during postoperative testing and are thereby skewed and erroneous. In short, previous theoretical studies denying patient recall were disproven. The brain's ability to collect data is continuous from the organ's first moment of viability until its clinical death. In essence, the mind is always opened to receive and process information.



The Nature of Information



The nature of information needs to be defined, and since information is stored as a series of thoughts, the nature of thought must be understood. Aristotle made the first recorded inquiries into natural science.

In his treatise *On the Soul* written circa 350 BC, he put forth the first observations of what now would be called biopsychology. Of the many observations that he made about the nature of the human mind in this treatise, the most pertinent to this thesis is his explanation of memory. Here, he distinguished memory from other internal images. A memory is a mental

picture (phantasm) that can be recovered. Aristotle believed an impression is left on a semi-fluid bodily organ that undergoes several changes in order to make a memory. His early observations became a foundation for understanding the human mind.

The modern quest to understand the nature of thought began with scientific inquiries. These inquiries turned to obtaining information pertaining to the biomechanical function of the brain when processing information. This line of inquiry led to tracing the origins of neuroscience and the basic premises upon which this science has been established.

The Anglo-Irish natural philosopher and scientist Robert Boyle (1627-1691) also turned his attention to the functions of the human mind. When he heard of cases of what is known today as psychosomatic illness, he became fascinated in the physical reaction to memories. He is credited as the first person to experiment on people afflicted with this circumstance, thus creating a path for neuroscience. Gordon Shepherd's book *Creating Modern Neuroscience: The Revolutionary 1950s* traces the origins of neuroscience and the processes involved in learning. It marks the beginnings of connecting the functions of the brain with the formation of memories with the anatomist Santiago Ramón y Cajal who discovered synapses in the brain. The modern research began in earnest with Donald Hebb. Many physiological changes mapped in the living human brain are outlined in Hebb's and Shepherd's books. These findings were incorporated to better understand the processes in layman's terminology (Hebb, 1980); Shepherd (2009).

Changes in the Brain

Physical changes occur within the brain to create thoughts. Of the 86 to 100 billion neurons (average) and the estimated 100 trillion synapses in each human brain, a unique combination of several pairs of each fire simultaneously. Unique series of synapses change in their strength. Some grow weaker and some stronger. They become a coordinated singularity working together to contribute to a unique simultaneous reaction. This reaction fires repeatedly, forming an imperceptible connection of lipoproteins, strengthened through repetition, that emit neurotransmitters (chemical messengers) connecting this unique structure to other parts of the brain and the nervous system. These neurotransmitters virtually control all bodily functions. When triggered, the entire series of altered synapses fire as one. This is the structure of a single thought also known as an *engram*.

> The synaptic plasticity and memory (SPM) hypothesis are not identified with any one individual scientist, it being an idea that has come forward in various guises over the years (…). At its heart is the notion that the memory of prior experience is mediated by the reactivation of 'traces' or 'engrams' whose basis involves alterations, possibly bidirectional alterations, in synaptic efficacy. The intellectual debt to Hebb, in particular, is very clear but the concept of 'memory of prior experience' has to be unpacked with respect to the distinct ways in which it can be interpreted. The most everyday sense of memory is that of an event happening to someone, it somehow being recorded in their brain, and then this person later bringing to mind some representation of that same event. (Takeuchi et al., 2014, p. 2).

The Thought Web

Engrams are single units of thought. A *thought web* is a complex memory consisting of a coordinated series of related engrams that, when triggered, are recalled to conscious thought simultaneously. When a single engram or bit of information is triggered for recall, it comes to conscious thought attached to other related engrams (Frankland et al., 2019).

The thought web is theoretically a completely unique conglomeration of related engrams that is created when change to unique sets of synapses become permanent and is interconnected by protein links. This study presents the concept long-term of a myriad of thought/ webs, crossing, intersecting, and interacting with each other, to construct an understandable model of an interconnected network. There are several types of memories formed within the brain. This study focuses upon the processes that culminate in memory (see Figure 19).

Types of Memory

Long-term memory is often divided into two further types: explicit (or declarative) memory and implicit (or procedural) memory (see Figure 21).

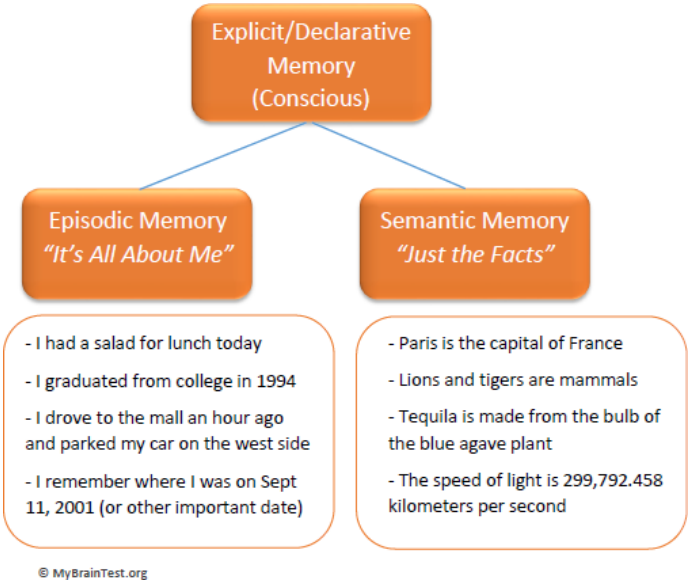
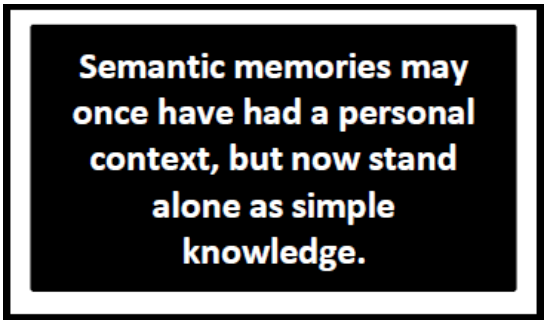


Figure 21. Types of Memory (MyBrainTest, n.d.)

Declarative memory is memory of facts and events that can be consciously recalled. It is sometimes called explicit memory because it consists of information that is explicitly stored and retrieved, although it is more properly a subset of explicit memory. Declarative memory can be further subdivided into *episodic memory* and *semantic memory*.

Episodic memory represents our memory of experiences and specific events in time in a serial form, from which we can reconstruct the actual events that took place at any given point in our lives. It is the memory of autobiographical events (times, places, associated emotions, and other contextual knowledge) that can be explicitly stated. Individuals tend to see themselves as actors in these events, and the emotional charge and the entire context surrounding an event, not just the bare facts of the event itself, is usually part of the memory.

Semantic memory is a more structured record of facts, meanings, concepts, and knowledge we have acquired about the external world. It refers to general factual knowledge, shared with others and independent of personal experience and of the spatial/temporal context in which it was acquired. Semantic memories may once have had a personal context, but now stand alone as simple knowledge. It therefore includes such things as types of food, capital cities, social customs, functions of objects, vocabulary, understanding of mathematics, etc. Much of semantic memory is abstract and relational and is associated with the meaning of verbal symbols.



The semantic memory is generally derived from the episodic memory, in that we learn new facts or concepts from our experiences; the episodic memory is considered to support and underpin semantic memory. A gradual transition from episodic to semantic memory can take

place, in which episodic memory reduces its sensitivity and association to particular events so that the information can be generalized as semantic memory.

Procedural memory, on the other hand, is the unconscious memory of skills and how to do things, particularly the use of objects or movements of the body such as riding a bike, tying a tie, or walking up a slope. These "body memories" are typically acquired through repetition and practice and are composed of automatic sensorimotor behaviors that are so deeply embedded that we are no longer aware of them (Mastin, 2010) (see Figure 22).

Of the 86 to 100 billion neurons (average) and the estimated 100 trillion synapses in each human brain, a unique combination of several pairs of each fire simultaneously.

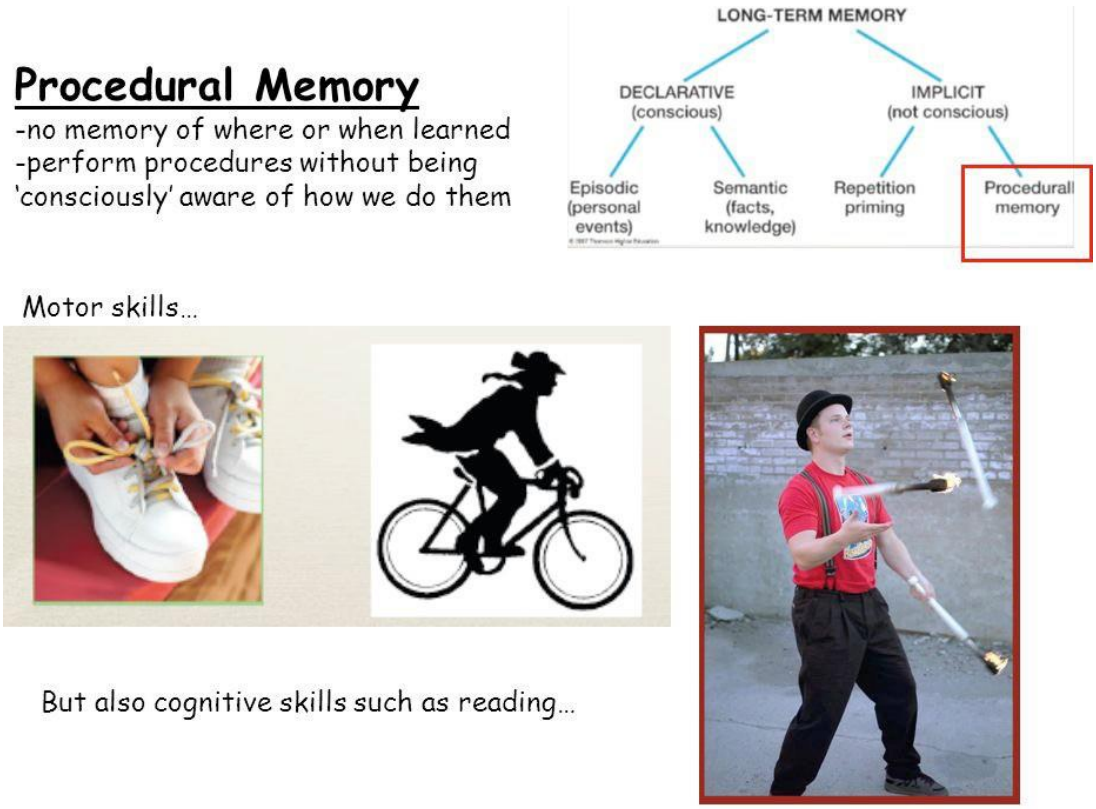
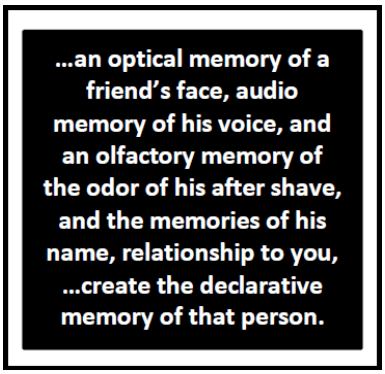


Figure 22. Procedural Memory

The Formation of Memory



The research and experimentation of this thesis are focused upon usable declarative memory, formed through combining the specific facts of semantic memory and the narrative memories of episodic memory, from which usable knowledge is shaped.

The Structure of Memory

Complex thoughts are constructed primarily from a compilation of factual material. This is *semantic knowledge*, the structured record of facts, meaning, and knowledge about the external world stored in the mind - general factual knowledge. Semantic memory is in part constructed from information provided by the eyes, ears, nose, taste buds, and skin, known as *sensual input*. For example, when recalling an acquaintance, the thought web draws bits of information from many parts of the brain and reassembles them as a whole. Semantic information (optical memory of a friend's face, audio memory of his voice, olfactory memory of the odor of his after shave, his name, relationship to you, factual data such as age, height, weight, etc.) is combined with episodic memory (of conversations and experiences shared) to create the declarative memory of that person. When recollected, an entire detailed memory, a unique set of data consisting of dozens of pieces of disparate information from different parts of the brain, is assembled and utilized by the mind as knowledge of a specific person. This knowledge allows for further interaction with this individual.

A further category of declarative memory, referred to as *autobiographical memory*, is sometimes distinguished, although it is actually just one area of episodic memory (see Figure 23). Autobiographical memory refers to a memory system consisting of episodes recollected

from an individual's own life, often based on a combination of episodic memory (personal experiences and specific objects, people, and events experienced at particular times and places) and semantic memory (general knowledge and facts about the world).

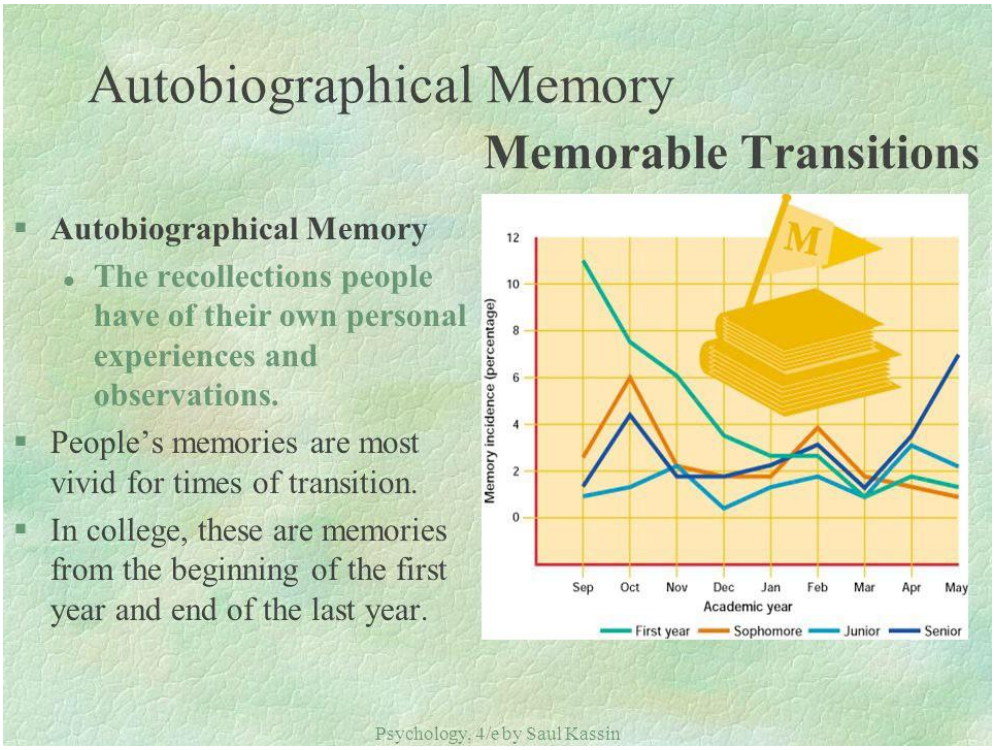


Figure 23. Autobiographical Memory (Cassin, 2004)

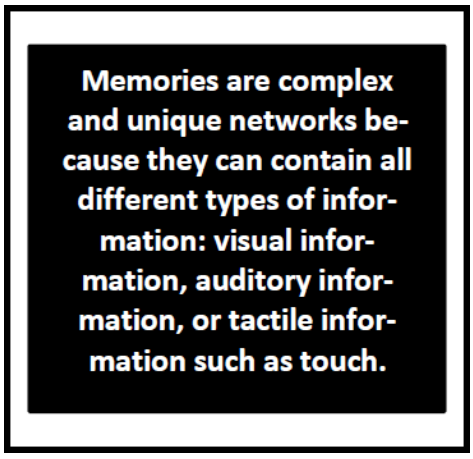
The preceding research provides a cursory model of a thought's conceptual structure. Next, the research seeks to determine how these theoretical structures remain intact within the brain and form memories. In her book *Blue Sky Science: How does your brain form memories*, Haley Vlach described a memory as comprised of many types of information tied together in one experience. The thought web model described earlier corresponds with the imagery in Vlach's theory.

The hippocampus is responsible for assigning relative importance to a memory and either allowing it to fade or committing it to long-term storage.

Vlach described the memory creation process as the connection of bits of information collected by various organs of sense, bound by one experience, location, and time. Bound by some commonality, these bits travel over a period of 2 to 12 hours to the brain's hippocampus, which integrates the bond information to create a memory. The hippocampus is also responsible for as- signing relative importance to a memory and either allowing it to fade or committing it to long- term storage. Vlach then describes *recall*, stimulating activity in this stored memory by exposure to information, sensual inputs, or similar situations that reactivate the memory (Vlach, 2015).

Memories are differentiated by the perceived importance of their content. This decision may be conscious or subconscious. If the information is of little value, it is erased after a short period of time (*short-term memory*). Ashort-term memory generally consists of temporary data (5 to 9 specific bits of data) stored between 0 and 30 seconds; for example, a phone number.

If the information is judged important, it moves to *long-term memory*; a memory may be stored for life. All memory referred to in this study is long-term memory. The formula for creating a long-term memory consists of repetition and reflection in the mind, and an incubation period of approximately 24 hours followed by migration to the hippocampus.



The award-winning New York Times science writer Sandra Blakelsee explains in layman's terms in her book *Phantoms in the Brain* the formation of chemical and/or electrical changes in the human brain, simple protein bonds and pathways connecting specific neural synapses and the simultaneous activation of these mechanisms to form a memory. A rationalization of the web model is offered in this thesis:

> The reticular activating system, a tangle of neurons in the brain stem that projects widely to vast regions of the brain, activates the entire cerebral cortex, leading to arousal and wakefulness, or, when needed, a small portion of the cortex, leading to selective attention. (Ramachandran & Blakelsee, 1998, p. 116)

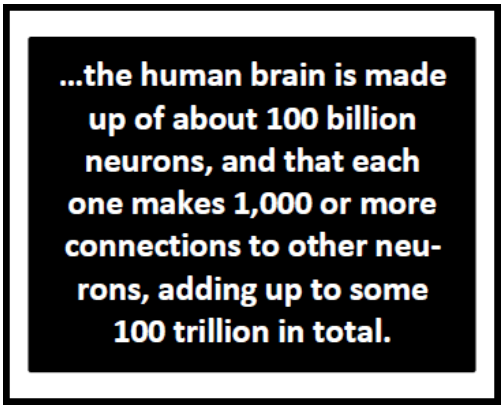
Research of the biomechanics of the human brain's process of retaining memory leads to the question of capacity. How much information can a human mind retain? The answer to this question is essential to understanding intelligence (see Figure 24).

	Sensory Register A temporary store for information from our senses.	**Short Term Memory** If attention is given, information passes into here.	**Long Term Memory** A permanent store of information.
Capacity The amount of information that can be stored.	Large – Eg; Each eye has 100 million cells each storing visual data.	7 items plus or minus 2.	Unlimited
Coding The format in which it's stored.	Depends on the sense Eg; Auditory, Visual, Tactile, Smell, Taste. Can be **Iconic** (Visual is stored visually) or **Echoic** (sound is stored acoustically)	Acoustic (sounds)	Semantic (meaning). It's split into 3 stores: Episodic, Semantic and Procedural.
Duration The length of time information can be stored.	Limited – If no attention given, **spontaneous decay** takes place and it fades away quickly.	Limited – 18 seconds.	Unlimited

Figure 24. Memory Stores, Coding, Capacity, and Duration (Findlotte, 2016)

Intelligence is the amount of recallable data that an individual can utilize and build upon. Like a computer, the mind is only as powerful as the data it can store and process. Both the mind and a computer have access to materials beyond their stored information, but it is the inherent knowledge in the human mind that drives all searches.

A 2016 article from *Scientific American* reveals groundbreaking research from the Salk Institute for Biological Studies that the capacity of the human brain is much larger than previously thought (Interlandi, 2016). It is established knowledge that the human brain is made up of about 100 billion neurons, and that each neuron makes 1,000 or more connections to other neurons, adding up to some 100 trillion in total.



We also know that the strengths of these connections, or *synapses*, are regulated by experience. A simple biological process takes place trillions of times: Upon stimulation, two neurons on either side of a synapse are simultaneously active, customizing the basic function of that synapse to become more robust. The dendritic spine (the antenna on the receiving neuron) also becomes larger to support the increased signal strength. The result is a customized network of vigorous synapses and dendritic spines, connected by protein threads. Dendritic spines were recently discovered to exist in three sizes: small, medium, and large; the size determines their susceptibility to stimulation. This network, when exposed to specific stimuli (recalled), functions

as a specific memory (Interlandi, 2016). Memories can contain all different types of information: visual, auditory and tactile. The most resilient memories are those with multiple kinds of information associated with them, which can be stimulated by a wider range of triggers (Vlach, 2015).

The next questions are, "How long can these complex, customized networks be stored in the brain? Do their viability and utility relate to their ability to be stimulated?"

Data is stored in the brain in two basic ways. The most common and immediate way is known as short-term memory. The more complex and advantageous way, essential to forming and retaining knowledge, is long-term memory. The primary model for memory is outlined in "Theory of Memory" by Richard Atkinson and Richard Shiffrin. Their 1968 theory proposes that there are specific components of human memory: sensory, short-term, and long-term (see Figure 25; Atkinson & Shiffrin, 1968).

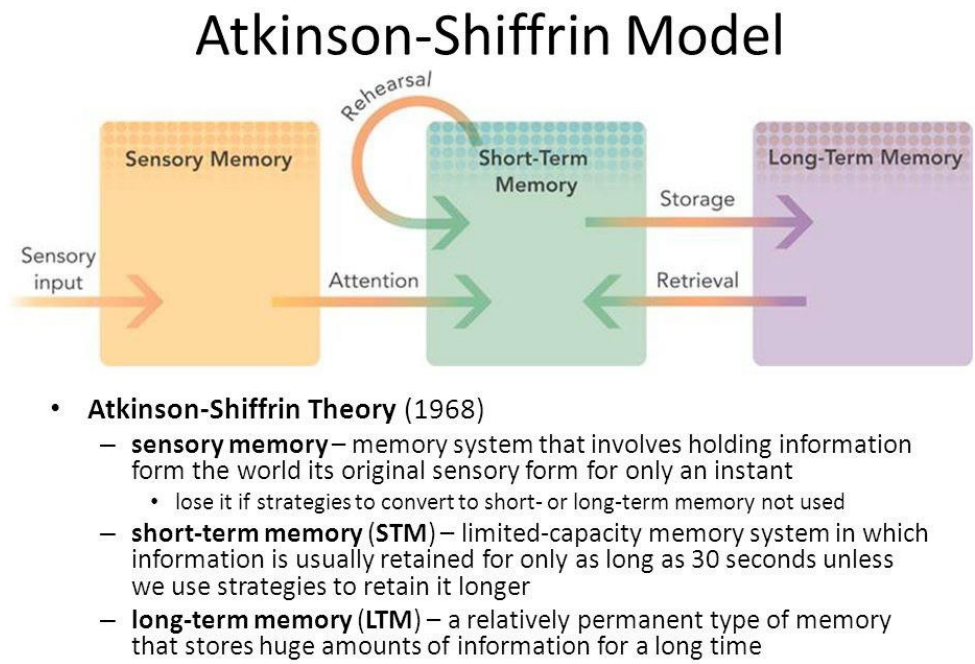


Figure 25. Atkinson-Shiffrin Model (1968)

Components of Memory

Sensory memory consists of any sensory information collected by the brain.

Short-term memory (also referred to as *working memory*) consists of memories of recent events that may need to be recalled for some reason, like when you last ate or what you had for breakfast this morning.

Atkinson and Shiffrin recognized two types of memories that are collected most commonly for the sensory register component: visual (iconic) and auditory (echoic). However, it is important to note that every human sense collects a memory (see Figure 26), the brain's solution for retaining important information it cannot afford to lose. Since the information decay rate is so high for most senses, the sensory register immediately "flags" important bits of data so they can be transferred into a person's working memory. Even short-term memory experiences information decay, but it is a slower process than decay in the sensory register. This storage point gives the brain time to evaluate whether or not the information retained is relevant. If it is, then the transfer process begins one more time.

Figure 26. What Makes a Good Storyteller?

Long-term memory is an almost permanent storage component. Information stored here is available on-demand. This data can also be transferred back to the short-term store so it can be manipulated. The purpose of a long-term store is to provide knowledge and experience at an individualized level. You memorized multiplication tables as a child; recalling that information and "data copying" to short-term storage to "display" that data when needed is evidence of long-term storage.

Long-term potentiation (LTP) as the "long-lasting increase in synaptic efficacy following high-frequency stimulation of afferent fibers."

Memory Encoding

In their book *Adventures in Memory*, Ostby and Ostby provided insight and added the important term *long-term potentiation* to the glossary. Hilde Ostby is a writer and editor, author of *Encyclopedia of Love and Longing*, and holds a master's degree in History of Ideas from the University of Oslo; Ylva Ostby is a clinical neuropsychologist with a PhD from the University of Oslo. Together, they examined long-term potentiation, a concept originally discovered by Terje Lomo, professor emeritus in medicine at the University of Oslo. They described it as "the smallest part of a memory, a tiny little memory trace." This trace (earlier described as an engram) is response to a recurring stimulus (Ostby & Ostby, 2018, p. 30-31).

Physical Changes in the Brain

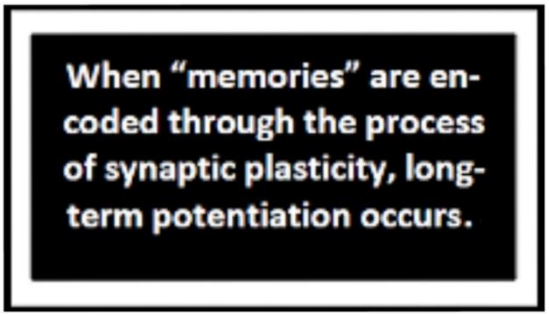
Delving into the body of research on the topic of long-term potentiation (LTP) revealed the history of its study. Early memory studies by Donald Hebb explored the functions of the brain's hippocampus as the mechanism of memory formation, but it was not until 1973 that long-term potentiation defined this specific mechanism. Shors and Matzel defined long-term

potentiation as the "long-lasting increase in synaptic efficacy following high-frequency stimulation of afferent fibers" (Shors & Matzel, 1997, p. 1). This definition reinforces the concept of a specifically formed web-like structure consisting of synapses, dendritic spines, and a framework of protein fibers, specifically configured to reproduce a memory when stimulated– again, reinforcing the web model of memory posited early in this section.

Research revealed the need to understand and create a model of the brain's memory-encoding process. Identifying and tracking memories is the key to understanding the process of long-term encoding. Neuroscience currently employs *functional magnetic resonance imaging* (fMRI), which couples MRI technology with controlled stimulation of the brain at different lengths of time to identify a unique stimulation pattern (a thought or memory). This led me to include dissemination of unique information and tested recall over different lengths of time in my human-based thesis experimentation (see Methodology section).

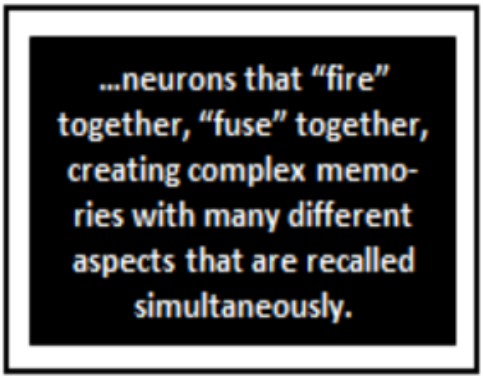
Neuroscientists using fMRI testing not only identified unique thoughts over time but furthered my understanding of their nature by finding that each stored thought, when stimulated, involved a distinct communication between the hippocampus where the thought is "stored" and the cerebral cortex of the brain, which is responsible for intelligence, personality, motor function, planning and organization, touch, and processing sensory information and language (Sneve et al., 2015).

They argue that an initial intensity-based encoding is necessary for short-term encoding of events (short-term memories). Additional processes involving hippocampal/cortical communication are required to transform these encoded events into stable long-term memories (Sneve et al., 2015).



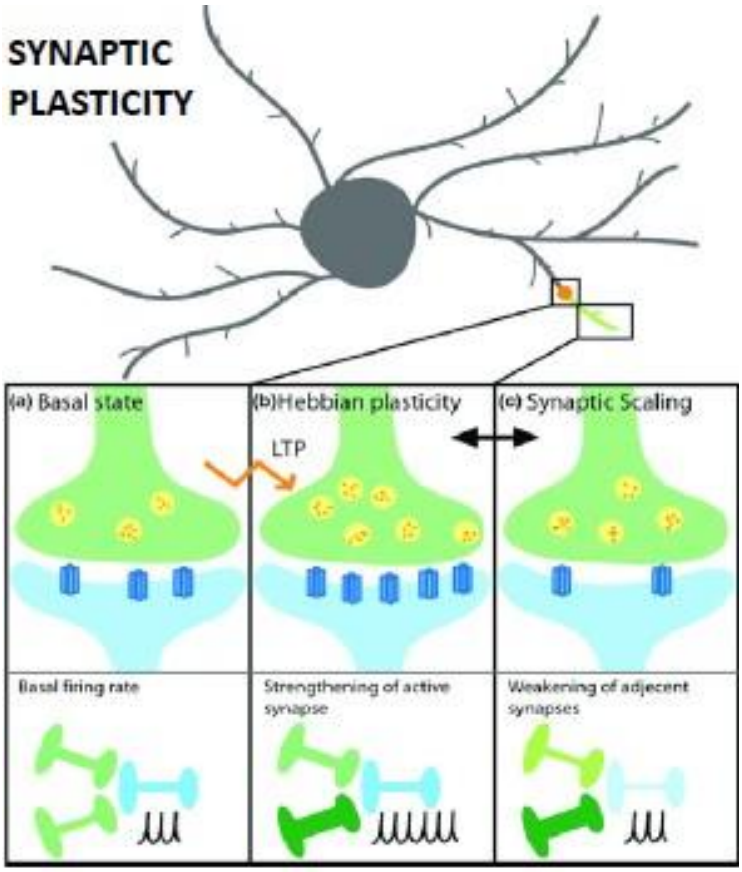
Long-term potentiation involves the communication processes the hippocampus and cortex use to turn a thought into a long-term memory. LTP is described as a long-lasting strengthening response of the postsynaptic nerve cell when the stimulation of that synapse occurs repeatedly; the capacity of groups of brain cells to respond in specific coordination when exposed to a specific stimulus, whenever and however often that stimuli occur; and the permanently enhanced transmission of signals to specific synapses by their surrounding neurons. Long-term potentiation involves *synaptic plasticity*, the capacity of signal transmission to specific synapses by their surrounding neurons to vary in strength. When memories are encoded through synaptic plasticity, long-term potentiation occurs. This change in the cellular mechanisms of the brain allows the permanence of memory and becomes the basis of learning (FLOW Psychology, 2014).

To further clarify, synaptic plasticity is the functional change to the junctions between neurons that allow them to communicate; that is, synaptic plasticity controls how effectively two neurons communicate with each other. The strength of communication between two synapses can be likened to the volume of a conversation. When neurons talk, they do so at different volumes–some neurons whisper to each other while others shout. The volume setting of the synapse, or the *synaptic strength*, is not static but can change in both the short term and long term.



Synaptic plasticity occurs in either short-term or long-term form. Short-term synaptic plasticity is useful in a conversation or while watching a television program. It allows a stream of information to remain in sensible order on a temporary basis. The connections in the brain expand (at a whisper) to collect and make sense of the information. If the information is not considered important or has little accompanying stimulation, the connections in the brain that

expanded to process the information shrink back to their original state and the information is eliminated. This allows room for the connections to expand, collect information deemed essential (at a shout), and remain in this transformed configuration, providing a unique and permanent memory. The plasticity refers to the "volume" of the signal. The volume in turn assigns relative value to the information collected at the point of that chemical reaction (see Figure 27).



Hebbian and non-Hebbian forms of synaptic plasticity. During basal state, synapses process stimuli via AMPARs (a, upper panel), leading to a defined firing rate (a, lower panel). LTP induces Hebbian plasticity, during which synapses increase the number of AMPARs in an input-specific fashion (b, upper panel), thereby strengthening synapses. Increased stimuli lead to an increased firing rate (b, lower panel). Synaptic scaling, the most studied form of non-Hebbian plasticity, acts via postsynaptic reduction in AMPARs (c, upper panel) through weakening synapses adjacent to the potentiated synapse to restore homeostasis and optimal global firing rate (c, lower panel).

Figure 27. Hebbian and Non-Hebbian Synaptic Plasticity (Schafer et al., 2017)

A new question arose. Since memory is a unique configuration of synaptic connections that physically transform to create a thought or memory, what are the functions of the individual neurons connected through this process? *The Secret Life of the Mind: How Our Brain Thinks, Feels and Decides* bridges a gap between neurology and psychology by presenting a direct connection between a physiological change in the brain as causality for the recollection of memories. This book defines the thought web model of memories central to this thesis (Sigman, 2015). This book explains from a different perspective the structural changes in the brain that occur in the creation of long-term memory. Mariano Sigman also creates a link to the field of psychology, approaching the creation of long-term memory as a function beyond the physical changes by including the concept that emotions are also retrieved. He cites the work of Donald Hebb, the pioneer of neuroscience, who theorized that when neurons are stimulated, some will be changed to retain memory of a place, others the memory of an odor and yet others, the memory of an emotion experienced in the course of the stimulation. Hebbs found that neurons that fire together fuse together, creating complex memories with many different aspects that are recalled simultaneously (Sigman, 2015).

As an example: Two people meet and find each other attractive at a barbeque, on a cool summer evening, under a star-filled sky. When that occasion is recalled, the details (all of which were created by simultaneous stimulation of different pairs of neurons, triggered by different sensual stimuli) contain the individual memories of each stimuli simultaneously. Therefore, the memory triggers the recollection of the initial attraction between the two individuals, the smell and taste of the barbeque, the tactile memory of the ambient temperature, and the ambient lightning of a fire and the star-filled sky. The different stimuli are “wired” together and create a fully integrated memory (Sigman, 2015).

Neurological Revelations

An initial exploration of neuroscientific literature provided a working model of thought and the path by which thought becomes memory. The literature further explains long-term memory, its formation and storage, its relative permanence and its interconnectivity within the brain, and the process by which the brain differentiates between important and disposable data. In short, this research has provided understanding of the biology of long-term memory and helped formulate and rationalize the theoretical model of memory as a web-like structure formed in the brain. (see Figure 19).

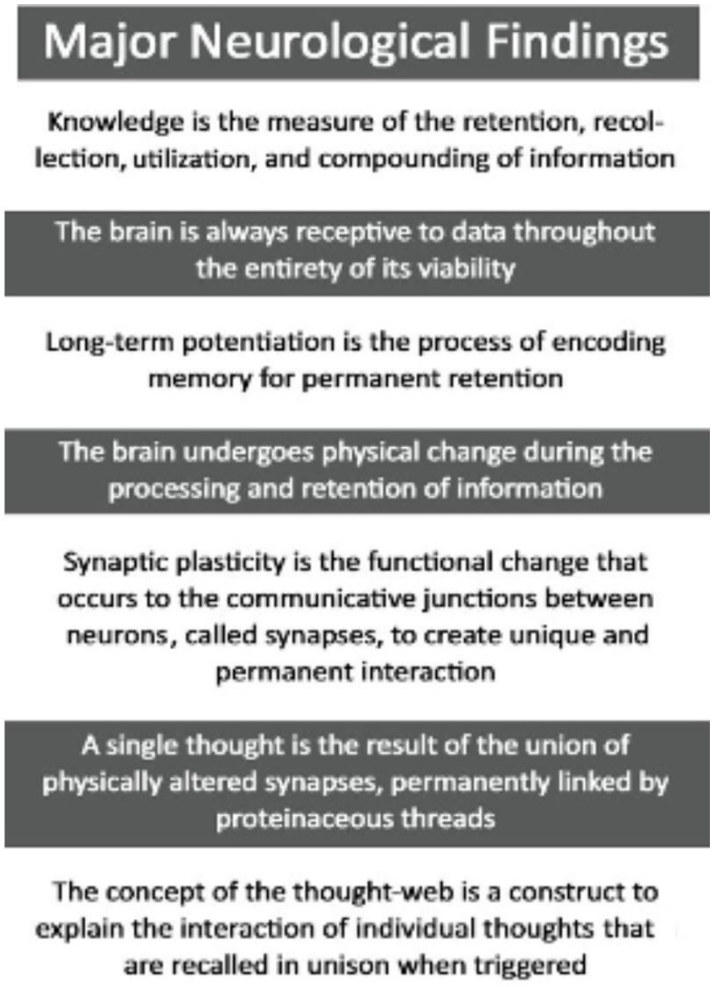
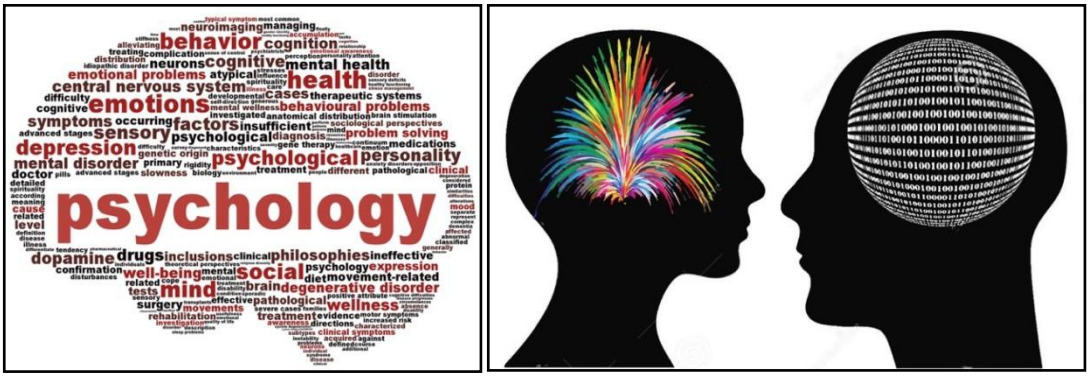


Figure 28. Major Neurological Findings of the Study

Psychology

Systems of Thought



How do we decide to retain knowledge? At this point, the observations of Daniel Kahneman in *Thinking Fast and Slow* become most significant in the pursuit of the answer to that question. He posits that the human mind functions in two modes, System 1 and System 2. System 1 operates quickly and spontaneously. It is the automatic default setting of human perception. Data entering the mind in this mode is swiftly triaged-either immediately identified (sometimes misidentified) or ignored. System 1 makes the decisions as to what System 2 will engage. System 2 is the analytical system that carefully considers, calculates, and forms complex thoughts. Thus, the frequent "doorman" of the mind is the impetuous, spontaneous System 1, which often irrationally formulates swift opinions and values pertaining to data. Often data presented to System 1 is misinterpreted, misunderstood, or simply rejected, never allowing it to become information. System 1 is the default mode in which the mind functions when not prompted by curiosity or any other stimulus to *willingly* engage the energy-draining System 2.

An example of this paradigm can be found in a simple magic trick. When a magician produces a dove from seemingly thin air, System 1 accepts that act as "magic." It is inexplicable, entertaining, and accepted as a marvel. If the same trick was presented to a person engaging

System 2, that person would question the reality of this phenomenon, searching for the mechanism, process, or skill that allowed the dove to appear instantaneously.

In the context of this thesis, understanding how to evoke the *decision* to willingly engage System 2, necessary to process data into information (the first phase of creating memory), is essential, and the field of psychology holds the keys to understanding the decision-making process. The following questions are posed: What triggers the employment of the System 2 mode of thinking? How does System 2 triage valuable data from disposable data? Can the mind be programed to accept potentially valuable data? Can System 1 be suppressed? How does emotion add or subtract from the value of data? In short, how does psychology effect long-term memory retention?

The Nature of Thought

The next goal is to formulate a methodology to optimize the acceptance, processing, storage, recall, and application of knowledge (Kahneman, 2011). To this end, the focus returns to the literature of Donald Hebb, who provides a unique model of the nature of thought. Hebb observed that memory is a complex reconstruction of a multi-faceted experience, in the absence of the experience recalled. Memory is the mind's ability to independently recreate an experience as a detailed mental image. His theory is that invention occurs as a result of compiling memories to conceive of something that has never been seen or heard of before. "Most thought is directly related to or excited by what is now present, but it is not limited to the present situation, and it always tends to be creative in some degree" (Hebb, 1980, p. 3).

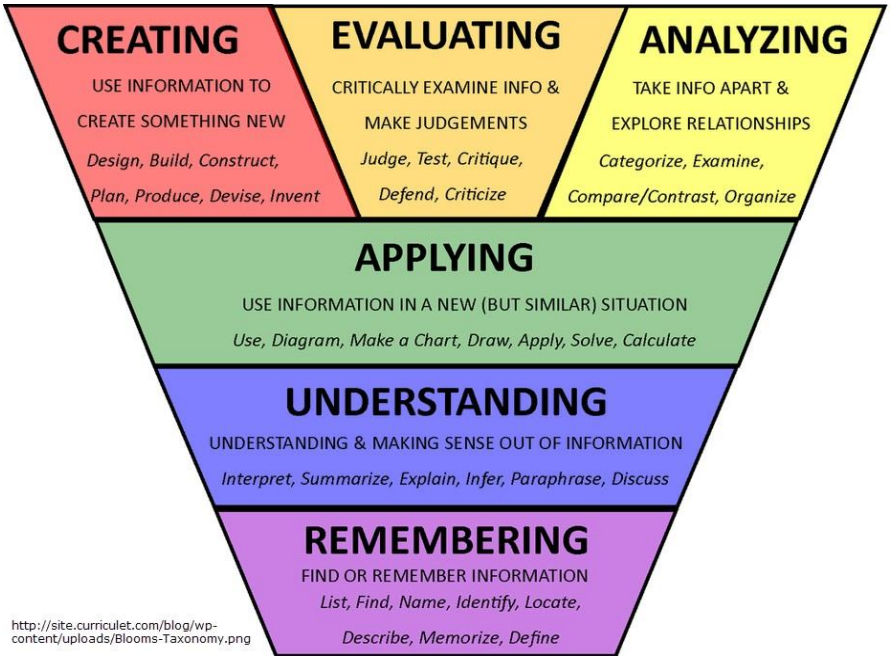


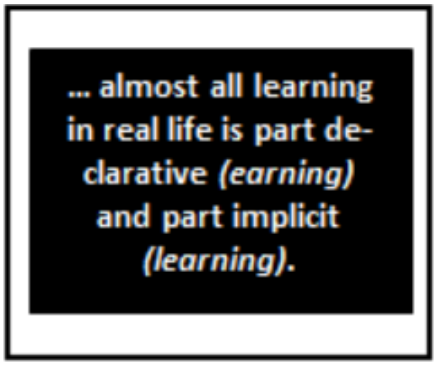
Figure 29. Bloom's Taxonomy (Curriculet, n.d.)

A methodology to optimize acceptance, processing, storage, recall, and application of knowledge is to create interest by gaining the learner's attention. The mind must be triggered to define the information presented as essential. This may be accomplished by creating a momentary element of excitement or emotional stimulation at the moment of information transfer. The mind of the recipient must be aware, alert, and in a heightened state of acceptance at the moment of information transfer (see Figure 29).

Neurology Verses Psychology

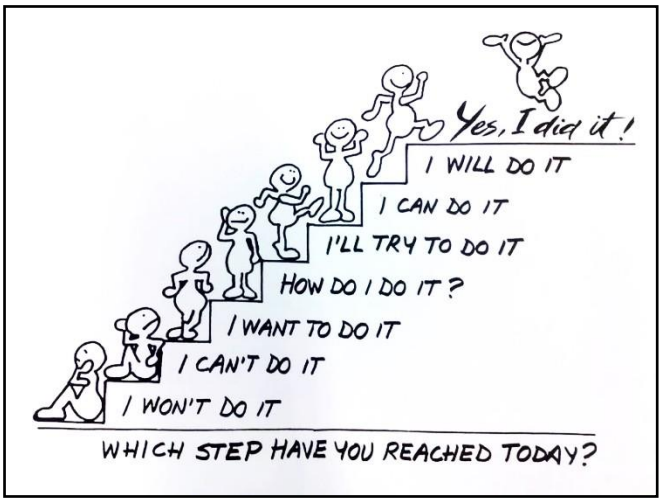
In *The Secret Life of the Mind*, the talented neurologist Mariano Sigman analyzed the functions of the mind, linking psychology to the neurological functions of the brain. The author cited the findings of great neurologist Larry Squire who divided learning into two categories. These two categories are *declarative learning*, which is conscious and can be explained in words, and *nondeclarative learning*, which includes skills and habits that are usually achieved without

the learner's awareness of the process. Declarative learning is when an individual learns the rules of a game and can in turn teach a new player those rules. In this case, the learner understands that he or she must work at remembering and understanding the rules through a deliberate process. Nondeclarative learning is when that new player becomes skilled at the game by playing it over and over again, unaware of the learning process (Sigman, 2015).



Implicit Learning

Implicit learning and implicit memory, forms of learning and memory that occur without the person's awareness, depend on different brain systems than those underlying consciously controlled (or explicit) learning and memory. Perceptual and conceptual priming are two examples of implicit memory. Perceptual priming is an increased ability to identify stimuli and is attributable to changes within perceptual brain processes (Curran & Schacter, 2001). "it is equally important to understand that they are inevitably abstractions and exaggerations, almost all learning in real life is part *declarative* and part *implicit*" (Sigman, 2015, p. 178-179).



The differentiation of these two learning paradigms must be considered when formulating a unique and effective learning methodology. Dissemination of specific information, such as a history or science lesson, requires a different approach than perfecting the use of oil paints or the operation of a bicycle.

New questions arose at this juncture: Does the mind have to consciously accept the data presented? Does an optimal state-of-mind for the acceptance of data exist? If so, can this optimal state-of-mind be attained through psychological or physical conditions? The author of *Your Memory: How It Works and How to Improve It*, Kenneth Higbee, revealed the state-of-mind, circumstance, physical wellness, and other external factors that can optimize or inhibit learning. He observed that students complain about forgetting what they had studied. While it may be true that they did not understand the material provided, it may also be true that they did not really study the material enough for it to be considered learned in the first place. They attempted to commit the information to short-term memory to facilitate testing but neglected to mentally or emotionally assign importance to the material.

'state-of-mind', circumstance, physical wellness and other external factors can optimize or inhibit learning.

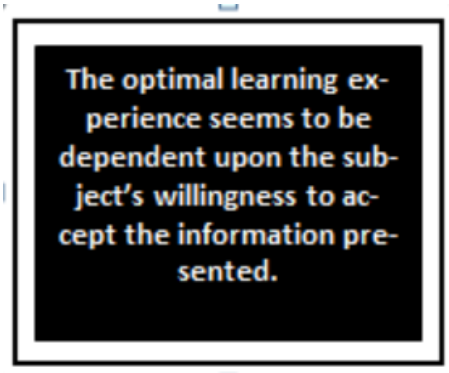
Information is encoded in different ways in the brain depending on whether they have emotional content. Memory attached to emotion is processed by the primitive structure at the center of the brain known as the amygdala.

The effect of assigning significance to the material would have triggered the mind to begin the process of committing it to long-term memory. He also noted that this phenomenon is at the root of the failure of cramming for a test (Higbee, 1996, p. 60).

The Optimal Learning Experience

The optimal learning experience seems to be dependent upon the subject's willingness to accept the information presented. But what are the optimal psychological conditions under which the system would be most effective? Do differences in the individual personalities of the learners affect their ability to accept information?

At the 14th Annual International Conference of the Bulgarian Comparative Education Society (BCES) held in Sofia, Bulgaria in June 2016, the effects of student personality upon academic achievement was a discussion topic. Slagana Angelkoska, Gordana Stankovska, and Dimitar Dimitrovski in their seminar and material entitled "The Personal Characteristics Predictors of Academic Success" discussed the effects of an individual's characteristics upon his or her ability to accept, process, recall, and utilize information. They consider the personal experiences, differences, talents, dispositions, and motives of the individual student. In short, they include the personality, environment, and activities of the individual as factors influencing an individual's ability to understand and retain knowledge.



The focus is shifted from a detailed biomechanical process to an individual participation or rejection of its implementation. This choice, either conscious or not, is based upon the psychological composition of the individual (Angelkoska et al., pp. 262-268). "If we analyze the personality of the student in depth, we will understand that the academic success, besides the influence of the curriculum external factors, is significantly influenced by the dominant traits of his personality" (Angelkoska et al., p. 262).

The original hypothesis of this research is that emotionally delivered data (information delivered associated with an emotional component) is more readily accepted and retained than information delivered without emotion. Inquiries of various individuals found specific memories. Michael Sweeney told us in his book *Brain: The Complete Mind; How It Develops, How It Works, And How to Keep It Sharp*, that "emotion improves memory." Information is encoded in different ways in the brain depending on whether the data has emotional content. He pointed out that simple memories have little or no emotional content and are encoded by the brain's hippocampus (Sweeney, 2009, p. 212). Memory attached to emotion is processed by the primitive structure at the center of the brain known as the amygdala (see Figure 1). This tiny and primal portion of the brain developed in the earliest of humans is most commonly associated with the emotions of fear and anxiety, and its size is positively correlated to the level of aggression in a given species. It is also associated with the emotion of pleasure, though mainly in a negative sense, (i.e., the pleasure sometimes inherent in aggression).

Emotion and Memory

The hippocampus is programmed for survival and is stimulated by emotion. Its function is to process data by imprinting it to many parts of the brain, to maximize the brain's ability to react to stimuli. While the hippocampus is an organ of logical processing and storage, the amygdala acts explosively, to imprint memory on as many parts of the brain as it possibly can. There is less of a chance of information rejection upon entering the mind with an emotional impetus through the function of the amygdala than when filtered through the logical, gaudier process. The shock of emotion causes the brain to release more chemicals and stimulate more neurons so the clothes you wore and what you said or did become linked with the memory of a disaster, whereas on a normal day such mundane minutiae would quickly be forgotten. "So called

flash-bulb memories linger in our mind because they were encoded with the most powerful of emotions" (Sweeney, 2009, p. 212).

Attachment and Memory

Upon further research, another psychological factor that affects an individual's acceptance of data became evident. *Attachment security* refers to a biological instinct in which proximity to an attachment figure is sought when the individual senses or perceives threat or discomfort. This instinct is predominantly expressed by juveniles but remains part of the life-long psychological make-up of most individuals in varying degrees of prominence (see Figure 30).

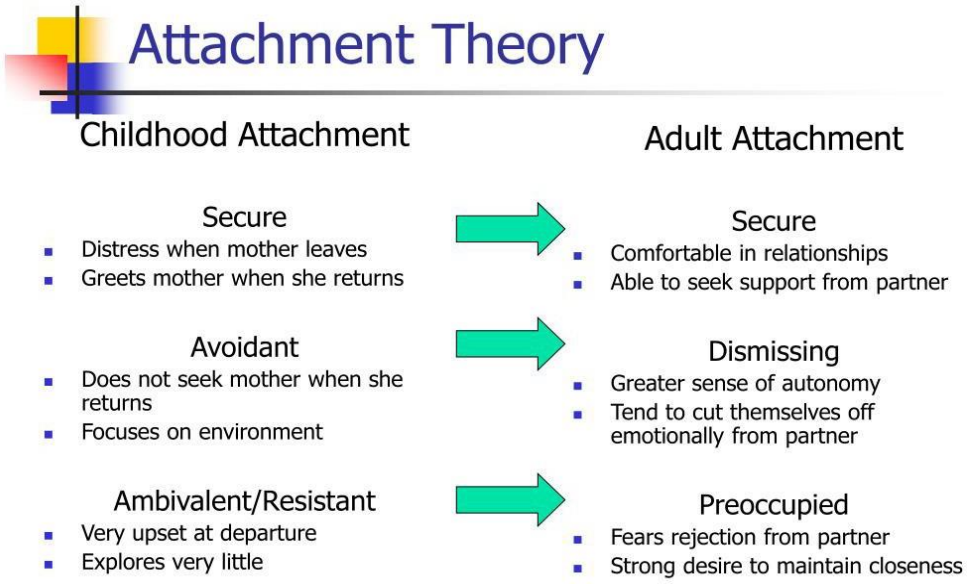


Figure 30. Attachment Theory (Deleon, 2020)

"Attachment State of Mind, Learning Dispositions, and Academic Performance During the College Transition" by Simon Larose, Annie Bernier, and George Tarabulsy explained that an individual's propensity to learn is closely related to his/her personal level of attachment

security. They created a personality model that equates a person's attachment to family and friends with his or her security of exploration. Through observation of students who have made the transition from high school to college, they found that those with a strong sense of personal security were more successful learners.

Insecure toddlers are less enthusiastic, less effective, and show less endurance during a challenging task than their secure counterparts.

In addition, they studied several other phases of learning using the same parameters. They found that toddlers with secure attachments to both parents are more eager to complete the Bayley scales, and secure preschoolers engage in more spontaneous reading. Insecure toddlers are less enthusiastic, less effective, and show less endurance during a challenging task than their secure counterparts. It was observed that 3-year-olds who had been insecure became less efficient at problem solving when faced with a possible failure, whereas the former securely attached children showed the opposite pattern. "Securely attached children consistently did better than their insecure peers, even when controlling for IQ and attention problems" (Larose et al., 2005, p. 282).

More recent studies have taken the issue one step further by showing that attachment quality, whether assessed with behavioral, representational, or interview measures, is associated with academic performance at different developmental periods (see Figure 33; 2019 SlideServ). The literature cited above reveals that there are tangible psychological conditions and factors that must be considered when designing an optimal method of information dissemination.

The Decision to Learn

A willing learner is a necessity. Willingness is a state of mind. The open and willing state of mind must be triggered in the individual. It is a state of mind that necessitates the System 2

mode of thinking, the state that requires energy to process thoughts. Many factors go into the triggering of this mode of thought and many of those factors have been discussed in the literature previously mentioned. A pattern of situational factors begins to appear: Interaction between teacher and student must be free from anxiety and resistance. The classroom atmosphere must be inclusive and engaging. The value of information must be clear and convincing. In short, we can only learn what we want to learn. We reject all data we deem to be unimportant or that is provided in a way that alienates us and so a perfect psychological state must be triggered in the learner.

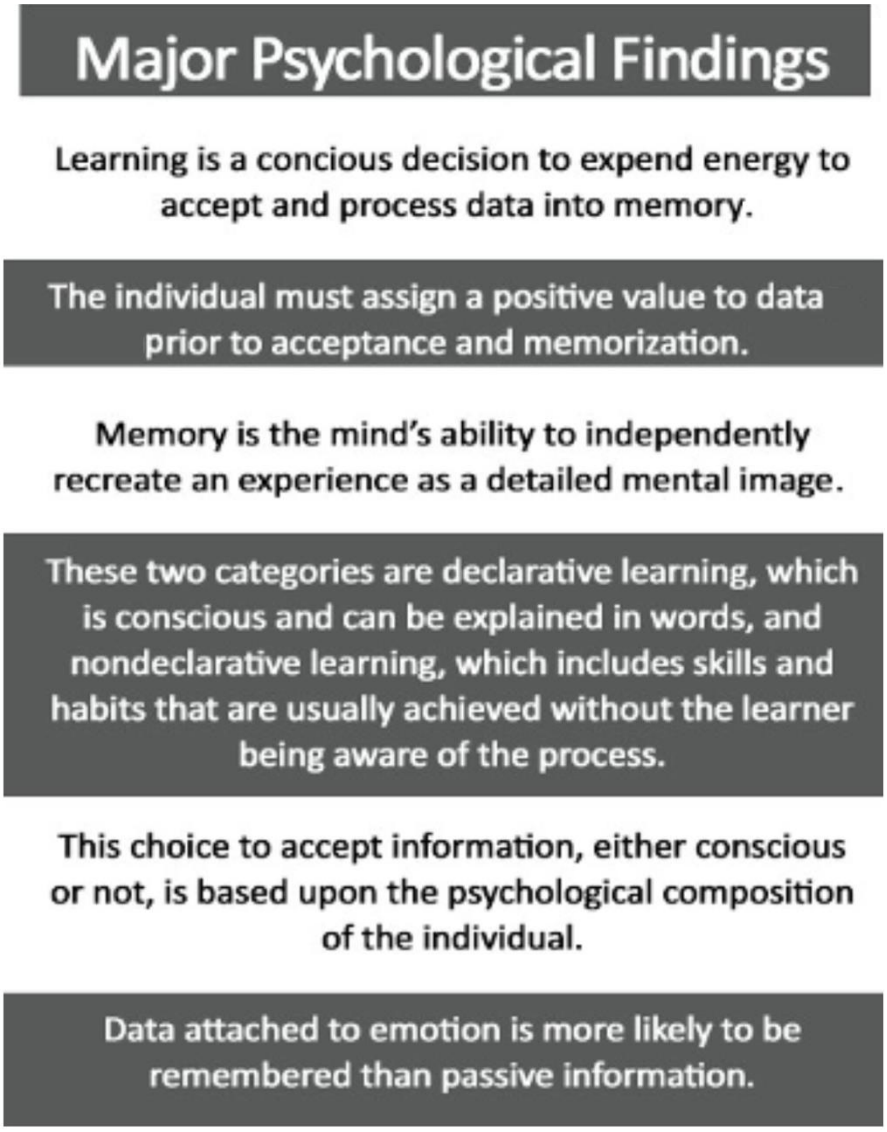
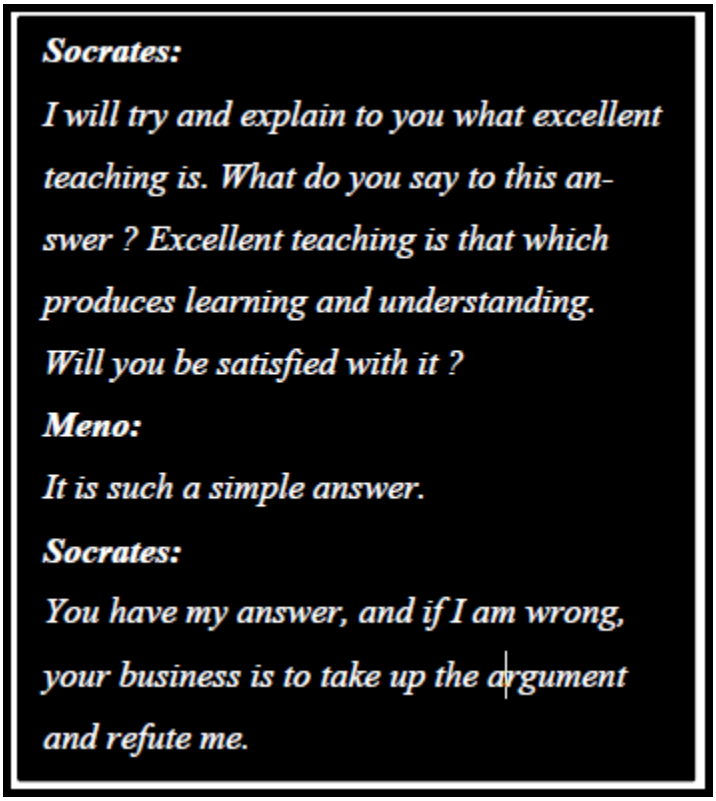


Figure 31. Major Psychological Findings of the Study

Educational Science/Pedagogy

The research requires the examination of current information-dissemination methods and seeks to create a theoretical model partially based upon existing methods that optimize the retention and recall of information. This research seeks the particular practices and paradigms of in- formation dissemination that are known to optimally produce knowledge as defined earlier and thereby increase overall intelligence. The goal of this research is to incorporate teaching methods that engage the learner. The following methods have proven effective to this end. The most examined methods exist in the field of pedagogy. This is the most common form of information- dissemination affecting everyone who has received a formal education. The onus of efficacy lies squarely upon the teacher. The role of teacher continues to evolve.



Studies of exemplary teachers by Tobin and Fraser (1990) have indicated that although expert teachers differ in their actual style of teaching and management, they all tend to use strategies that maximize student time-on-task, encourage active participation, ensure that students understand the work and that they can perform at high levels of success, and create a positive and supportive classroom environment (Westwood, 1996).

Effective Teachers

The research (Westwood, 1996, p. 68) suggests that effective teachers:

- have well-managed classrooms where students have the maximum opportunity to learn.
- maintain an academic focus.
- have high, rather than low, expectations of what students can be helped to achieve.
- are business-like and work oriented.
- show enthusiasm.
- use strategies to keep students on task and productive.
- impose structure on the content to be covered.
- present new material in a step-by-step manner.
- employ direct (explicit) teaching procedures.
- use clear instructions and explanations.
- use a variety of teaching styles and resources.
- frequently demonstrate appropriate task-approach strategies.
- monitor closely what students are doing.

- adjust instruction to individual needs and re-teach where necessary.
- provide frequent feedback to students.
- use high rates of questioning, to motivate students and to check for understanding.

Literary specialist and Edutopia consulting editor Rebecca Alber lists five highly effective teaching methods:

1. Teacher Clarity

When a teacher begins a new unit of study or project with students, she clarifies the purpose and learning goals and provides explicit criteria on how students can be successful. It is ideal to also present models or examples to students so they can see what the end product looks like.

2. Classroom Discussion

Teachers need to frequently step offstage and facilitate entire class discussion. This allows students to learn from each other. It is also a great opportunity for teachers to formatively assess (through observation) how well students are grasping new content and concepts.

3. Feedback

How do learners know they are moving forward without steady, consistent feedback? They often will not. Along with individual feedback (written or verbal), teachers need to provide whole-group feedback on patterns they see in the collective class' growth and areas of need. Students also need to be given opportunities to provide feedback to the teacher so that she can adjust the learning process, materials, and instruction accordingly.

4. Formative Assessments

In order to provide students with effective and accurate feedback, teachers need to assess frequently and routinely where students are in relation to the unit of study's learning goals or end product (summative assessment). Alber recommended that teachers spend the same amount of time on formative evaluation as they do on summative assessment.

5. Metacognitive Strategies

Students are given opportunities to plan and organize, monitor their own work, direct their own learning, and self-reflect along the way. When we provide students with time and space to be aware of their own knowledge and their own thinking, student ownership increases. Research shows that metacognition can be taught (Alber, 2015).

Effective Learning Environment

Wherever we are, we would all like to think our classrooms are “intellectually active” places. Progressive learning environments are highly effective and conducive to student-centered learning. But what does that mean (see Figure 32)?

The reality is, there is no single answer, because teaching and learning are awkward to consider as single events or individual “things.” It is all a bunch of rhetoric until we put on our white coats and study it under a microscope, at which point abstractions like curiosity, authenticity, self-knowledge, and affection are hard to pin down (Heick, 2020).

Figure 32. 10 Characteristics of the Highly Effective Learning Environment (Heick, 2020)

Effective teachers can only optimize their information delivery in an effective learning

The new model opens the environment to a rich and full interaction between instructors and learners. As stated previously, the efficacy of an instructor is incumbent upon his or her guided interaction with learners, directed and clear lessons, observation of the learner's progress and understanding, and ultimate control of the direction of the flow of information. These practices are mirrored in the requirements for the entirety of the learning environment. In academia and most other areas of information distribution, the instructor is bound by the paradigm of the institution. To optimize the efficacy of teachers, the institution in which they function must also adapt these new methods and philosophies (Heick, 2018).

Effective Learners

The optimization of information transfer requires the optimization of the learner. According to Maryellen Weimer, the distinguished scholar, author, and the editor of *The Teaching Professor* (a newsletter founded in 1987 that helps college faculty improve their teaching, share best practices, and stay current on the latest pedagogical research), the seven characteristics of a good learner are as follows:

1. Good learners are curious.

They wonder about all sorts of things, often about things way beyond their areas of expertise. They love the discovery part of learning. Finding out about something they did not know satisfies them for the moment, but their curiosity is addictive.

2. Good learners pursue understanding diligently.

A few things may come easily to learners but most knowledge arrives after effort, and good learners are willing to put in the time. They search out information, sometimes aspiring to find out everything that is known about something. They also read, analyze, and evaluate the

information they have found. Most importantly, they talk with others, read more, study more, and carry around what they do not understand: thinking about it before they go to sleep, at the gym, on the way to work, and sometimes when they should be listening to others. Good learners are persistent. They do not give up easily.

3. Good learners recognize that a lot of learning isn't fun.

That does not change how much they love learning. When understanding finally comes, when they get it, when all the pieces fit together, that is one special thrill. But the journey to understanding generally is not all that exciting. Some learning tasks require boring repetition; others, a mind-numbing attention to detail; still others, periods of intense mental focus. Backs hurt, bottoms get tired, the clutter on the desk expands, the coffee tastes stale—no, most learning is not fun.

4. Failure frightens good learners, but they know it's beneficial.

This part of learning offers special opportunities that are not present when success comes quickly and without failure. In the presence of repeated failure and seeming futility, good learners carry on, confident that they will figure it out. When faced with a motor that resists repair, my live-in mechanic announces he has yet to meet a motor that cannot be fixed. Sometimes it ends up looking like a grudge match, man against the machine, with the man

undeterred by how many different fixes do not work. He is frustrated but determined to find the one that will, all the while learning from those that do not.

5. Good learners make knowledge their own.

This point is about making the new knowledge fit with what the learner already knows, not making it mean whatever the learner wants. Good learners change their knowledge structures in order to accommodate what they are learning. They use the new knowledge to tear down what is poorly constructed, to finish what is only partially built, and to create new additions. In the process, they build a bigger and better knowledge structure. It is not enough to just take in new knowledge. It has to make sense, to connect in meaningful ways with what the learner already knows.

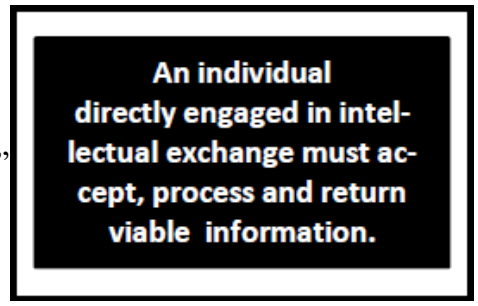
6. Good learners never run out of questions.

There is always more to know. Good learners are never satisfied with how much they know about anything. They are pulled around by questions: the ones they still cannot answer, or can only answer part way, or the ones without very good answers. Those questions follow them around like day follows night, with the answer bringing daylight but the next question revealing the darkness.

7. Good learners share what they have learned.

Knowledge is inert. Unless it is passed on, knowledge is lost. Good learners are teachers committed to sharing with others what they have learned. They write about it and talk about it,

and they can explain what they know in ways that make sense to others. Because they aren't trapped by specialized language, they can translate, paraphrase, and find examples that make what they know meaningful to other learners. They are connected to the knowledge passed on to them and committed to leaving what they've learned with others. Good teachers model this kind of learning for their students, which makes me believe that "good learner" belongs on those lists of good teacher characteristics (Weimer, 2014).



These qualities have been repeated consistently by many analysts of modern pedagogy. Good learners are actively involved in every aspect of their education. They possess acute understanding of the task of learning. They reinforce their knowledge by questioning the facts and repeating what they have learned by teaching others. Their efforts reflect the processes that occur in the human mind to create and retain usable knowledge. The habits of good learners are proactive in the process of building overall intelligence.

Metacognition

Metacognition is a key concept and an integral element in the design of an optimal methodology of data dissemination and learning. Metacognition is one's ability to use prior knowledge to plan a strategy for approaching a learning task, taking necessary steps to problem solve, reflect on and evaluate results, and modifying one's approach as needed. It helps learners choose the right cognitive tool for the task and plays a critical role in successful learning. By its definition, it is the conscious evaluation of new data and the value of its addition to existing knowledge.

Metacognition requires a conscious effort to engage the mind in analysis and active evaluation. Daniel Kahneman's definition of the System 2 mode of thinking and its necessary mental engagement comes into focus. The mind, usually in the passive and low energy System 1 mode, must become actively engaged. Data retention, active analysis, and thought processing, all necessary to understand and retain information, begin with this conscious mental engagement (see Figure 33).

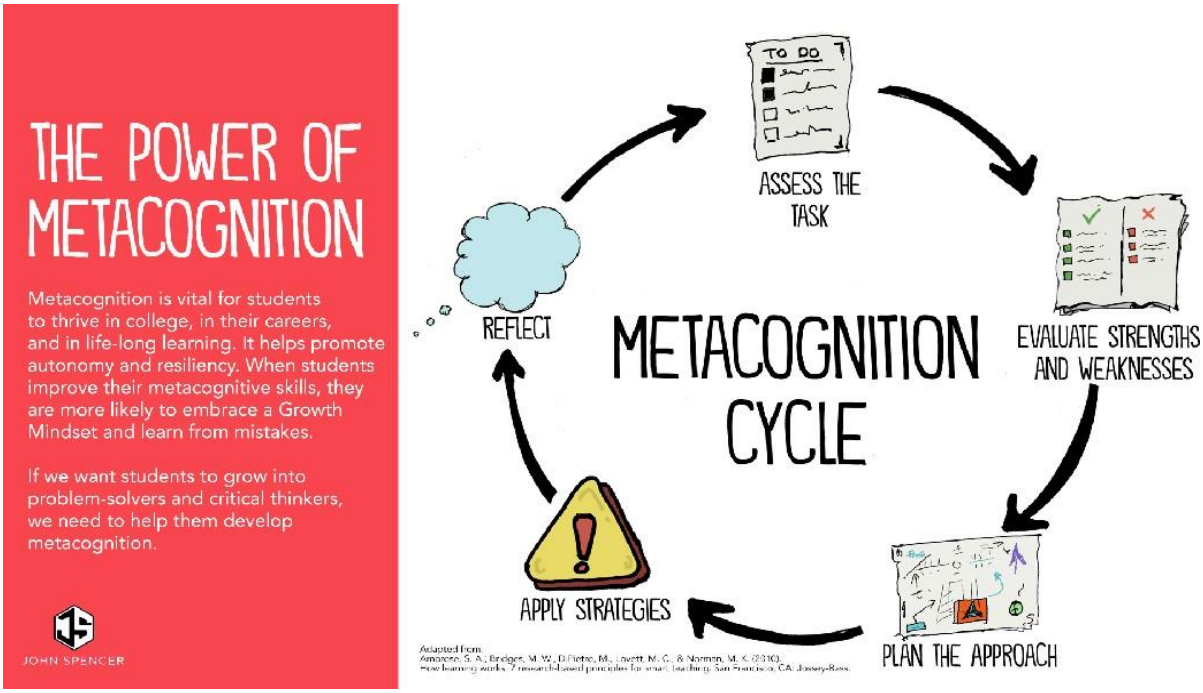


Figure 33. The Power of Metacognition (Spencer, 2018)

Metacognition refers to awareness of one's own knowledge, what one does and does not know, and one's ability to understand, control, and manipulate one's cognitive processes (Meichenbaum, 1985). It includes knowing when and where to use particular strategies for learning and problem solving as well as how and why to use specific strategies. Flavell (1976), who first used the term, offered the following example: "I am engaging in Metacognition if I notice that I am having more trouble learning A than B; if it strikes me that I should double

check C before accepting it as fact" (Meichenbaum, 1985, p. 232).

Metacognition is composed of two elements: *metacognitive knowledge* and *metacognitive regulation*. The first, metacognitive knowledge, refers to an individual's understanding of his or her own cognitive processes; the individual's grasp of his or her own skill set pertaining to learning (that is, the most successful approach, specific problem-solving techniques, etc.). The second element, metacognitive regulation, deals with an individual's adjustments to his or her individual technique of optimally learning material; that is, the adjustments an individual must make to his or her rate of learning, best times to study, and specific approaches tailored to specific material. The efficacy of metacognition is dependent upon the quality and quantity of instructor/learner interaction.

To summarize the preceding section, the five most highly effective teaching methods (teacher clarity, classroom discussion, feedback, formative assessments, and metacognitive strategies) must be incorporated into the methodology of an optimal instructional paradigm. All elements indicate a paradigm of interaction, engagement, and discussion. The participation of the learner is essential to promote acceptance, analysis, and the eventual processing of data, including data that would otherwise be denied attention and deleted. The teacher can only be effective in an environment that promotes effective methods. The institution in which the instructor functions must adapt and support the most effective teaching methodologies.

When considering the model of thinking modes presented in Daniel Kahneman's book, the previously described teaching techniques are designed to force the learner to abandon the low energy System 1 mode of thinking, which devalues most information and employ the System 2 mode, which is beneficial to optimal information processing. An individual directly engaged in intellectual exchange must accept, process, and return viable information. An individual

anticipating engagement must conscientiously engage System 2 thinking to prepare. System 2 thinking, which requires the active awareness and understanding of one's own thought processes, is metacognition.

The Learning Pyramid

The Peak Performance Center provides resources and services to individuals and organizations as they strive to achieve performance excellence. The educational division's primary goal is to provide techniques and strategies to maximize learning and improve educational performance. They focus on maximizing the learner's ability through assessments such as emotional intelligence measurements, learning styles indicators, and personality type indicators. They also provide various learning strategies and methods to enhance learning. Their mission is parallel to the goal of this thesis.

The Peak Performance Center in conjunction with the National Training Laboratories in Maine created a list of seven teaching methods rated by their effectiveness based upon individuals' retention percentage of data provided by each method and tested. The resulting data inspired the creation of the Learning Pyramid (see Figure 34). The Learning Pyramid illustrates the percentage of learner recall associated with different approaches. The first four levels (lecture, reading, audiovisual, and demonstration) are passive learning methods. In contrast, the bottom three levels (discussion group, practice by doing, and teach others) are participatory (active) learning methods. The Learning Pyramid clearly illustrates that active participation in the learning process results in a higher retention of learning (The Peak Performance Center, 2018).

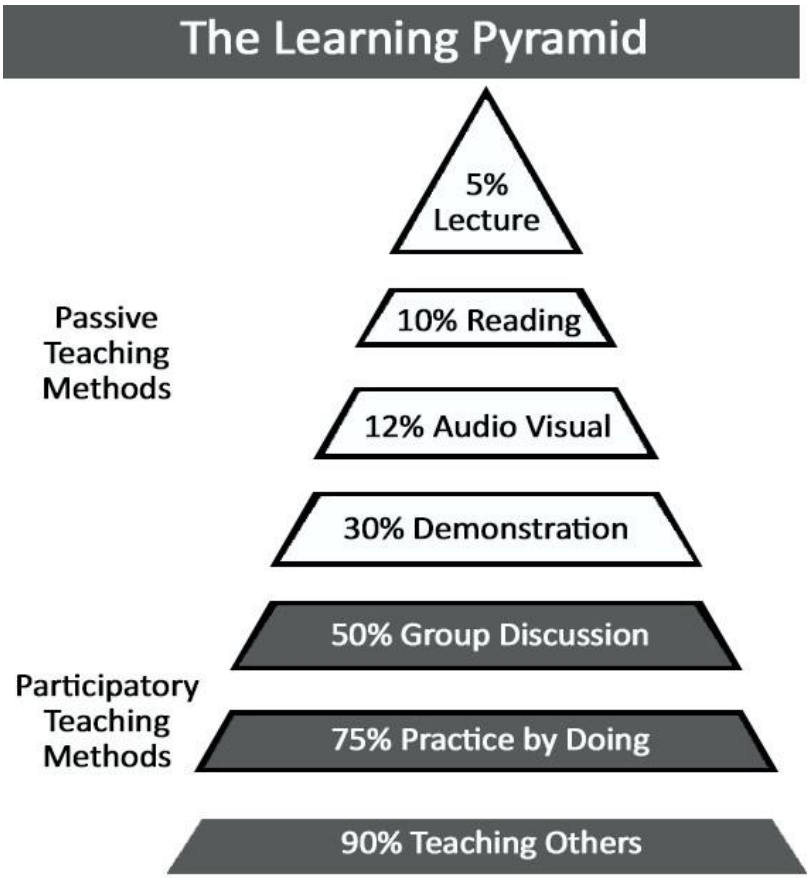


Figure 34. The Learning Pyramid (The Peak Performance Center, 2018)

Chunking

Another highly effective method of learning is known as *chunking*. The term applies to both a method of mathematical multiplication and, pertinent to this thesis, an approach for making more efficient use of short-term memory by grouping information (see Figure 35). Chunking breaks up long strings of information into units. The resulting chunks are easier to commit to memory than a longer, uninterrupted string of information. This method is used to reduce the cognitive load as the learner processes information, grouping content into smaller, more manage- able units and making the information easier to process. This method involves carefully timed and portioned delivery of information separated by timed breaks of silence and

reflection. There are several steps to the chunking process (the number of steps used will depend on the type of information you are chunking):

1. Break larger amounts of information into smaller units
2. Identify similarities or patterns
3. Organize the information
4. Group information into manageable units (The Peak Performance Center, 2018).

Figure 35. Chunking Example (How Design, 2015)

The application of Miller's Magic Number can be easily visualized by considering something as commonplace as a telephone number. Ten concurrent numbers pose a problem to remember. Miller's chunking method was applied to every 10-digit phone number in the United States by a man by the name of Ladislav Sutnar, with the area code bound by parenthesis, the next three digits separated by a space to the left and a dash to the right followed by the final four digits. This simple separation of units made phone numbers far easier to remember.

Chunking as described involves presenting an entire chapter of a textbook in carefully separated segments. Each segment is presented as an understandable, unique set of facts. These facts stand as singular units of information for thoughtful consideration, scrutiny, and memorization. Neuroscience suggests that information undergoes a process of mental repetition to begin the process of retention (see Figure 36).

The chunking concept originated with George Miller, a psychology professor at Harvard University in the 1950s, who wanted to explore the limitations of short-term memory. Miller's research revealed that the human brain could remember seven chunks, plus or minus two, in the

short-term memory. “The magical number seven plus or minus two…” (Cowan, 2015, p. 1).

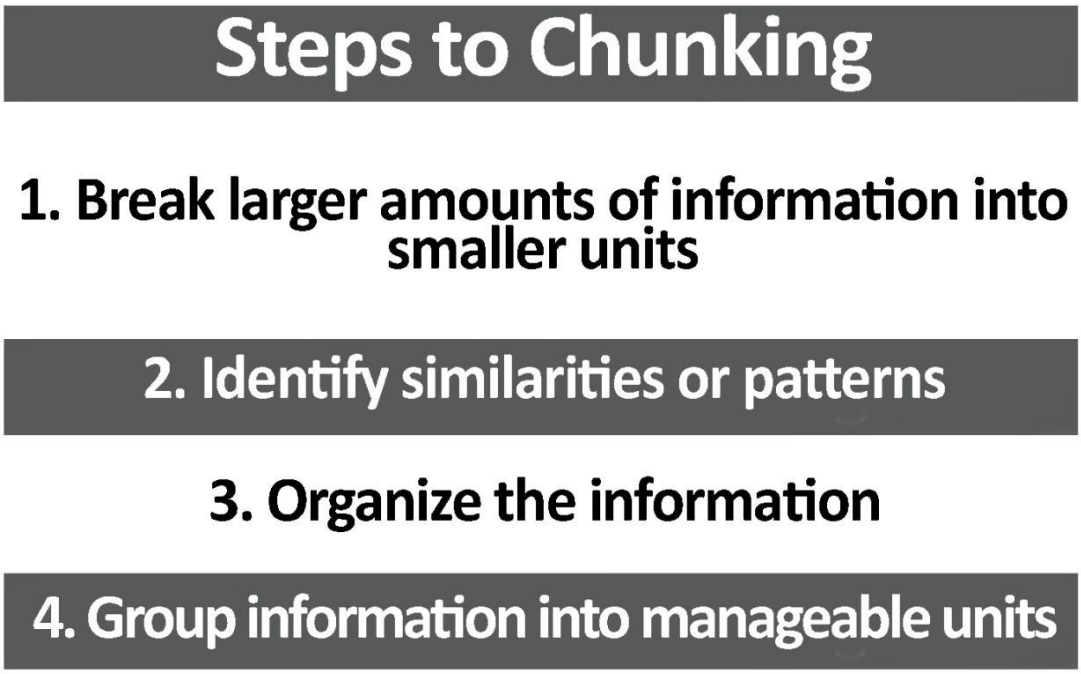
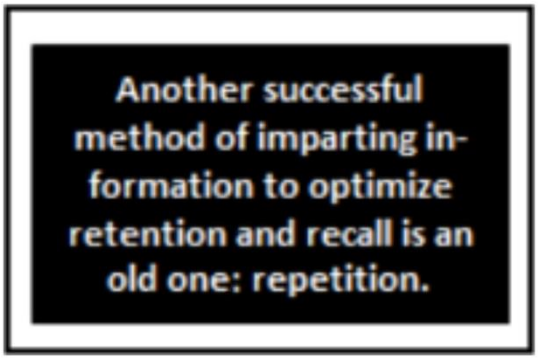


Figure 36. Steps to Chunking (The Peak Performance Center, 2018)

In short, chunking reduces the cognitive load as the learner processes information. Chunking provides small, digestible portions of information, capable of short-term storage and allows time for the process of rehearsal through introspection and discussion. Chunking also allows for the addition of triggers to facilitate recall (The Peak Performance Center, 2018).

Repetition

According to the Atkinson-Shiffrin Theory of Memory, as delineated previously in the Neuroscience section, information is “rehearsed,” allowing for short-term memories to be stored for an indefinite period. Recalling these memories often requires a trigger.



In his book, *Memories Are Made of This*, Rusiko Bourtchouladze stated that practice makes memory perfect. When the mind repeats, reviews, ruminates upon a thought over and over, the memory of that thought grows stronger. Bourtchouladze referred to one of the pioneers of memory research, psychologist Hermann Ebbinghouse. Ebbinghouse pioneered the development of experimental methods for the measurement of rote learning and memory and first quantitatively showed that repetition gives longer-lasting memories. The author quoted Leonardo DaVinci who noted, "I have discovered that it is of some use when you lie in bed at night and gaze into darkness to repeat in your mind the things you have been studying. Not only does it help the understanding but also the memory" (Bourtchouladze, 2002, p. 8). The book offers many reinforcing opinions pertaining to the benefit of repetition in the creation of long-term memory since short-term memory, the initial entry point of all memory, can only retain small amounts of data at any given time. As basic as this may seem, it is essential to teaching, advertising, and any other application or discipline that benefits from information retention and recall (Bourtchouladze, 2002, p. 8).

The exploration of literature pertaining to effective methods of information dissemination has revealed preferences for both chunking and repetition. These two methods were carefully included in the framework for a theoretical method of information dissemination. Further research may reveal more effective methods.

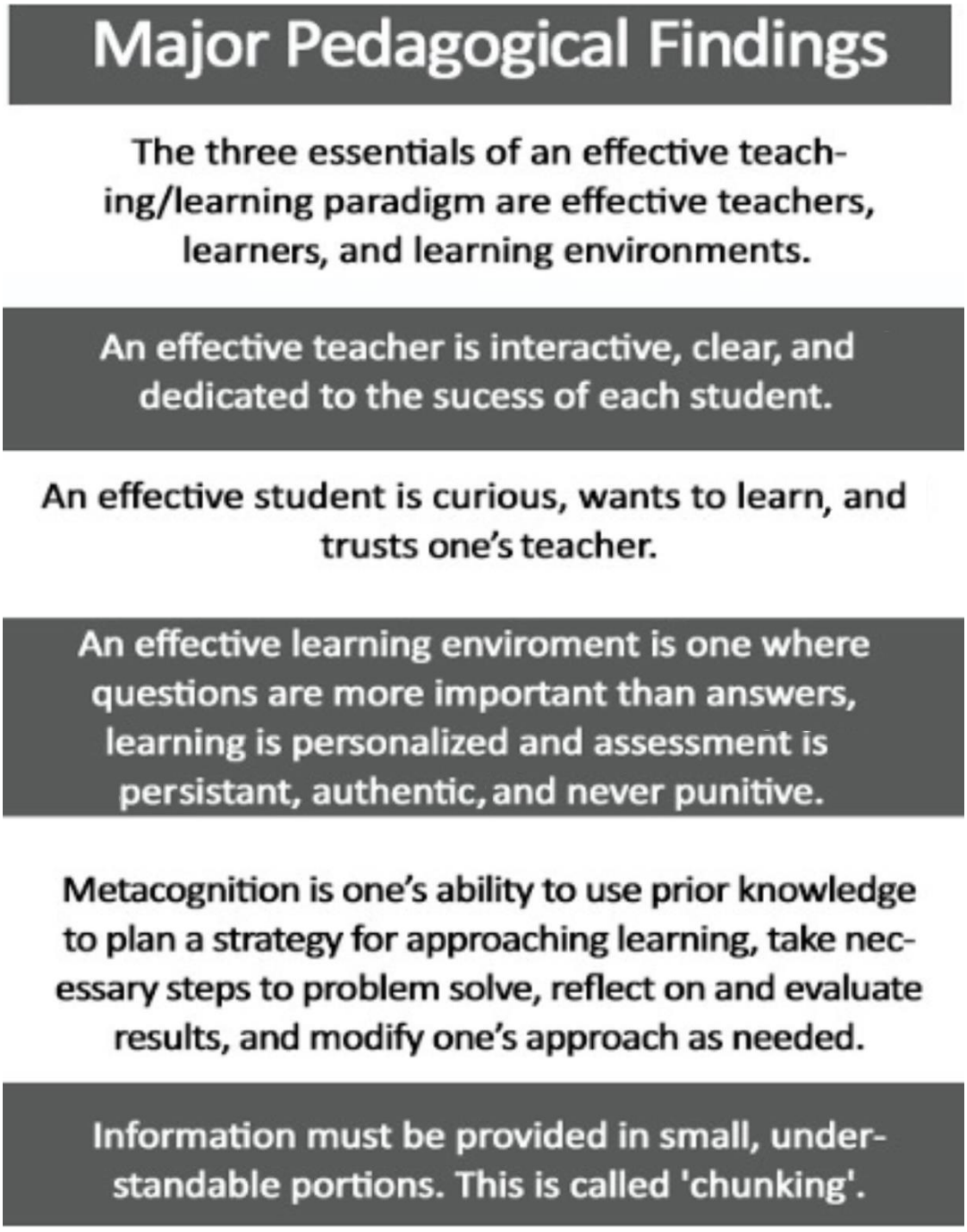
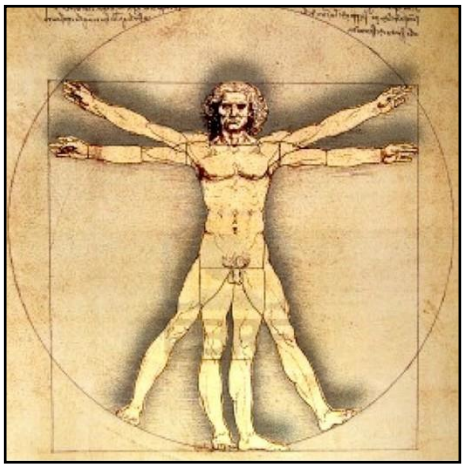


Figure 37. Major Pedagogical Findings in the Study

Human-Centered Research



This fifth and final area of research goes to the very core of design, the human perspective. Having re- searched the mechanics of the mind through neurobiology, conscious and unconscious engagement of processing and retention through psychology, effective methods of teaching and learning through the examination of pedagogy, and the influences of the physical surrounding human cognition, the final piece of this puzzle lies in the confines of the human mind.

Individuals collect information from the moment they become cognizant of the world around them until the mind ceases to function. In the course of this journey, the mind is exposed to a universe of information. The human brain is a repository for a massive but finite amount of this information. Why does the brain select certain bits of information to process into memory? What signals the mind to attach value to particular moments in time to allow them storage space in the hippocampus? Why are other pieces of information, that upon reflection would have been of great value, willfully discarded or unable to become memory?

The goal of this research is to examine why certain bits of information are retained and why much is rejected. This proved to be the key to unlock the vast potential of the mind's ability to retain, recall, and utilize information. The research also examines why the brain ignores and rejects vast amounts of valuable data.

Chapter 3 Methods

Human-Centered Experiments

The following experiments were designed to test these alternative treatments of information in a cross-section sample of the population, selected after responding to a general call for volunteers from Staten Island NY and neighboring communities. First was a workshop employing human-centered design methods (explained in *Innovating for People…* (LUMA Institute, 2012)) ... and then a set of comparative classroom sessions in which a unique and detailed narrative was presented to two independent sets of volunteers. The only prerequisites for participants were that they were between the ages of 18 and 80 years old and had completed at least 12 years (grades 1 through 12) of formal education. All volunteers were given a choice of participation based upon the time most convenient to each and were provided three possible timeslots over 3 weeks. They were not made aware of the nature of the session. When participants selected their most convenient time, they were assigned to either the workshop or one of the two class- room sessions. The resultant participants met the prerequisite conditions and came from a great variety of sub-demographics, creating a truly diverse selection. The following pages describe the experiments and the observations gained through their implementation.

Subjects/Sample

The volunteers consisted of undergraduate students (aged 18-21) engaged in undergraduate studies and in part, a group of adults, aged 45 to 80. These two groups represented a cross-section of demographics with their significant difference being sources and consumption of data.

The workshop consisted of 14 volunteers. The classroom sessions assembled a Study group of 12 participants and a Control group of 11.

Restrictions

- All potential participants had to agree to participate in a mature and ethical manner.
- All participants experienced a relatively standard education to the exclusion of home schooling, charter schooling employing unique paradigms, former Montessori students, or any participant from a markedly unique educational background.
- Participants from the 45-85-year-old demographic could not be currently enrolled in a graduate program, professional training, or any specific licensing program.

Data Collection Workshop

Prior to the construction of a final methodology for the presentation of data to a study group, information was collected to ascertain positive and negative aspects of the learning process. The workshop was designed to collect data about the factors and circumstances that enhanced or inhibited the educational experiences of a convenience group of participants. The workshop employed methodology derived from the LUMA Institute's *Innovating for People*

Handbook of Human-centered Design. When combined, these methods revealed human-centered considerations and perspectives that are otherwise unavailable via traditional research (see Figure 38).

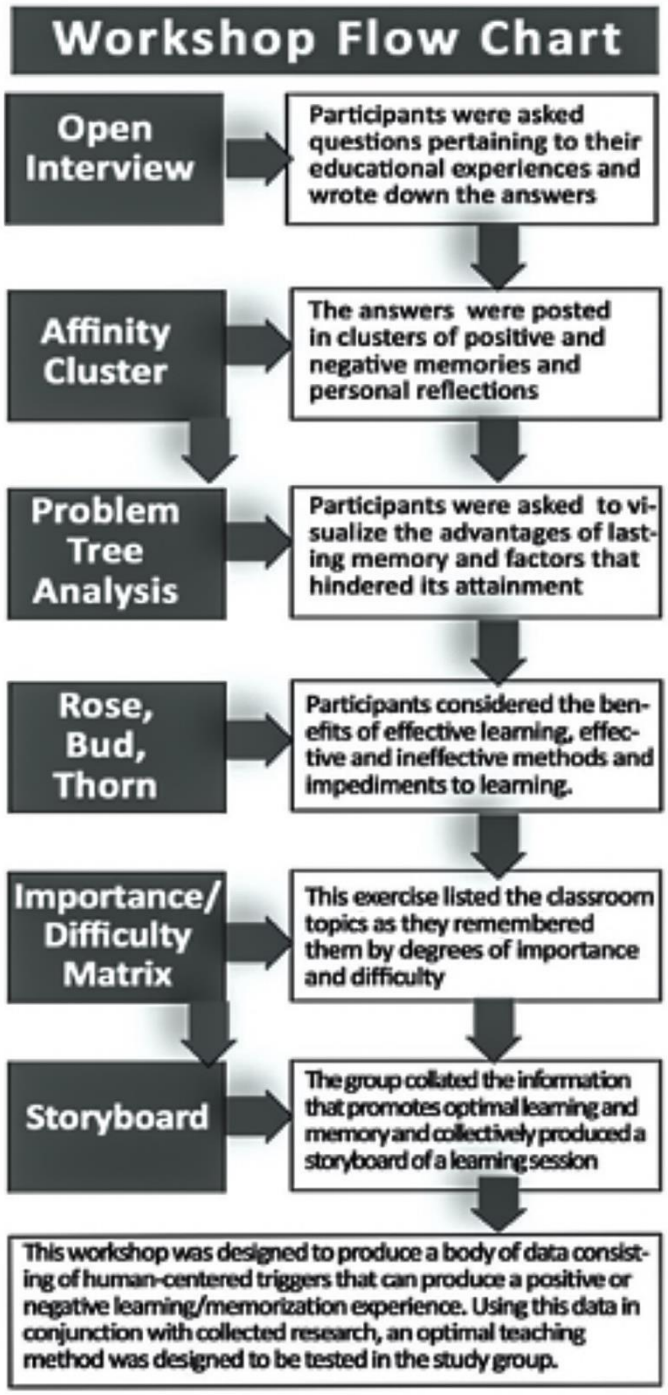


Figure 38. Workshop Flow Chart

Workshop Goals

The goal of this workshop was to discover the positive and negative stimuli, methods, and materials gleaned from the emotional responses of the participants (12 females and 9 males, ranging in age from 18 to 80 years of age). This data was used to guide the design of a specific method of information preparation and presentation and was ultimately used as the basis of the presentation of unique material to the Study group at a later date.

Description of Workshop as Conducted

The workshop was conducted online on March 28, 2020, at 11 a.m. and again at 7 p.m., employing human-centered design methods (LUMA Institute, 2012). The workshop comprised 21 participants who were provided via email worksheets coordinated to each method. The methods were presented to all in PowerPoint during two identical Zoom sessions. Participants were given time to ask questions, make observations, and interact as a group. They were instructed to fill out the worksheets and return them as soon as possible.

Interviews

The workshop began with an introduction describing the goals of the exercises, a brief discussion of common aspects of the educational experience, and an explanation of the questionnaire to follow. This segment was followed by a series of directed interviews conducted in a Zoom group, focusing upon each participant's learning experiences. These proceedings required the participants to discuss their personal memories, positive and negative experiences, relationships with teachers and classmates, and memories of specific physical settings and objects from that period in their lives.

A series of interview questions were introduced into the group discussion. The questions were designed to facilitate the collection of data specifically meant to reinforce and reexamine research previously conducted in the fields of neurobiology, psychology, and pedagogy. Each

question was followed by a subsequent series of questions (see Table 1), to encourage each participant to answer the lead questions in greater depth. This method was employed to promote System 2 thinking (Kahneman, 2011), requiring conscious effort and interaction on the part of each participant and produced individual data points from the convenience sampling, which when analyzed produced interesting trends further discussed in workshop observations. These questions were based in neurobiology and psychology, seeking to define how and why memories form. The answers revealed the type of memory recalled (e.g.: visual, conceptual, sensual) and the reasons they were psychologically valuable enough to merit long-term retention.

Table 1 Interview Questions

Interview Questions:

THINK BACK, TRY TO REMEMBER:

Subjects, lessons, facts, concepts, formulas

The books and materials you used in school

Your teachers, surroundings, classmates

Values, perspectives, rules and ethics

The emotions that you associate with those years

Your personal wardrobe and supplies from that period

Favorite candy, toys, possessions

EXERCISE 1: INTERVIEW

Try to remember your educational experience from grades 1 through 12.

Write down a few specific memories of school.

List the subjects you remember the most about.

Why do you believe you remember these subjects more than others?

Describe your favorite teachers, name, subject, grade:

Which subject did you enjoy the most? What made it fun?

List the subjects you remember little or nothing about.

Describe your worst teachers, name, subject, grade:

Which subject did you enjoy the least? Why?

Affinity Clusters

The data collected in the interviews was used to generate an affinity clustering exercise (see Figure 39). Responses to the interview questions were grouped into three themes: negative memories, positive memories, and clearest memories. Each reply was marked with the age and sex of the respondent. It was the intent of this exercise to discover the differences and similarities relative to their memories and experiences in the course of their educations. The age and sex notations were used to determine demographically driven trends. Surprisingly, no such trends emerged.

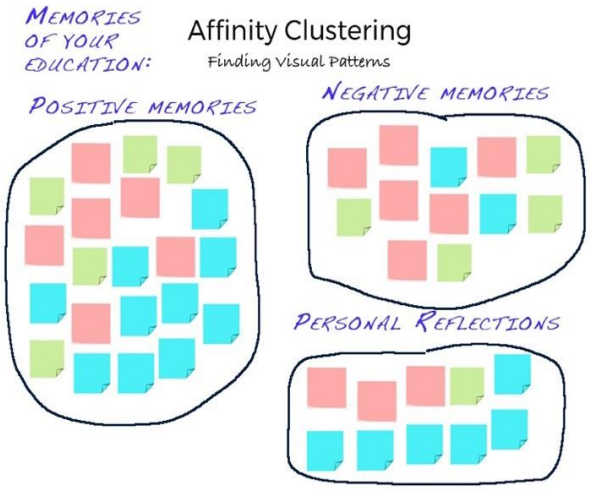


Figure 39. Affinity Clustering (PrometSource, n.d.)

Each participant was asked to make notations for three categories: positive memories, negative memories, and clearest memories (see Table 2). These three categories fed off the data revealed in the interview method. The category “Positive memories” was included to prompt the participants to recall and list their memories of positive factors and circumstances that promoted learning. The category “Negative memories” was included to prompt participants to list long term memories of factors that caused them to reject information and impeded the learning process.

The “Clearest memories” category was included to create a data pool of commonalities (both positive and negative) and circumstances in their educational experiences that are commonly remembered and recalled. The data was compiled in each category and analyzed for emerging positive, negative, and shared patterns common to all unique participants. The data from this exercise evoked memories of a period in life when the participants were actively processing information in a similar paradigm, focused their attention on the line of inquiry to follow, and revealed patterns enabling or discouraging long-term information retention. The data also revealed memorable data points common to the overall educational experience.

Table 2 Affinity Clustering Questions

Affinity Clustering Questions:

Now that you have turned your thoughts to your education, let’s sort it out.

What did you like? Dislike?

Please answer in as few words as possible:

Write down your favorite memories of your educational experience.

Write down your worst memories of your educational experience.

Write down your clearest memories of your educational experience.

Problem Tree Analysis

A *problem tree analysis* was conducted using the core problem “Forgetting your lessons” to discover the root causes and defining the effects (the branches) as reasons it is important to utilize and retain information successfully (see Figure 40). This visualization followed the more

specifically targeted affinity cluster with a wider perspective, designed for the participants to provide generalized ideas of the benefits of consciously working to create permanent memories and collectively list the factors and circumstances inhibiting their ability to create permanent memories. The goal of this method is to obtain data identifying common incentives and to employ conscious effort to process information into knowledge and data, identifying factors and circumstances that inhibit learning.

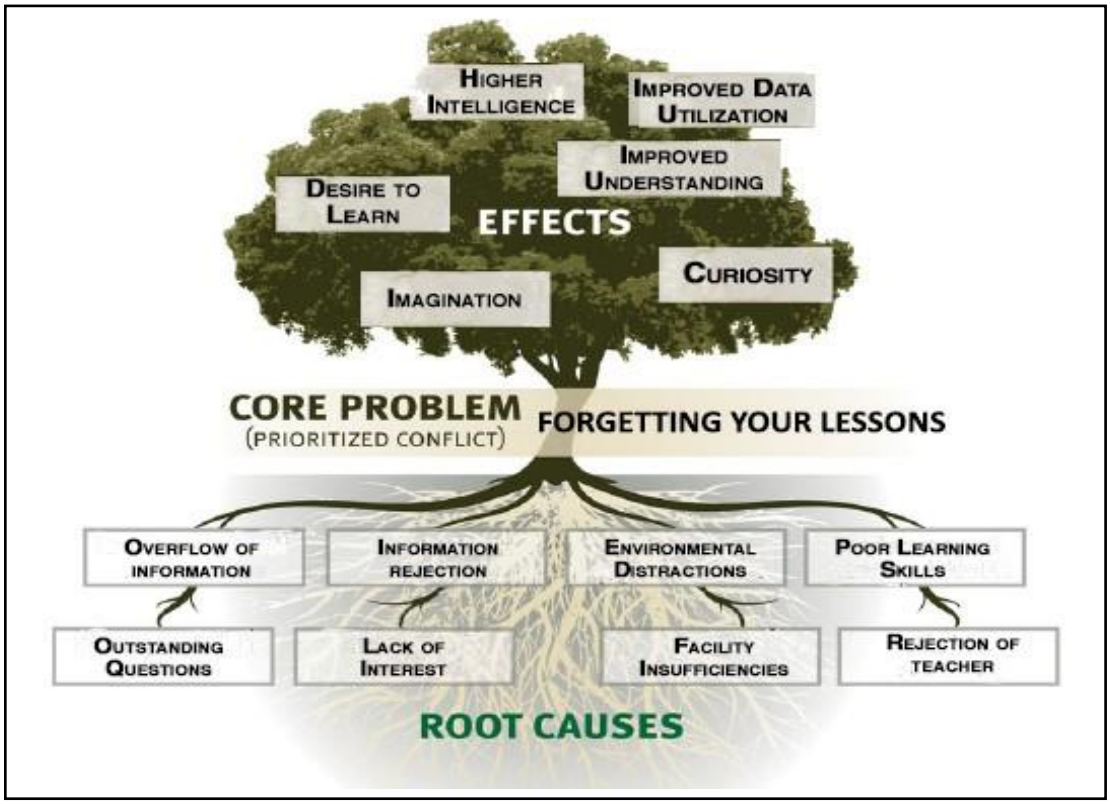


Figure 40. Problem Tree Analysis (ODI, 2020)

Table 3 Problem Tree Analysis Procedure

Problem Tree Analysis Procedure

In this exercise we will create a figurative tree where the trunk or main topic is
"FORGETTING YOUR LESSONS" We all analyze the reasons and results of forgetting some,
most or all of the information provided you through grades
1 through 12.
The overall purpose of education is to provide you with knowledge-based tools to assist you through life.
If these tools are not remembered they cannot be utilized
throughout your life.
Why did you forget the information that could have made
life better for you?

ONE WORD ANSWERS IF POSSIBLE
In this section known as the root, list:
1. The negative effects of forgetting the volumes of information provided throughout your
education to you personally.
2. The impediments to successfully learning. (What conditions, influences or lack-of do you think
most prevented you from learning).
In this section known as the branches or leaves, list:
1. The greatest personal disadvantages of not being able to retain important information.
(i.e.: being better employed, better spoken, knowing more about a particular subject, knowing more in general, being of greater
value to others, etc.)

Rose, Bud, Thorn

A *Rose*, *Bud*, *Thorn* charting was employed to visually consider the benefits of effective learning, and effective and ineffective methods of and impediments to learning (see Figure 41). This method provided yet another perspective to view the questions presented in the preceding

problem tree analysis. Participants ranked factors and circumstances including class engagement, teacher approach, textbooks, visual presentations, homework, testing, school hours, nutrition, parental participation, extracurricular activities, and other topics (see Table 4). This method was designed to expand upon the problem tree analysis and collectively visualize the many positive and negative factors and circumstances that affect the learning process.

Figure 41. Rose, Bud, Thorn Diagram (LUMA, 2012)

Table 4 Rose, Bud, Thorn Instructions

Rose, Bud, Thorn Instructions

Having examined the advantages, missed opportunities and problems of your educational experience,

this exercise is meant to sort-out and clarify what we have discovered.

First the Rose. Write down what benefits you have gained in your education.

What educational tools have tangibly helped you?

Next, the Thorn. What do you believe you needed that your education either did not provide,

or did not effectively explain? Where did your education fail you?

Finally, the bud. Here I want you to suggest ways to improve your education.

What would be more effective than what you've experienced? What would have helped you to learn and apply knowledge better?

Importance /Difficulty Matrix

The *importance/difficulty matrix* exercise focused on specific examples of information judged important to learn and the degree of difficulty involved in learning that material. Using this matrix (see Figure 42), the participants listed the most difficult information types to retain from left to right (such as mathematical formulas, historical dates) and by importance of data from top to bottom (such as silly commercials to survival facts) (see Table 5). Data collected

with this method was used to analyze the relative levels of anxiety and perceived difficulty that may have inhibited or promoted the acceptance of types of information (LUMA Institute, 2012).

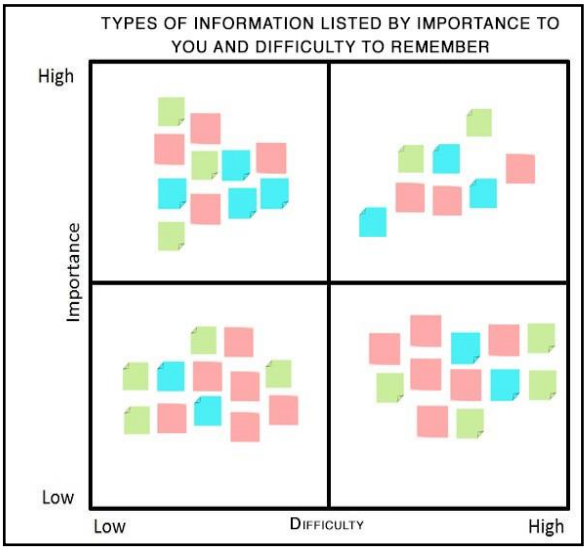


Figure 42. Importance/Difficulty Matrix (LUMA, 2012)

Table 5 Importance/Difficulty Matrix Instructions

Importance/Difficulty Matrix Instructions

We are exposed to many different topics and subjects in the course of our educational experience. Some we understood easily. Some may still be vague and of little use to us in our everyday lives. Using your personal experience, write down the various topics and subjects from your education by the degree of importance in your life and by degree of difficulty to learn.

Importance/Difficulty Matrix.

As you write each topic and/or subject down assign it two values:

1 through 10 for the level of personal difficulty to learn.
1 being easiest, and 10 being the hardest

A through J for its degree of importance to you.
A being the least important and J being the most

Storyboarding

The workshop concluded with the visualization of a productive and memorable learning experience through collectively *storyboarding* a classroom lecture. The participants collated the best practices, approaches, and methods from their collective past and discussed weaving these positive teaching tools into one cohesive lecture session, culminating in the production of a storyboard (see Figure 43). This visualization served as a point of departure for the design of my Study group session (LUMA Institute, 2012).

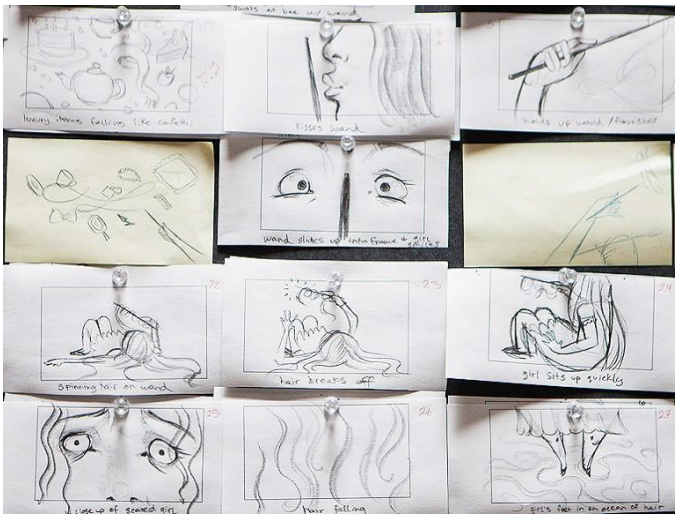


Figure 43. Storyboarding Diagram

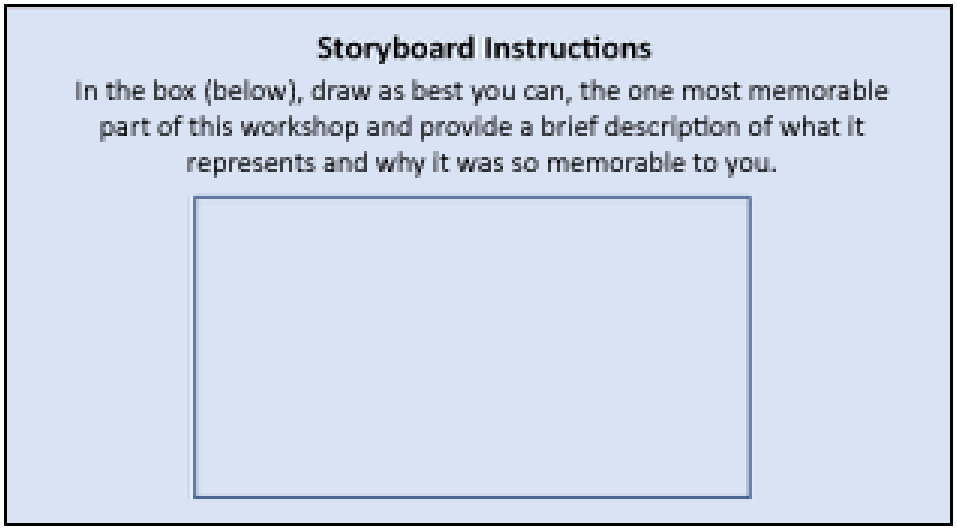
NOTE: The intention of this exercise was to create a visual narrative of this workshop. In the original design, participants were to draw (or describe the image to be drawn) their clearest impressions of the workshop.

Due to the late redesign of the workshop due to the COVID-19 pandemic and the subsequent quarantine, which eliminated the use of a common workspace, an online Zoom format was used. This confused and altered the process and results of this method. The instructions were first explained in the presentation and then included on the worksheet (see

Table 6).

Without real-time direction by the instructor, a central whiteboard to group and compare the panels, confusion of the purpose and execution of this method, and the fact that the worksheet instruction was delivered as part of the response sheet transmitted by email, the exercise devolved into confusion and failed to provide the intended results. The instruction produced responses, primarily in the form of written descriptions and extremely poorly drawn images. Although the original format could not be presented as intended, the responses still provided some flashes of insight into the participants, overall impressions, and experience.

Table 6 Storyboard Instructions

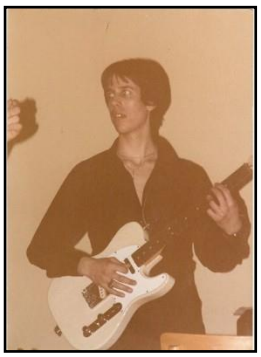


Participant response

F46 (educator):

I have discovered that my memories of elementary school are much more vivid than those from high school. Perhaps I was happier in elementary school than high school. However, most of my school memories are more about the people, experiences, etc. than what I was taught.

M59 (health care worker):



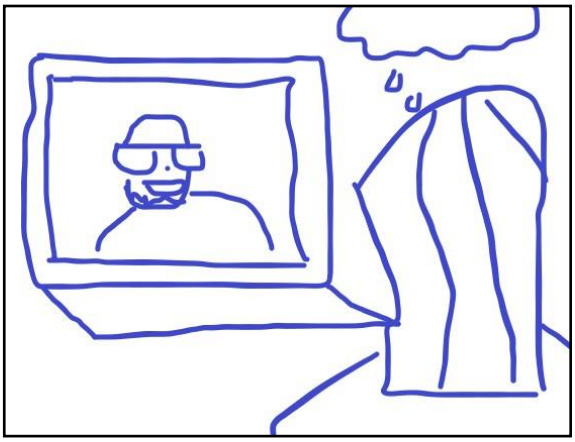
Doing this exercise reminded me of my High School Days. Thinking about my youth, how long ago it was and where I am today made me reminisce. Remembering some of those passionate teachers was also nice. I know of each of their demises and took pause for each one of them. There are many from my college years too. I couldn't draw so I provided a picture of me performing at the H.S. Talent Show in 1979.

F78 (educator): "I have no idea where to start on this question. I also have no idea how I would make a drawing electronically and send it to you. I'm rather confused*."*

F62 (educator): "It reminded me of my love of reading and writing and how those formative years influenced my career and my love of learning."

F72 (clerical worker): "The most memorable part of this workshop was allowing me the chance to look back on my education and see how it made me who I am today."

F27 (worker in the health fields):

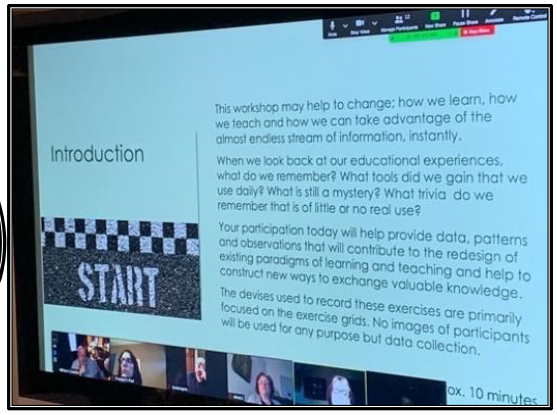


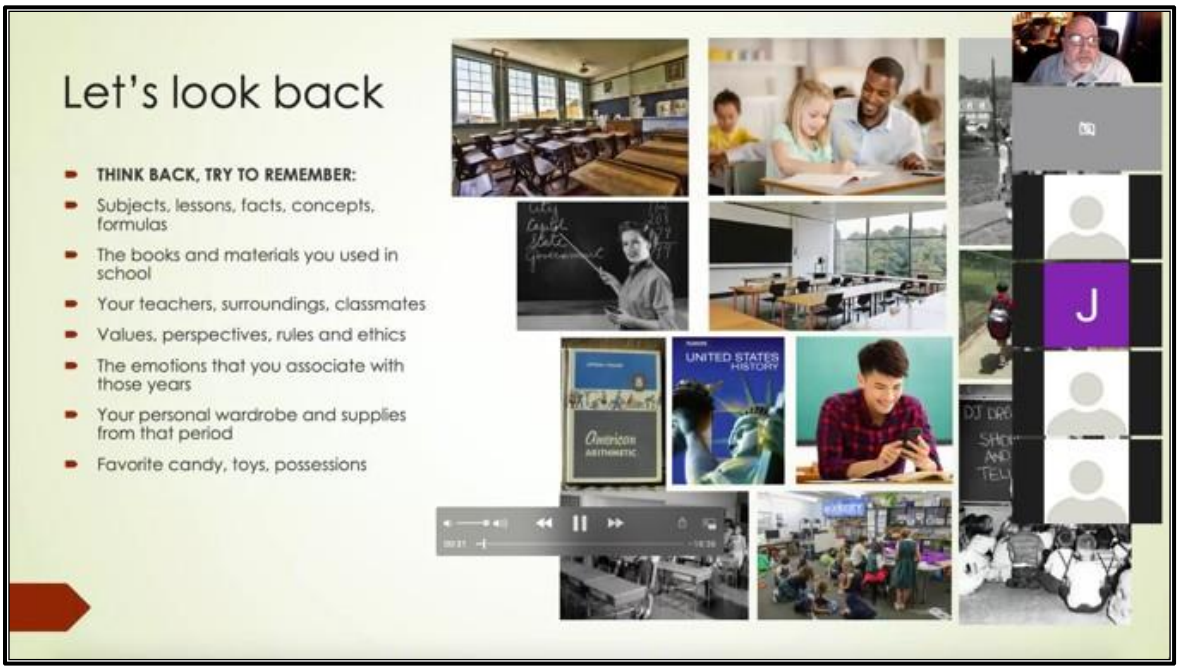
F59 (entrepreneur):

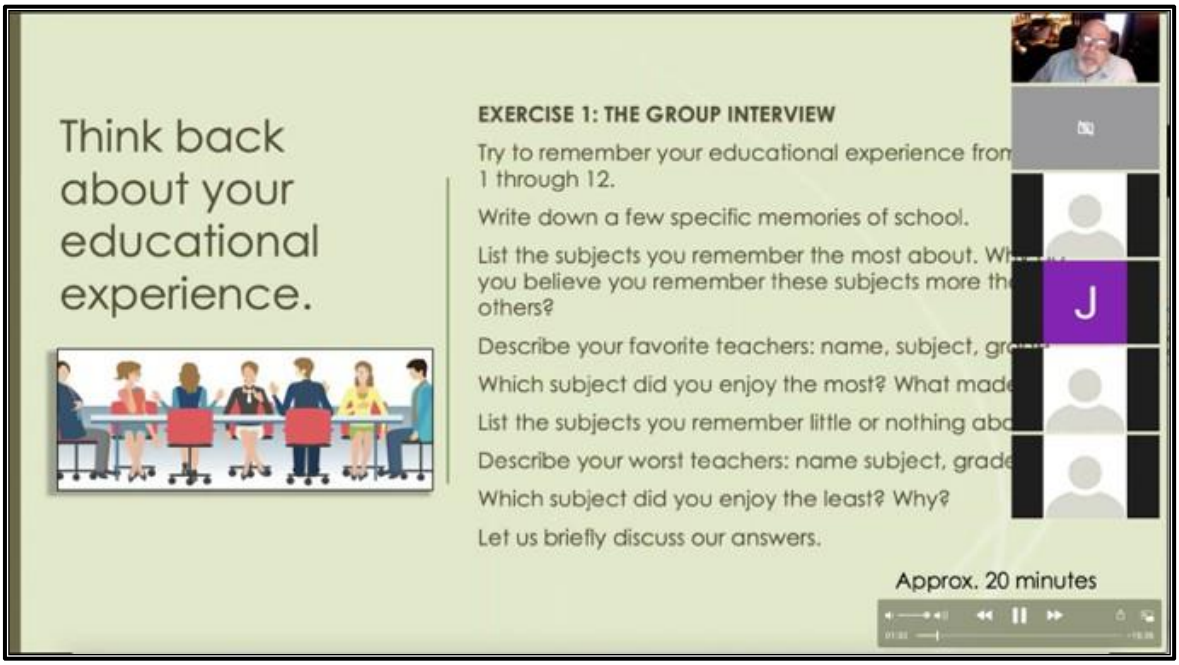
Coming home from school with my report card, two F's one in Science and the other in Social Studies. It was about 1½ mile walk home. I was alone, scared and crying. Suddenly I heard a voice throughout my entire being and it said, 'this is not my measurement this is man-made.' All of me at once realized God spoke to me clearly, I understood but knew my parents would not. It didn't matter, at more core I understood that God measured a person not by grades or report cards but something deeper a feeling a compassion for others and even though I knew my parent's reaction I was calm, assured and driven.

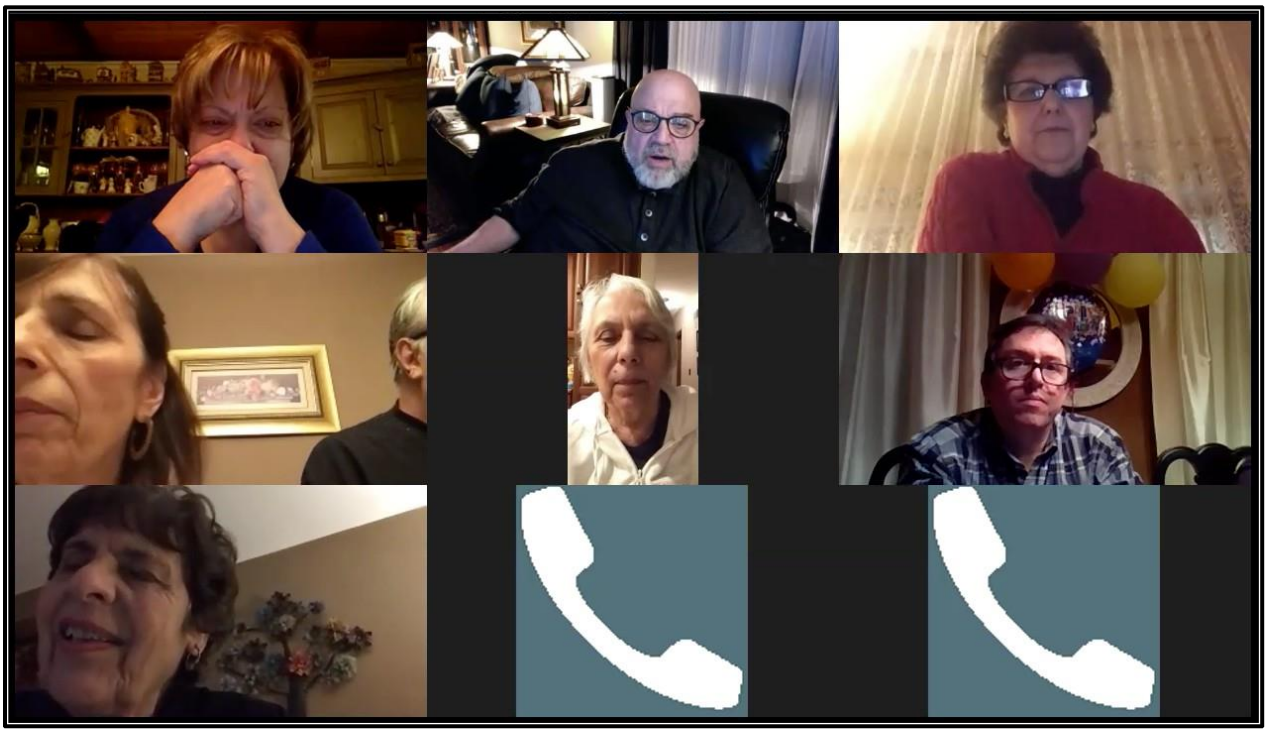
F73 (homemaker): "I thought of my education and how it made me what I am today. I think I had a successful education."

Stills from the Workshop Sessions

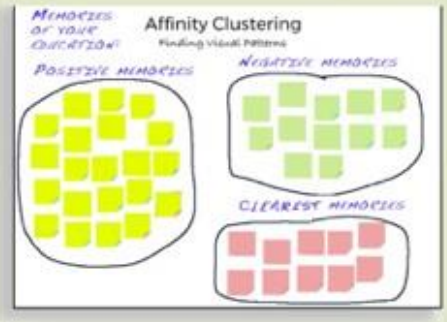



Let's look back
THINK BACK, TRY TO REMEMBER:
Subjects, lessons, facts, concepts, formulas
The books and materials you used in school
Your teachers, surroundings, classmates
Values, perspectives, rules and ethics
The emotions that you associate with those years
Your personal wardrobe and supplies from that period
Favorite candy, toys, possessions
UNITED STATES HISTORY
J


Think back about your educational experience.
EXERCISE 1: THE GROUP INTERVIEW
Try to remember your educational experience from
1 through 12.
Write down a few specific memories of school.
List the subjects you remember the most about. Wh
you believe you remember these subjects more th
others?
Describe your favorite teachers: name, subject, gr
Which subject did you enjoy the most? What mad
List the subjects you remember little or nothing abo
Describe your worst teachers: name subject, grad
Which subject did you enjoy the least? Why?
Let us briefly discuss our answers.
Approx. 20 minutes
J



Compare your answers with others



EXERCISE 2: AFFINITY CLUSTERING

Now that you have turned your thoughts to your education, let's sort it out. What did you like? Dislik

Write down your **favorite memories** of your educat experience on the ***yellow Post-Its.***

Write down your **worst memories** of your educatio experience on the ***green Post-Its.***

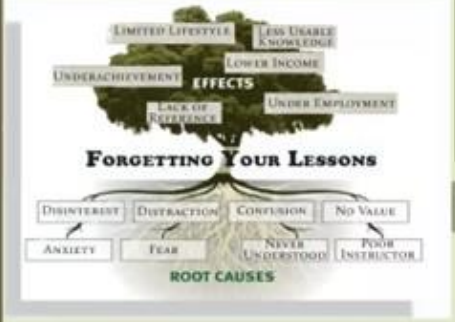
Write down your **clearest memories** of your educa experience on the ***pink Post-Its.***

When you have done this, come up to the Affinity Clustering diagram and place your Post-Its in the p circle..

Now, lets see if there is a pattern.

Approx. 15 minutes

Take a step back and look at the at the big picture



EXERCISE 3: PROBLEM TREE ANALYSIS

The overall purpose of education is to provide yo knowledge-based tools to assist you through life.

If these tools are not remembered they cannot b utilized throughout your life.

Why did you forget the information that could ha made life better for you?

We'll populate this "Problem Tree" with the nega effects of forgetting the volumes of information provided throughout your education (the top of tree) and the impediments to successfully learnin retaining this important information (roots).

The core problem (the trunk of the tree) is "Forge Your Lessons"

ussion on how to populate t v pattern emerges.

Approx. 15 minutes

A picture of our progress

EXERCISE 5: THE STORYBOARD

Let's see what we have learned and how far we come. What factors of your education helped yo What factors of your education proved ineffectiv denied you some valuable knowledge?

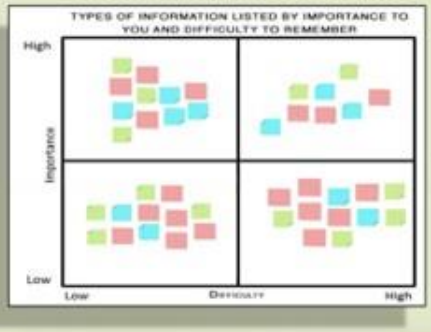
This final grid is a storyboard. Since this workshop h beginning middle and end, we are going to illust and script, in these nine boxes, just what we disco and how we discovered it.

Let's work together to decide what picture best represents our activities and write beneath each what we've concluded.

We are building a visual summary of the entire wo and you should take a picture of it for your own b Often what we commit to an image is far more memorable than what we simply commit to memory.

Approx. 15 minutes

Hard, easy, important, trivial



EXERCISE 4: IMPORTANCE/DIFFICULTY MATRIX

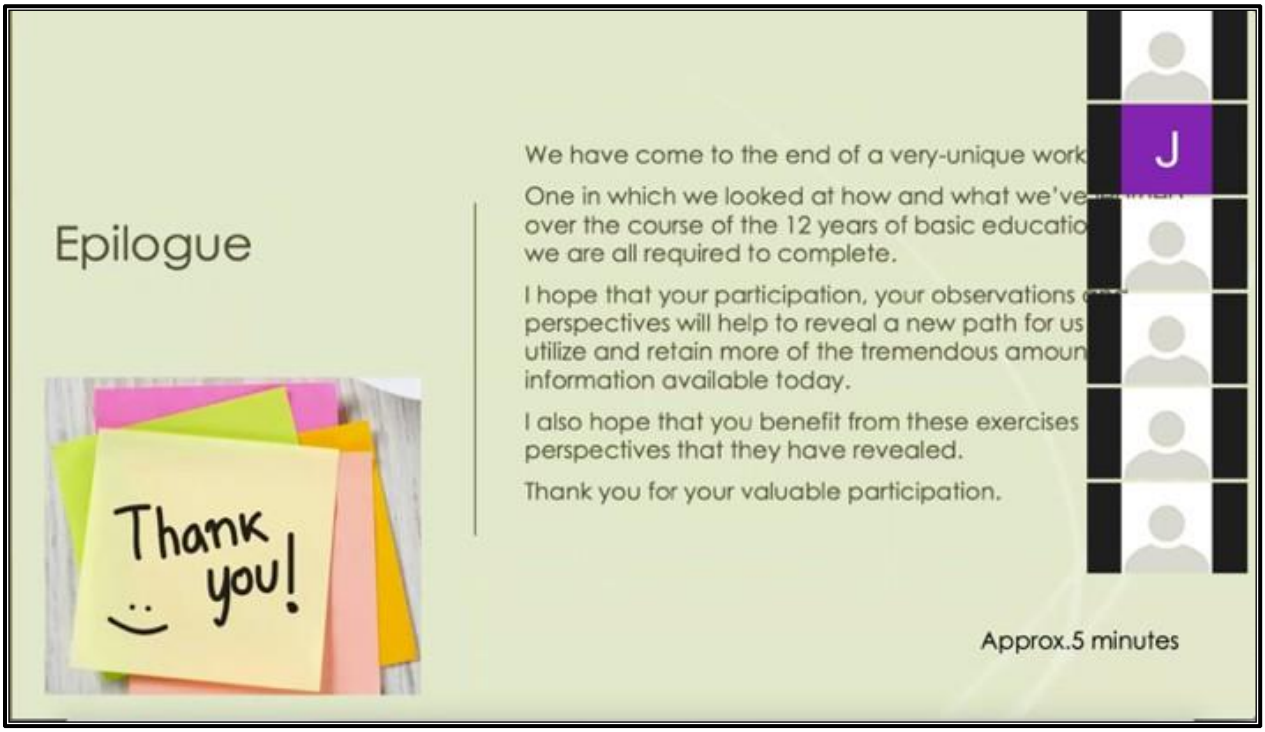
We are exposed to many different topics and sub the course of our educational experience. Some understood easily. Some may still be vague and use to us in our everyday live.

Using your personal experience, and more Post-It down the various topics and subjects from your education and place them on the Importance/D Matrix.

Please notice that the entries range left to right a to bottom as low in importance and difficulty in t lower left corner, to high in importance and diffic the upper right.

Judge the level of difficulty and the degree of importance and place your answers according t

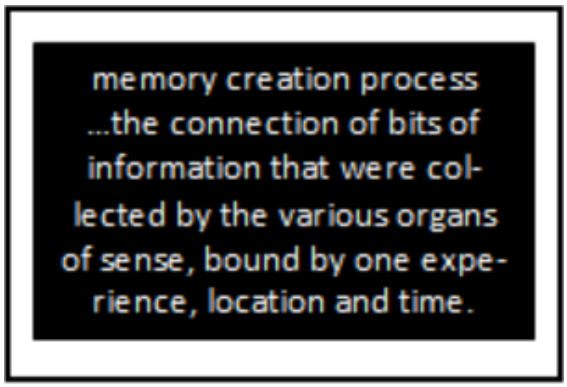
Approx. 15 minutes


Epilogue
We have come to the end of a very-unique work
One in which we looked at how and what we've
over the course of the 12 years of basic educatio
we are all required to complete.
I hope that your participation, your observations
perspectives will help to reveal a new path for us
utilize and retain more of the tremendous amoun
information available today.
I also hope that you benefit from these exercises
perspectives that they have revealed.
Thank you for your valuable participation.
J
Thank you!
Approx.5 minutes

Observations Based on Workshop Data

Unexpected Revelations of Memory Retrieval

When memories are retrieved, they are often accompanied by emotions. When, upon retrieval, a memory or emotion causes distress, the mind seems to consciously stop the cycle of repetition and retract the memory/emotion and repress it, protecting from future triggering. The retracted memory may become distorted as a protective process designed to avoid the disturbance or pain that retrieval had caused.



The workshop had an unexpected effect upon the older participants. The intention of this workshop was to trigger specific memories. Instead, the exercises seemed to create a cascade of memories. For example, when asked for a response to the specific question, "Who was your favorite teacher? Why," not only did several participants provide a name (or in many cases several names), but a detailed narrative of each person cited including specific acts of encouragement, personal conversations, physical characteristics, and shared experiences beyond the classroom. Each "favorite teacher" memory was accompanied by a plethora of ancillary memories, seemingly inextricable from the whole. These memories were overwhelmingly accompanied by re- called emotions, ranging from vague amusement to examples of deep happiness or melancholy. The memories were retrieved as a complex package of memories (thought webs) accompanied by differing degrees of emotion.

A female participant, age 74, said, "The workshop left me very depressed. It brought up some very painful memories." A male participant, age 72, embarked on a negative tirade of memories concerning his time in a Catholic grammar school. He described his teachers as

"…horrible nuns …" and was able to recall and describe a specific incident as follows:

> In the sixth grade Sister Grace Marie asked me the names of the two American Islands that Japan occupied during WW2. I knew the answer, but I could not say it. So, she called me stupid, and picked on a girl for the answer. The girl jumped up and said, "Attu and Kiska". The nun praised her and smacked me. I knew that answer. I will never forget Attu and Kiska.

His memories were both crystal clear and emotionally charged. Several other respondents experienced a flood of emotions along with their recollection of memories of times and incidents long past.

As described previously in this thesis, engrams (single units of thought) are tied together by a coordinated link or a thought web. When the thought web is triggered, it rises to recollection as a specific cluster of engrams. The resulting recall is memories of facts, conditions, people, events, and other ephemera related to the engram intended to be recalled. Some of the adjoining engrams or memories are willingly considered to have value and others are treated as valueless ephemera. All of these recalled memories remain either actively or passively in the conscious mind. They may remain in the forefront of thought if given renewed value. They may be revised prior to returning to long-term memory if they cause pain or embarrassment or they may just linger in the subconscious possibly to be processed into dreams (Frankland et al., 2019).

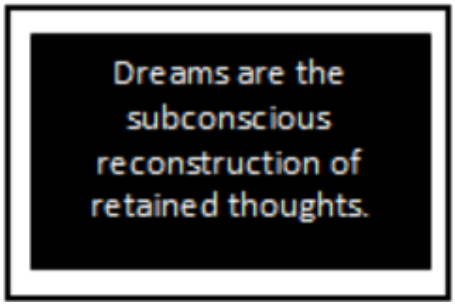
Several participants reported dreams that included people and situations from their school years, which they feel were provoked by the workshop. One female respondent, age 61, described vividly dreaming of walking to school without her parents, accompanied by classmates she had not thought of for decades. The fragmented dream ended with a vivid

recollection of her eating Jello, which her grandmother had regularly given her after school. She claimed that she could actually taste the treat and woke up craving Jello.

This would indicate that the memories called upon to answer the questions posed in the workshop were going through another memory-storing and strengthening process as described in the neuroscience section of this thesis. Memories go through a period of subconscious repetition, as would new information being processed for retention. This subconscious process often lends imagery to dreams in the same way that a child, having seen a horror film, may tend to have nightmares triggered by the emotion-based images retained during the viewing.

In Haley Vlach's book *Blue Sky Science: How does your brain form memories?* the author described the memory creation process as the connection of bits of information collected by the various organs of sense, bound by one experience, location, and time. After being bound by some commonality they travel over a period of 2 to 12 hours to the brain's hippocampus which integrates the bound information to create a memory. The hippocampus is also responsible for assigning relative importance to a memory and either allowing it to fade or committing it to long-term storage (Vlach, 2015). She then described *recall* as stimulating activity in this stored memory by exposure to information, sensual inputs, or similar situations that reactivate the memory.

Long-term memory indicates a memory may be stored for life. All memory referred to in this study is long-term memory. The process for data to be stored as long-term memory consists of a period of repetition and reflection in the mind, followed by an incubation period of approximately 24 hours, and then migration to the hippocampus portion of the brain (Vlach, 2015).



Dreams are the subconscious reconstruction of retained thoughts. The female respondent who described her dream recalled some very specific memories associated with but not directly pertaining to her educational experiences. Her mind was triggered by the exercises in the workshop, to recall memories of a specific period of her life. Although asked to recall specific facts from that period, the triggering caused associated memories to emerge. Because they were not direct answers to the questions presented, they remained repressed and not overly expressed. They were, however, recalled, and presented themselves in her dream, her personal reconstruction of reality. This indicates that memories do not exist as singular units but as parts of a much greater conglomeration of stored thoughts. These thoughts, when recalled are uniquely reconstructed in the individual's mind.

In *The Secret Life of the Mind,* Mario Sigman presents a model of the mind's reconstruction of reality in a chapter entitled "The Framework of Thought." In this chapter, the author said:

> From the day we are born the brain already forms sophisticated conceptual constructions, like the notion of numerosity, and even morality. We root our reconstruction of reality in those conceptual boxes. When we listen to a story, we do not record it word by word but rather we reconstruct it in the language of our own thoughts. That is why people emerge from the same cinema with different stories. We are the scriptwriters, directors and editors of the plot of our own reality. (Sigman, 2015, p. 219)

This is highly pertinent in the educational environment. The same thing that happens

with a film occurs with a class; each student reconstructs it in his or her own language.

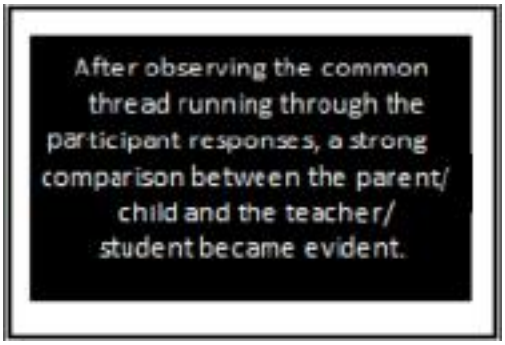
> Our learning process is a sort of convergence point between what is presented to us and our predisposition for assimilating it. The brain is not a blank page on which things are written, but rather a rough surface on which some shapes fit well, and others don't. That is a better metaphor of learning. A problem of congruity, of matching. (Sigman, 2015, p. 219)

The workshop may have exacerbated this effect in that the individual's perception tends to lead to unique constructs of common experiences. The examples provided in previous paragraphs alluding to emotional reactions and the unexpectedly recalled memories, either conscious or subconscious, reflect the model of the framework of thought as defined by Sigman.

One of the results of this workshop was a marked increase of conversations pertaining to the quantity and quality of memories drawn up during the process. A distinct aspect of these conversations was the shared emotional experiences, ranging from amazement to melancholy. The experience produced a catharsis of stored often forgotten emotion. It incited verbal comparison of individual experiences in search of commonalities. Following this spontaneous response during the workshop presentation, the mood lightened tangibly. When the written answers were extrapolated and compared, these commonalities and emotions were evident.

The Teacher/Student Relationship

A very important observation became evident in review. The collected answers indicate that there is a parallel in the effects of the parent/child relationship and the teacher/student



relationship. The parent/child relationship is known to determine many traits that combine to form an individual's overall personality. Parental input of emotions, information, frequent encouragement or discouragement, habits, language, and many other factors are responsible for programming much of their offspring's mental and emotional makeup. After observing the common thread running through the participant responses, a strong comparison between the parent/child and the teacher/student became evident. For example, nurturing, empathetic, and engaged teachers are cited as (at least in part) having greatly influenced the student to exhibit the same qualities. They are credited with inspiring the future success of several participants.

Many of the participants expressed that major decisions in their lives were made based upon the influence of one or more teachers. These decisions included their choice of career and the amount of education they pursued. They associated the influence of teachers with the formation of their ethical foundation, work ethic, and level of professionalism achieved. In retrospect, many of the older participants associated the influence of specific teachers with the entire path of their lives.

F46 (educator):

Reading for school has always fostered my love. Throughout my educational career I was always encouraged to read for educational purposes as well as pleasure.

I wanted to be a teacher and I loved the way my 7th grade religion teacher, Mrs. Genovese, would dress. I kept a daily journal of the outfits that she would wear so that I could copy them when I became a teacher.

[List the subjects you remember the most about. Why do you believe you remember these subjects more than others?]

F78 (educator):

I remember them most because of the practicality and relevance to my life. They interested me because I could apply them to what I was doing and/or wanted to do. The most important things I learned were self-discipline, respect and ethics. I learned that I need to be able to take care of myself. In some areas I am mostly self-taught, after the fact. I sought out information on my own when it was necessary and relevant to my life.

M63 (insurance salesperson): "Poor reading skills in grammar schools may have prevented me from becoming a doctor or lawyer…or Wall Street financial guru."

F61 (a published author of four biographical books):

I enjoyed reading and discussing books although I mainly remember reading One Flew Over the Cuckoo's Nest in 9th grade. I also enjoyed speech very much and using Mad magazines as inspiration to write parody speeches. They were very well received. I loved reading and visiting the St. Finbar's (school) Library and reading biographies about women.

[Write down your clearest memories of your educational experience.]

"Feeling empowered by my ability to write. Loving art classes."

[Write down what benefits you have gained in your education. What educational tools have tangibly helped you?]

Reading was the key to knowledge. Always having access to libraries was our internet. Speech classes gave me confidence to present ideas, etc. Seeing how teachers could have a negative effect on student's psyches made me more compassionate and made me

want to diversify methods of teaching employing KATV methods and not just chalk and talk/memorization. Reading was the greatest blessing of all.

M57 (physician):

My favorite classes were 7th and 8th grade science taught by Roger Ahern. It is because of him that I ultimately went into the medical field…Dr. Randy Cohan, who taught radiology in podiatry school helped me to succeed in that field.

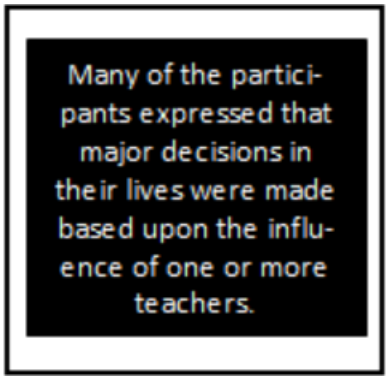
F27 (worker in the health fields):

I always found biology interesting because of the topic alone. It didn't really matter who the teacher was, I just thought science was fascinating. I went to Catholic school, so there was a big emphasis on learning about the history of the Catholic religion. I was also fascinated by what happens after death once I understood that concept, and religion provided an explanation. Creative writing was my favorite subject because it provided a way for me to express my thoughts and channel my imagination.

Ms. Moffet taught exercises in creative writing that still stand out so clearly in my mind. She'd ask us to complete tasks like writing the most accurate method of tying your shoes. She'd then have one of your classmates come up, untie their shoes, and place them on a desk. Everyone would read the instructions they wrote to see whether or not that person could tie their shoes by following the direction given. The first time we did the exercise, no one in the class could accomplish this task. It was exciting because we were being forced to use our brains in a way other than just regurgitating information. I think I also liked it so much because I had a difficult time relating to the kids in my class throughout kindergarten to eighth grade, but everyone was so involved in the task at hand, and so willing to laugh at our inability to complete it, that I never

felt left out.

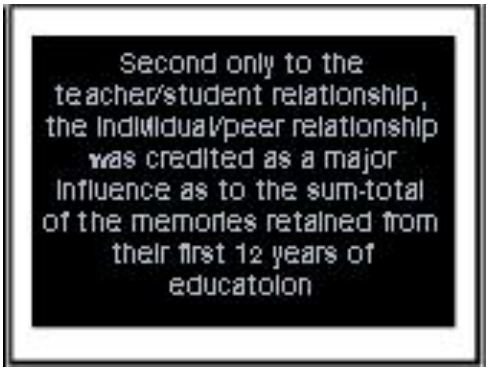
The teacher/student relationship outweighed all other influences tested in this workshop. The individual's ability or inability to remember specific information, associated strategic thinking techniques, and associated memories (classmates, locations, and other particular memories associated with a specific subject) were strongly influenced by his or her relationship with an individual instructor. Because of this predominant reaction across age and gender, the teacher/student relationship has gained a new prominence in the factors determining the quality, quantity, and endurance of human memories.



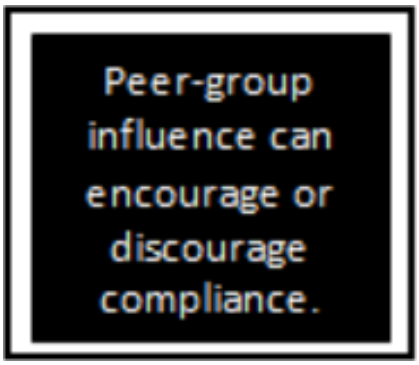
The Individual/Peer Relationship

The individual/peer relationship became a prominent and recurring theme in the responses to the workshop exercises. Second only to the teacher/student relationship, the individual/peer relationship was credited as a major influence as to the sum-total of the memories retained from their 12 years of formal education.

Peer influence was more directly associated with the evaluation of information to be accepted or rejected by an individual. This factor was directly associated with what information was considered acceptable and objectionable within a peer group. Examples of this evaluation of acceptable and objectionable information are specific subjects (often taught by popular or unpopular instructors as considered by the peer group), specific social, athletic, and political information, and the credibility or



incredibility of concepts, rules, ethics, religion, social mores, and insufficiently researched/understood information. These peer group evaluations seem to weigh highly upon an individual's conscious effort to remember or discard. Following Daniel Kahneman's observations and theory in his book *Thinking Fast and Slow,* all permanent memory requires the conscious employment of the process of memorization described as a function of System 2 thinking. That is to say, memorization requires a voluntary processing of memory based upon the value assigned to a specific bit of information by the individual. This process requires the expenditure of energy, effort, and time, all of which must be allowed and initiated by the momentary compliance of the individual.



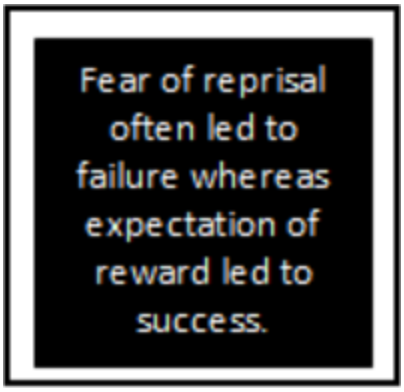
Peer group influence can encourage or discourage compliance. This is not a function of systematic review and evaluation but more of a process of presentation, discussion, agreement, and evaluation. For example, the peer group may find themselves required to take a course in calculus. The subject is presented and discussed on the basis of what has been said by other peers and peer groups, their opinions and evaluations, and an overall agreement and evaluation of the prospect of doing well in calculus. The expectation of success or failure weighs heavily upon the actual outcome for each peer as he or she approaches the subject with preconceived expectations. The evaluation is never permanent in that it is either reinforced or dispelled by the experiences of each peer in a regular repeat of the original process of presentation, discussion, agreement, and evaluation.

Peer group evaluation will change as experience and the addition or subtraction of individuals changes the peer group dynamics. This relationship is also one that evolves as the

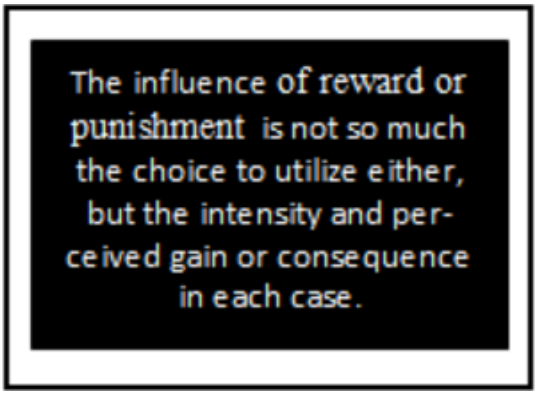
peer group changes members, experiences more factual input, and matures. The result of analysis of the answers provided by the participants in the workshop strongly indicate that individual/peer influence is a major factor involved in the retention or rejection of information.

The Effects of Reward and Punishment

Elements of reward and punishment affect the teacher/student and individual/peer relationships, and beyond them, the parent/child, employer/employee, and virtually every two-part relationship in an individual's life. Through the responses of the participants and observation of life in general, the effects of reward and punishment are, at best, complex to define.



Individuals remembering examples of reward or punishment used to drive effort or instill values seem to describe differing results. As posited previously, memories are more effectively accepted and retained when accompanied by emotions. Reward and punishment both produce an emotional response. Circumstance and intensity constantly vary in each individual occasion.



The influence, it would appear, is not so much the choice to utilize reward or

punishment but the intensity and perceived gain or consequence in each case. Therefore, no absolute value can be assigned to either method, but instead to the form, intensity, and perceived value of the outcome of either influence.

Participants described teachers, parents, and peers who praised and berated them publicly. They described tangible rewards of gifts or money and consequences ranging from minor castigations to physical assault. The results were expressed in terms of the efficacy of each method as compared to their intensity. The outcome was primarily based upon the individual's reaction to stimulus. For example, several respondents described fear of a corporal punishment for failure. For some, this motivated success. For some, the fear of reprisal disrupted their ability to learn and therefore failed. The expectation of reward enhanced their ability to achieve and therefore succeeded.

The following quotes from several workshop respondents illustrate the adverse effects of fear and perceived punishment, either psychological or corporal:

F62 (teacher): "I disliked Ms. Nagel in my sophomore year of high school because she was cold and mean…just like the math she taught."

M18 (student): "I remember presenting a science project in the 5th grade and my teacher began to yell at me because I was reading the project off the board. Since then, I've lost interest in science."

M72 (physicist, educator):

> In the sixth grade Sister Grace Marie asked me the names of the two American Islands that Japan occupied during WW2. I knew the answer, but I could not say it. So, she called me stupid, and picked on a girl for the answer. The girl jumped up and said, "Attu and Kiska". The nun praised her and smacked me. I knew that answer. I will

never forget Attu and Kiska.

My worst memories of school came from too many other experiences involving beatings (and even a mock hanging) from the good nuns at Saints Simon and Jude Grammar School to relate here.

F74 (educator):

My worst teacher was my Earth Science teacher in my freshman year in high school. (Poor instruction). She was a very old Nun and I think she was not a science teacher. They were probably using her because they did not have anyone else. This was my first experience with science. We had no science in grammar school. She would read from the book and expected us to memorize what she had read in class. Her classes were boring and confusing. She was also nasty and made sure she had a demeaning comment for every girl in the class. This was the only class I ever failed in all my school years.

M59 (health care worker):

My least favorite teacher is Miss Phillips. In first grade she would pull my ear insist I sit still and remain quiet. Also, Mrs. Adams in Kindergarten, stood with her arms crossed blocking the door…I feared being berated for not completing an assignment correctly or on time or being scolded for miniscule events.

Although these methods (known in general as “the carrot or the stick”) have been widely utilized in many past models of teaching, they prove to be detrimental to the learning process by changing the focus of the student from willing learner to defender/survivor, shutting down both the necessary assignment of value to the subject matter and the will to process information.

These counterproductive elements must be consciously removed from any new

paradigm of teaching.

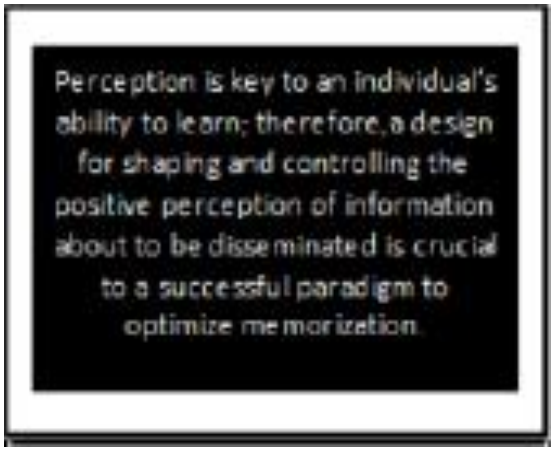
Sometimes the threat came from the other students. Peer pressure or anti-social or aggressive behavior on the part of fellow students ruined the learning experience of some respondents.

F60 (entrepreneur): “My worst experience was bullying. In high school an older gal named Cynthia. Just mean and mean spirited.”

M59 (corporate sales): “I remember the group dynamics. Not fitting in with the ‘in crowd’, being bullied, not being athletic.”

Perception Over Fact

An additional observation was made in the course of this exercise. The influence of perception over fact is evident in all of the aforementioned interpersonal relationships and predominant in the function of memory retention.



Perception drives evaluation of information. The evaluation of information either triggers the process of memorization or the outright rejection of bits of information. Perception is influenced by a myriad of factors. Perception is key to an individual’s ability to learn; therefore, a design for shaping and controlling the positive perception of information about to be disseminated is crucial to a successful paradigm to optimize memorization. By attaching positive emotions, concern, personal stakes, logical reason, and overall value to the pending lesson, the process of memorization could be triggered.

Workshop Conclusions

This human-centered workshop produced a rich harvest of crucial observations pertaining to the theory and goals of this thesis. By culling information from a group of participants that varied in gender and spanned a wide range of age groups, common trends of thoughts and perceptions became evident. At the time of the group presentation and discussion, the verbalization of these trends was minor, possibly due to a combination of the online nature of the exercise and the perceived reactions of an unknown cohort.

In general terms, this research revealed that much of information retention, recall, and usage is highly influenced by emotional circumstances, perceived value, and the myriad of influences imposed upon an individual through interpersonal relationships. These observations have necessitated the rethinking and redesign of the classroom presentations to be delivered in the period following this workshop and proved to formulate a rich and crucial portion of the research for this thesis.

Figure 44. Major Workshop Findings

The Classroom Sessions

Next in the research process came a set of comparative classroom sessions in which a unique and detailed narrative was presented to two independent sets of volunteers. One session presented the information using a method designed and utilized in a large, progressive school system in northern New Jersey. The second session presented the same set of facts using a method designed based on the findings of the design-thinking workshop discussed previously. The volunteers were tested on their retention and the critical thinking attained through these exercises using one identical set of questions for both groups, and the data points were analyzed to compare the efficacy of both methods.

Description of Classroom Research

Due to the extreme self-confinement made necessary by the COVID-19 pandemic, the workshop required an online redesign. The classroom sessions were conducted online Saturday, April 18, 2020. The control session was conducted at 11 a.m. utilizing Zoom, with an instructor and 10 participants online.

The subject of both sessions was a unique fictitious story with one set of common facts. The control session was presented as a factual narrative stressing the facts, concepts, and critical thinking. Christopher Volk, a middle school history teacher from the Saddle River school district in New Jersey, instructed his class using the method standardly used in that district.

The experiment was conducted using *experimental design*, providing two independent test groups with 90-minute instruction periods, using fictitious material unique to this exercise. One of the groups was instructed in a standard (“authority” or “lecture”) style. The remaining group of 11 individuals was instructed in a manner designed to increase interest, emotion, and

the overall desire to accept and retain while utilizing the same written content. These two methodologies stand as the study's *independent variables.*

Employing this methodology is meant to generate data free from extraneous variables. The use of small, isolated groups, completely unique information (unavailable beyond the bounds of the experiment), and two specifically designed methods of instruction should produce comparable and viable results. The experiments were designed to compare the quality and quantity of information recalled by two distinct test groups; each having been given the same information using two distinct methods. Testing took place one week and two weeks from the date of the original 90-minute instructional session for each group. Due to the online format of the classes, there was no written material.

The tests were designed to reveal the retention and ability to recall specific factual material using the form of fill-in-the-blank questioning and a short essay recalling the lesson's narrative (based upon information common to both presentations). Each student received an identical online test and completed and returned the test within two days of their receipt. Testing was con- ducted online to ensure greater participation and eliminate cheating or discussion. The resulting data gathered from the two testing groups represents the dependent variable in this experiment.

The data revealed a comparable similarity in quantity and quality of learned and retained data. These results revealed that the human mind processes information more efficiently when exposed to the newly designed method.

To facilitate comparable results in this experiment, a study group of 12 participants and a control group of 11 were assembled. The entirety of volunteers consisted of students (ages 18-21) engaged in the undergraduate studies and in part, a group of adults (ages 45 to 80. These two

groups represented a cross-section of demographics with the significant difference being their sources and consumption of data.

Use of the undergraduate demographic was designed to test the results from individuals at the pinnacle of a continuous 14-plus years of a learning paradigm (predominantly consisting of traditional teaching methods). Use of the 45- to 85-year-old demographic was designed to test the results from individuals several decades removed from a learning paradigm (predominantly consisting of traditional teaching methods).

Procedures

Both groups were presented the material in an online Zoom session due to the restrictions imposed during the COVID-19 pandemic. This was in place of the classroom setting, originally designed utilizing elements found through research contained in the literature review. Both groups were tested, using identical test forms at one and two weeks following the sessions. All quizzes were returned by email.

The convenience sampling of this process was achieved through the participation of volunteers from both demographic age groups, having experienced different levels of education and unique personal backgrounds. Each participant in the experiment was expected to be relatively unique from all others while meeting the pre-existing requirements. The use of the two age demographics was designed to provide data pertaining to the covariance of the two independent variables (groups). Their unique answers were registered including age identification.

Instruments: Control Data

Data created specifically for this experiment was required. This unique data stands as a control and was designed to eliminate extraneous variables that exist with standard (textbook)

data. This is based upon the possibility that some members of a convenience group of individuals, within a sampling group, have varying degrees of prior knowledge of materials available to the general public. A set of completely unique data eliminated this possibility.

To this end, a fictitious narrative was produced and presented as the subject matter for this exercise. From this point forward, this subject matter is referred to as Control data. The Control data contains events, dates, characters, locations, and other fact sets unique to this study. The amount of material was designed to allow its dissemination and discussion within a 90-minute period. The control data included fictitious images, maps, and other graphic materials similar to standard textbook materials.

Instruments: Study Data

The Study data is the same factual material that was contained in the Control data, rewritten in a style that utilized data gleaned from the workshop session. This resulted in the inclusion of the following set of style changes and trigger elements:

- A real and rational value of the material was provided prior to the lesson.
- Emphasis upon a positive teacher/student relationship was clearly exhibited.
- Instructor interaction with each student in the session was provided.
- The text was composed as a narrative rather than a textbook-styled lesson and included specific emotional and empathetic triggers.
- Compelling photos and music were inserted into the PowerPoint presentation meant to promote better retention through the inclusion of emotional and literal elements.
- Major points of data were reiterated at least one or two times with the intention of starting the voluntary repetition of data, necessary to trigger the neurobiological retention process. Vigorous group discussions were initiated at the end of each

chunked section of instruction.

- Participants were complimented for good questions and comments at the end of each chunked section of instruction to provide positive feedback and encourage memorization.

Other Materials

This experiment included two standardized tests distributed to all participants of both sessions. Each test consisted of a combination of six identical multiple-choice questions and a brief essay. The first quiz was distributed by email to all participants exactly one week from the classroom sessions and the second quiz at exactly two weeks. Each completed test was returned within 24 hours by email.

Location

Due to conditions imposed by the COVID-19 pandemic, both the workshop and class-room sessions were held online as Zoom sessions. Participants for each session were assembled and instructed independently of the other. As a result, the Control group consisted of 10 participants, and the study group of 11.

Procedures

This experiment was designed to test the comparative acceptance, retention, and utilization of the same material delivered to similar samplings of participants, using two distinct methods of delivery (see Figure 45).

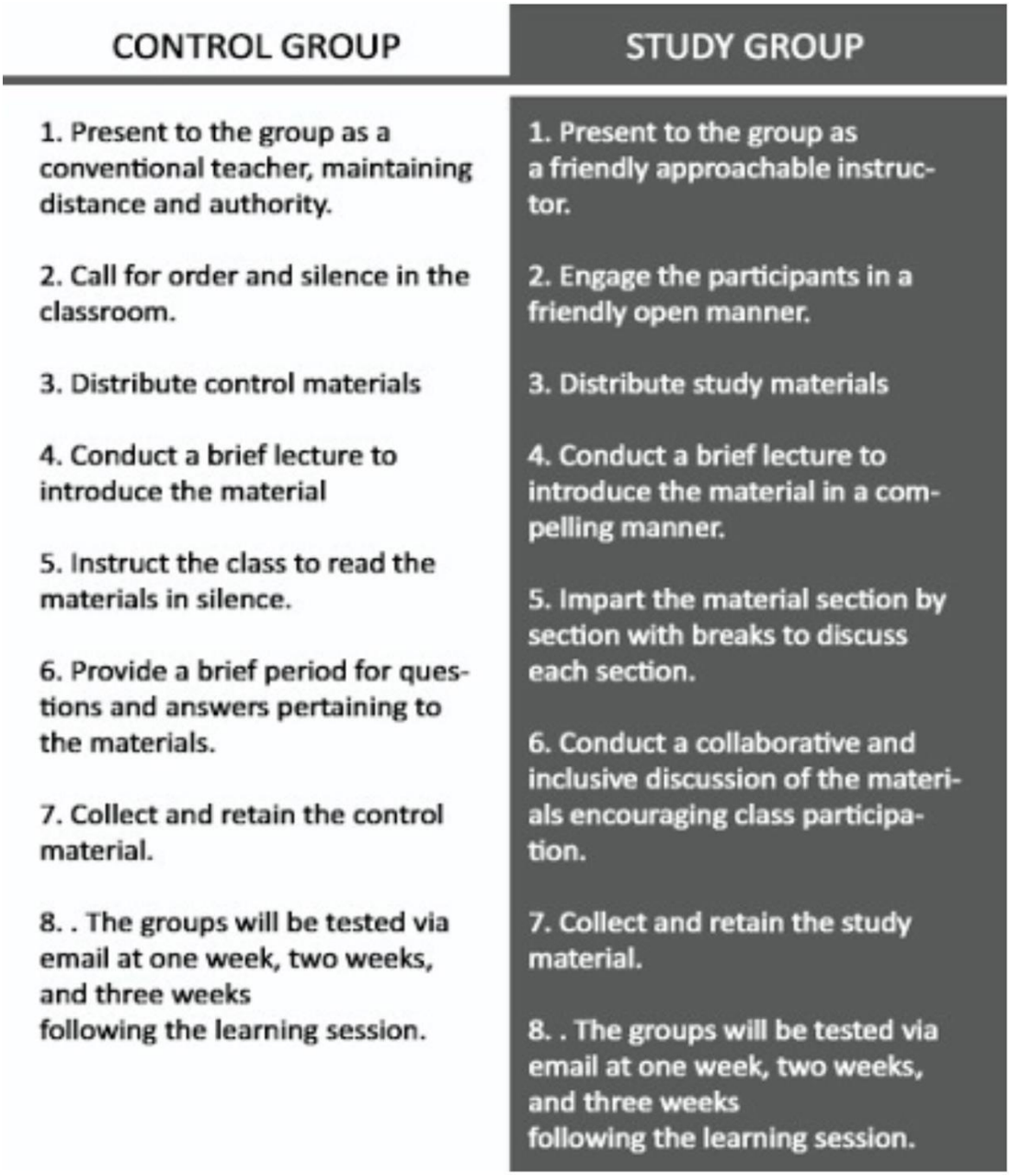


Figure 45. Class Sessions Procedural Chart

The *independent variable* for this experiment is the use of two distinct methods of information dissemination to provide similar data. The *dependent variable* for this experiment is the quantity and quality of the data retained and recalled following the learning sessions.

The goal of the experiment was to observe the similarities and/or differences of the quantity and quality of the data retained and recalled following the learning sessions in an effort to ascertain an outward indication of any changes in the long-term potentiation of each participant.

Detailed Classroom Sessions Procedural

The control group (undergraduate students and adults ages 45 to 80) was provided with an instructional session of approximately 90 minutes, utilizing the commonly used authority, or lecture, style. (The following reflects revised format.)

1. The participants were assembled in a Zoom session hosted by the instructor, Christopher Volk.
2. Order and silence were requested (specifically by asking participants to mute themselves during instruction).
3. A PowerPoint was presented consisting of the existing maps and materials written in a textbook format by the control group instructor.
4. The instructor conducted a lecture based upon the control data.
5. The instructor presented additional PowerPoint presentations to define specific terms.
6. The instructor allowed a brief period for questions and explanations.
7. The instructor informed the participants of the testing schedule and ended the Zoom session.

Study Group Procedure

1. Participants were assembled in a Zoom session hosted by the instructor, William Castello.
2. The instructor provided a cordial welcome and a complete explanation of the pending session.
3. The instructor established the value of the information about to be presented.
4. The instructor presented a PowerPoint presentation of the existing maps and study data enhanced with emotionally compelling photos and music.
5. The instructor narrated the presentation in segments, while breaking after each segment for

detailed explanation and questions.

6. The instructor retold the story emphasizing the main points and encouraging questions and observations.
7. The instructor allowed a group discussion of the lesson curated by the instructor.
8. The instructor informed the participants of the testing schedule and ended the Zoom session.

Detailed Study Group Session Procedural

This session was approximately 90 minutes, utilizing a method designed specifically for this experiment:

1. The Study group was cordially addressed prior to the instruction, at which time they were introduced to each other and to the instructor and encouraged to interact in an informal manner. The short period of small talk and humorous banter created an atmosphere of ease, conviviality, and comfort (a welcoming, happy, and open atmosphere). This was needed to encourage ease and acceptance of the in- formation to be provided, to create the optimal psychological paradigm for information acceptance. They then were collectively made aware of what was about to transpire and of the value of the exercise.
2. The group was asked to observe a PowerPoint presentation of the Control data

   and think of questions and comments for each segment. The Study Group presentation was specifically designed to attach emotional and visual triggers to the factual materials. This was accomplished by presenting each specific fact with an appropriate visual and audible element. The additional elements were designed to subtly trigger emotions. The factual materials were delivered as a narrated story rather than a straightforward lesson.
3. Each short segment of information contained a cohesive group of facts designed to form a single layer of information. Employing the chunking method, each layer of information was

carefully summed up and opened to questions from the participants.

4. The entire narrative was reiterated and summarized**,** stressing emotional intonations, hints of humor, and surprise. This manner of instruction is meant to connect information to emotional stimuli, which is supposed to make information more easily accepted and remembered.
5. A period of dialogue and discussion of the control data was conducted in an open forum with all participants speaking freely and interacting.
6. The participants were thanked and encouraged to try to retain as much information as possible.
7. The group was informed that they would be tested at one week and two weeks following the session and the Zoom meeting was ended.

Internal validity

The experiments were designed to avoid any foreseeable confounding variables. By using a study group consisting of differing ages, life experiences, exposure to educational norms, and levels of education, a norm for the group may be collected and factored into the pool of data. Each participant was issued a brief questionnaire to collect data pertaining to background, education, and relationship with any other applicant.

In an effort to facilitate a working timed series of tests, the first test was conducted at the end of the online classroom session. Subsequent tests were conducted online to ensure that no limitations of schedule, travel, personal health, or circumstance disrupted testing.

The control variables consisted of the following: use of a standard lecture style for the Control group and a designed lecture style for the Study group. The two groups were isolated from each other and provided the same data independently. Identical testing and polling materials were issued to every participant. Subsequent testing was conducted at the exact same time intervals for both groups.

The material used for this experiment was completely unique, compiled of fictitious materials to create a simulated chapter from a nonexistent textbook. This was to ensure that no previous knowledge or subsequent research could affect the outcome.

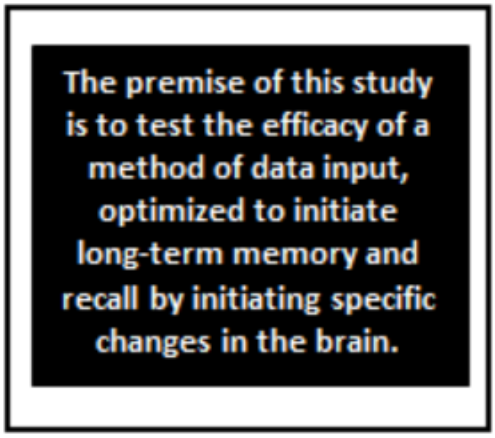
Chapter 4 Results

Classroom Sessions Overview

Due to the exceptional conditions imposed by the mandatory sequestering due to the COVID-19 pandemic and the subsequent closing of all facilities reserved for these sessions, an online format was designed and utilized. Two Zoom sessions were conducted on Saturday, April 18, 2020: one for the Control group at 11 a.m. and a second for the Study group at 2 p.m.

Control Group

The Control group of 10 participants was conducted in an online session by Mr. Christopher Volk. Mr. Volk is a 7th grade history teacher currently employed by the Bergen County public school system. He graduated with honors from Ramapo College, NJ, in 2016, with a bachelor's degree in education. He was chosen to conduct this session based on his education, recent entry into a progressive school district, and high rating as a teacher. His method of teaching reflects the most current paradigm of standardized teaching nationwide.



Ten days in advance of the scheduled sessions, Mr. Volk was provided a basic version of the subject materials (see Appendices A and B). He was given that time to formulate a lesson plan according to his current scholastic guidelines. As the Study group instructor, I asked to

remain uninformed as to the delivery method, so as not to be influenced in any manner that might affect my own delivery method. I conducted the Study group at a separate time and with 11different participants.

Both presentations were built around 24 specific data points that were the basis of two subsequent tests, issued one and two weeks following the sessions. The tests for both groups were identical (see Appendix C). Mr. Volk was instructed to include each of the 24 data points in his presentation. Both the Control and Study groups were provided the same 24 data points via two different delivery methods.

Study Group

The Control presentation followed current classroom procedures and methods as required by the instructor's local board of education. In contrast, the Study presentation was designed utilizing the results of the research in neuroscience, psychology, pedagogy, and the human-centered workshop observations as described in section 3, part Detailed Study Group Session Procedural. It was constructed using specific triggers and behaviors found to optimize the acceptance, processing, retention, and utilization of information.

Each session employed one instructor and a diverse group of volunteers and lasted approximately 1 hour and 30 minutes. Both sessions were recorded via the Zoom video feed and saved as MP4 files (available upon request). Both sessions consisted of approximately 1 hour of presentation utilizing several visual aids and maps, followed by a half hour of questions and discussions on the topic.

One standard test with 12 questions was given to all participants on April 27, 2020, exactly one week after the classroom sessions, and a second test consisting of 12 different questions but on the same basis was given one week later, on May 4, 2020. The Week 1 test was a combination

of multiple-choice questions specifically designed to test memorization and critical thinking data points delivered via the two different methods and using different memory triggers to promote retention.

Results of Group Testing

Week 1 Results

The raw data from Week 1 classroom sessions involving both the Study and Control groups indicate that over the elapsed period of one week, the participants' ability to recall information requiring both simple memorization and more complex cognition produced nearly identical results (see Tables 7 and 8).

Table 7 Week 1 Study Group Results

STUDY GROUP INSTRUCTED BY WILLIAM CASTELLO

QUESTIONS	1	2	3	4	5	6	7	8	9	10	11	12
F67	B	A	A	C	A	B	A	C	D	C	C	D
M62	C	C	A	C	A	B	A	C	C	B	D	D
M24	B	C	A	C	A	B	A	C	D	C	C	D
F80	B	B	C	C	A	B	A	C	D	C	D	D
F59	B	C	C	D	A	B	B	C	D	C	C	D
F70	B	C	B	C	C	B	A	B	D	C	D	D
F62	B	C	C	A	A	C	A	C	B	C	D	D
F76	B	C	C	B	C	A	A	D	B	B	C	D
F71	B	B	C	D	C	B	A	D	D	B	C	D
F75	B	C	A	D	A	B	A	D	B	B	D	D
M18	B	C	C	D	A	B	A	C	D	B	A	D
CORRECT	10	8	4	8	8	9	10	7	7	7	5	11

Chart key: **A** = correct answer, A = incorrect answer
Participants are identified by gender (M/F) plus age

Type of question: Memorization Cognition

Table 8 Week 1 Control Group Results

CONTROL GROUP INSTRUCTED BY CHRISTOPHER VOLK

QUESTIONS	1	2	3	4	5	6	7	8	9	10	11	12
F28	C	C	A	D	A	B	A	C	D	B	C	A
F56	B	C	A	C	D	B	A	C	D	B	D	A
M20	B	C	C	C	D	B	A	C	D	B	D	D
F19	C	C	A	C	A	D	B	B	D	B	D	D
F60	B	A	C	D	D	A	A	C	D	B	D	D
M72	B	C	A	C	A	A	A	C	D	B	D	D
M68	B	C	A	C	A	B	A	C	D	C	D	D
F65	C	D	A	D	D	C	A	C	D	A	D	D
M19	C	C	A	D	D	B	A	B	B	B	A	A
M62	C	C	C	D	C	B	C	C	A	B	D	D
CORRECT	5	7	7	4	4	6	8	8	8	8	8	7

Chart key: **A** = correct answer, A = incorrect answer
Participants are identified by gender (M/F) plus age

Type of question: Memorization Cognition

The period of one week reflects the typical time period between instruction and testing in the standard pedagogy paradigm today. The Study group attained an overall correct percentage of 69% compared to the Control group's correct percentage of 67%. Both groups, as measurable units, proved to attain an overall passing grade above 65%. The charted data analyzes the results as overall correct and incorrect answers (Table 9), the comparison of the efficacy of each method by specific question (Table 10), and the overall success and failure by specific question (Table 11).

Table 9 Week 1 Percentage Correct/Incorrect

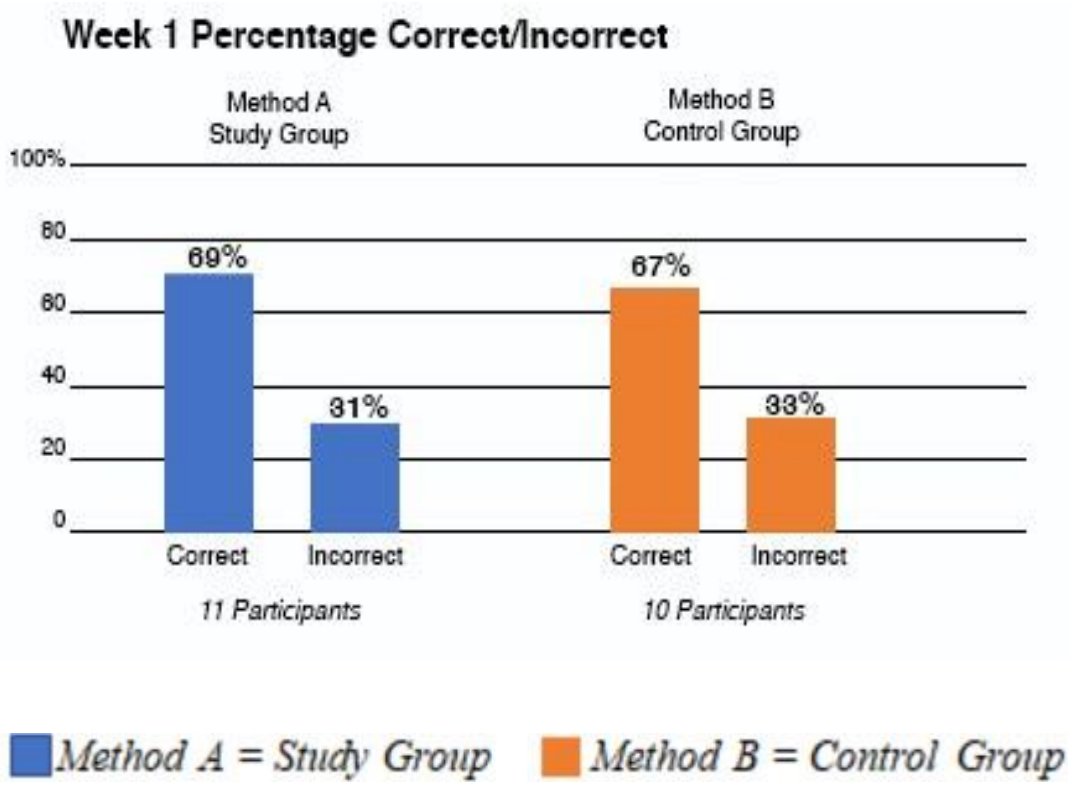


Table 10 Week 1 Percentage of Correctly Answered Questions by Method and Type

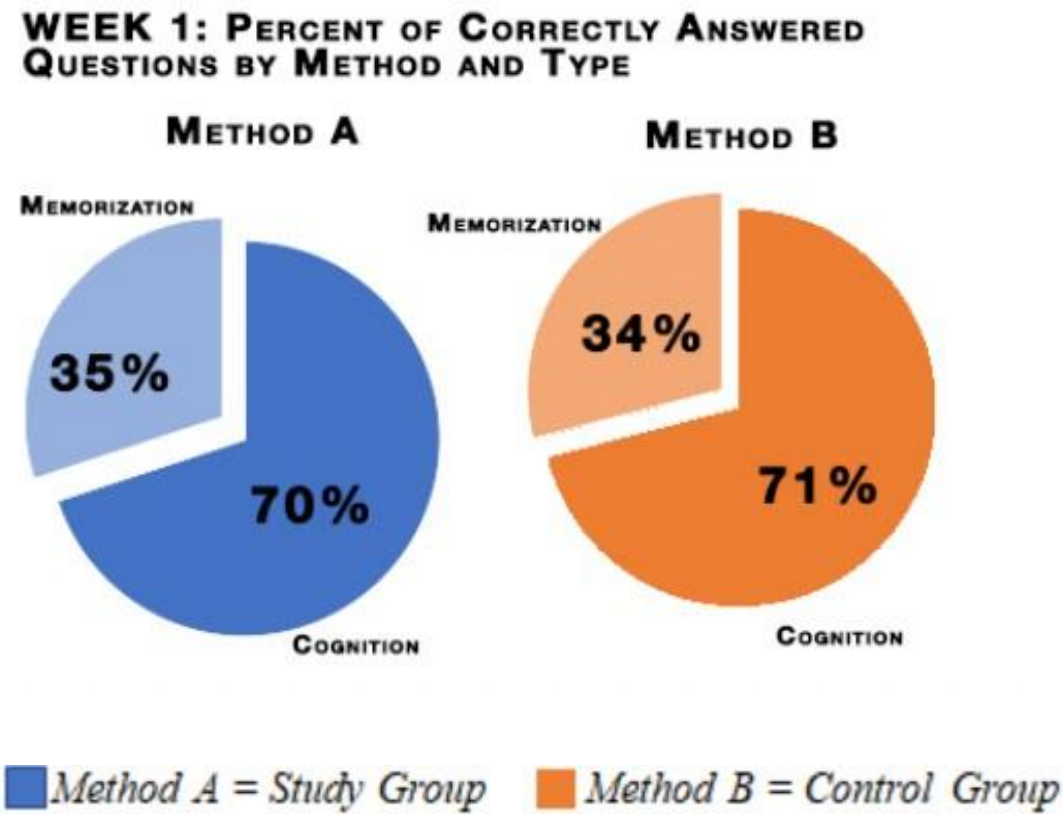
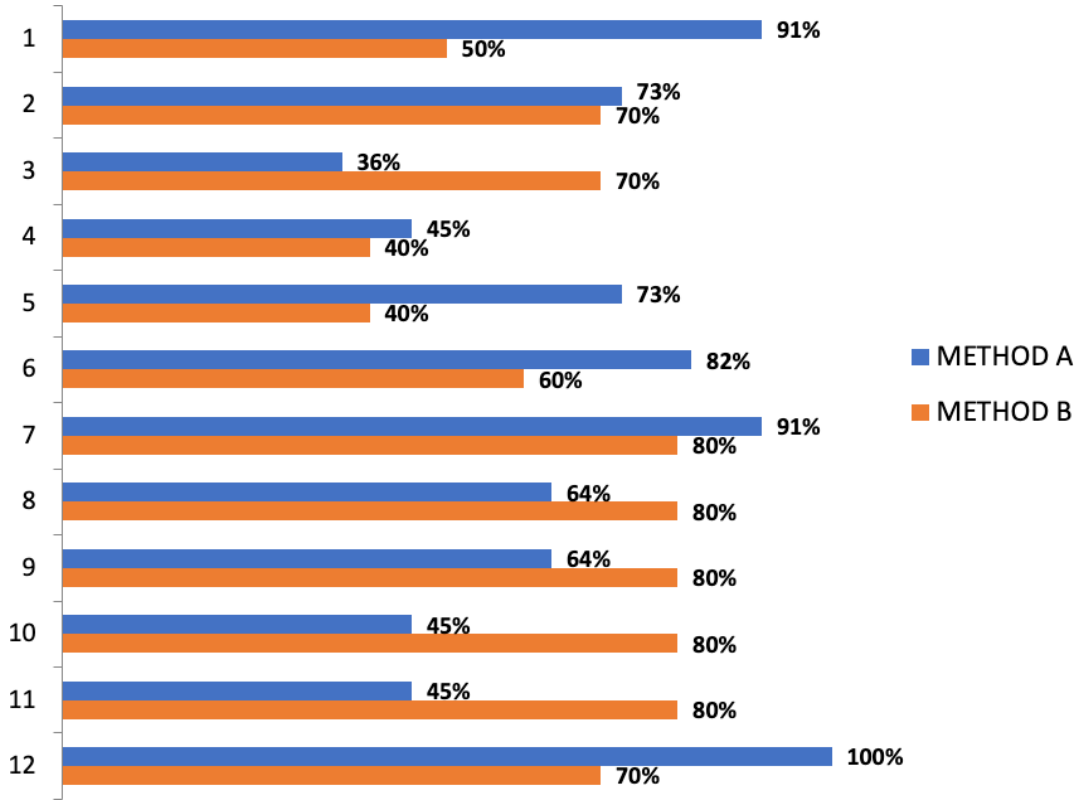


Table 11 Week 1 Comparison of Correct Answers by Question



Week 2 Results

Upon analysis of the Week 1 classroom session results, although the overall correct/in-correct data were identical within a reasonable percent of deviation, the data pertaining to specific types of questions (e.g., memorization vs. cognition) displays more deviation between the two methods of teaching. These deviations seem to be the result of delivery versus type of material. This observation is a result of comparing the type of process required to retain specific information with the type of delivery by which each bit of information was delivered. That is to say, the correct answers coming from Method A (the Study group) relate to the specific method of data dissemination used therein, as becomes obvious in the same in Method B (the Control

group). Where Method A included emotional triggers and varying emphasis to deliver specific data points, Method B employed vector portions of instruction to explain specific concepts. (Recorded video upon request.)

After 14 days, the participants were given a quiz consisting of 12 new questions directly taken from the common data provided in both classroom sessions. This two-week period reflects approximately twice the average time lapse between a lesson and the subsequent testing in the standard pedagogy paradigm today. Both groups, as measurable units, differed greatly. The Study group attained an overall correct percentage of 63% compared to the Control group's correct percentage of 37%. It has become obvious that the two different methods produce notably different results.

Table 12 Week 2 Study Group Results

STUDY GROUP INSTRUCTED BY WILLIAM CASTELLO

QUESTION	1	2	3	4	5	6	7	8	9	10	11	12
F67	D	C	B	B	B	A	A	*	B	B	C	B
M62	A	C	D	D	B	A	C	*	B	C	B	D
M24	A	C	B	D	B	C	C	*	C	B	A	A
F80	B	C	C	D	B	C	C	*	B	C	A	A
F59	A	C	B	D	B	A	A	*	C	C	D	A
F70	B	C	A	D	A	B	A	*	B	C	D	A
F62	A	C	D	D	B	D	C	*	B	C	A	A
F76	D	A	D	D	B	A	C	*	C	B	A	A
F71	A	C	A	D	B	A	C	*	C	B	D	A
F75	A	C	A	D	C	A	C	*	C	B	D	A
M18	A	C	B	D	B	A	C	*	C	B	D	A
CORRECT	8	10	2	10	9	7	8	*	5	5	2	9

Chart key: A = correct answer, A = incorrect answer
Participants are identified by gender (M/F) plus age
Type of question: Memorization Cognition
Question 8: * = correct answer
* = incorrect answer

Table 13 Week 2 Control Group Results

CONTROL GROUP INSTRUCTED BY CHRISTOPHER VOLK

QUESTIONS	1	2	3	4	5	6	7	8	9	10	11	12
F28	A	A	A	D	B	D	A	*	C	B	A	A
F56	A	C	B	C	C	C	C	*	B	C	A	A
M20	A	A	B	D	B	C	C	*	C	B	C	D
F19	B	A	A	D	C	C	A	*	B	C	B	A
F60	A	A	B	C	C	C	C	*	A	B	D	A
M72	B	A	B	D	A	A	C	*	C	B	C	A
M68	B	A	D	C	B	D	A	*	D	C	A	A
F65	B	A	C	A	C	C	C	*	C	C	A	A
M19	A	A	C	D	C	B	C	*	B	B	C	A
M62	A	D	B	D	D	A	C	*	C	B	B	B
CORRECT	6	1	3	6	3	2	7	*	3	4	4	8

Chart key: **A** = correct answer, A = incorrect answer
Participants are identified by gender (M/F) plus age
Type of question: Memorization Cognition
Question 8: * = correct answer
* = incorrect answer

The charted data analyzes the results as overall correct and incorrect answers (Table 14), the comparison of the efficacy of each method by specific question (Table 15), and the overall success and failure by specific question (Table 16).

Table 14 Week 2 Percentage Correct/Incorrect

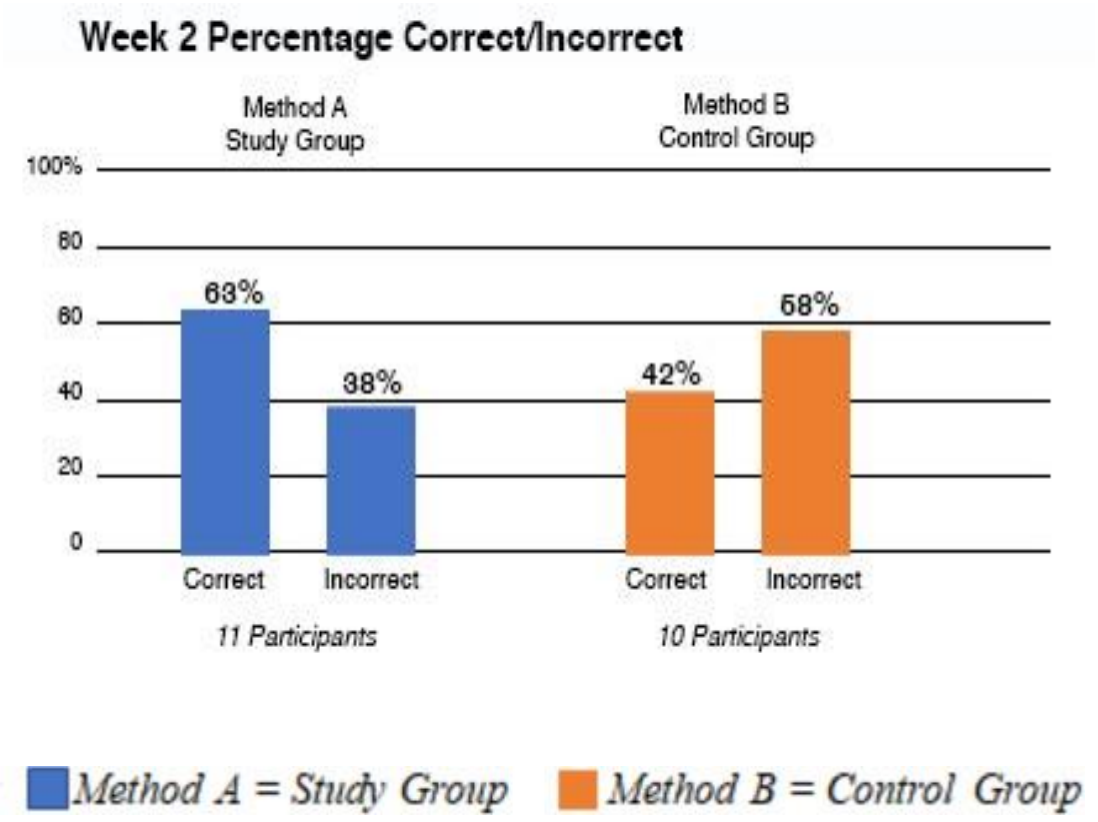


Table 15 Week 2 Percentage of Correctly Answered Questions by Method and Type

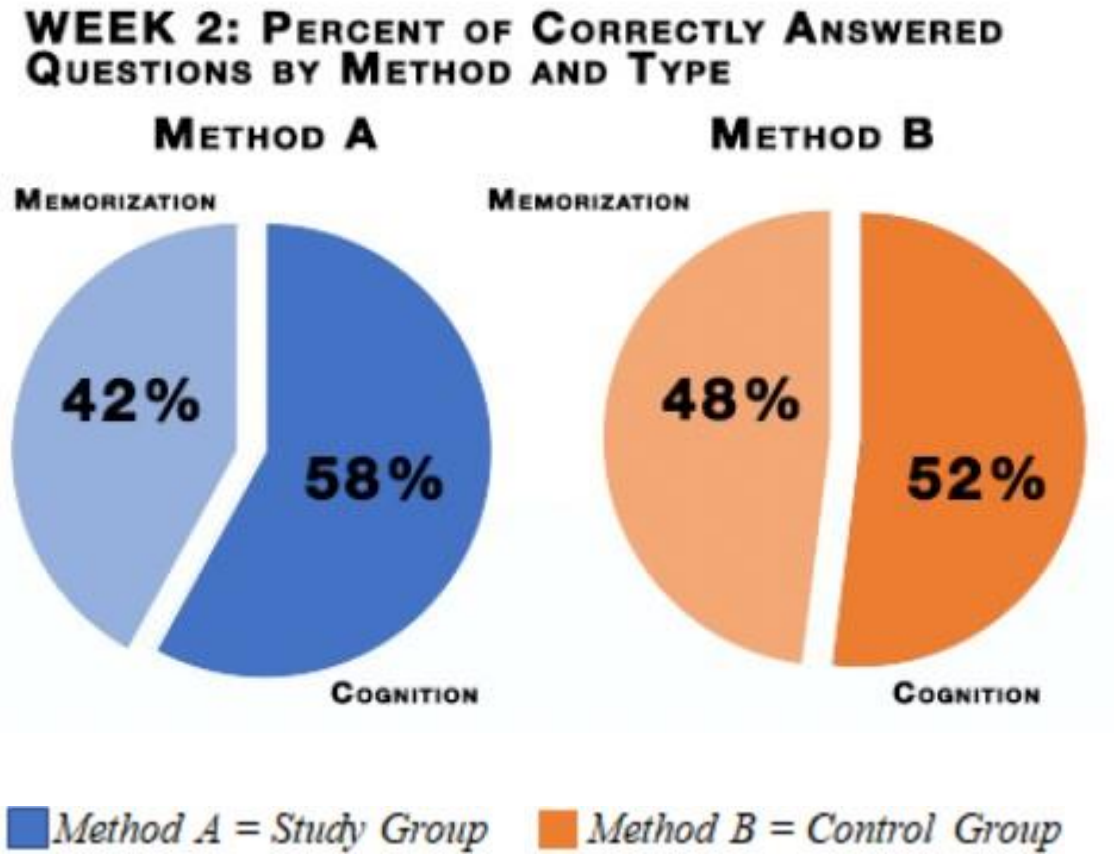


Table 16 Week 2 Comparison of Correct Answers by Question

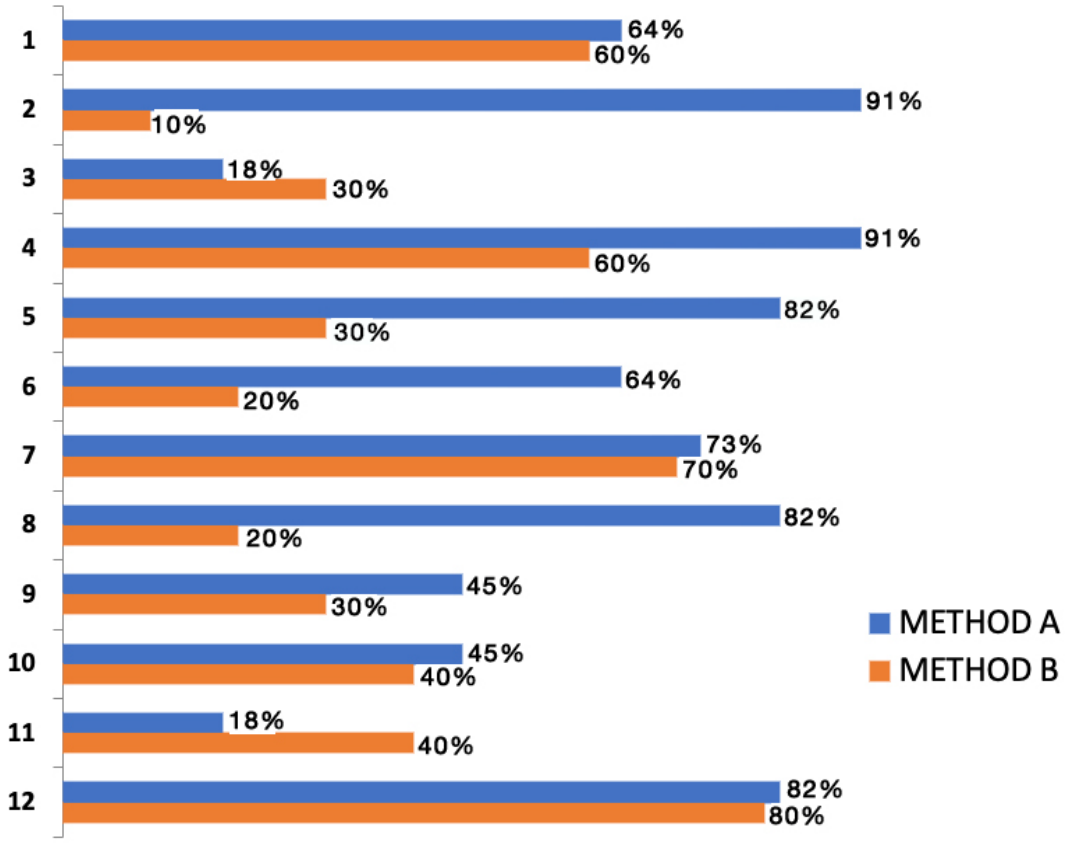
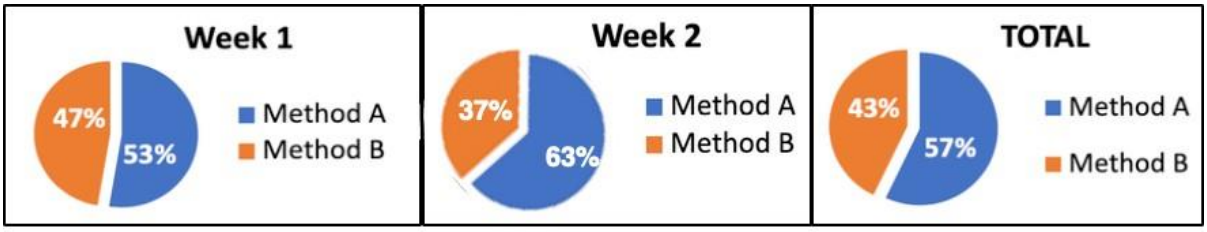


Table 17 Week 1 & 2 Comparison of Correct Answers by Method



Analysis of Results

The results of testing have been tabulated and analyzed. The primary results reflect the overall percentages of correctly answered questions in testing for Week 1 and Week 2. The results of testing one week after the sessions produced very similar percentage of retention. The Study group totaled 69% (68.8%) correct answers and 32% (32.2%) incorrect answers. The Control group totaled 67% (66.7%) correct answers and 33% (34.3%) incorrect answers.

The results for testing 2 weeks after the sessions produced different results. The Study group totaled 63% (62.8%) correct answers and 38% (37.2%) incorrect answers. The Control group totaled 42% (41.6%) correct answers and 58% (58.3%) incorrect answers.

Human-Centered Research Findings

As previously mentioned, the Study group was provided the information using Method A, a construct of the research in this thesis. The construct formed into a method employing the following strategies:

- The establishment of a congenial relationship between instructor and participants
- Stressing the importance and value of the information to each recipient, prior to the distribution of information, to establish an active learning paradigm of System 2 thinking (as described in *Thinking Fast and Slow* by Daniel Kahneman)
- The utilization of a storyteller persona rather than that of an instructor, to more efficiently engage the participants in the material
- Chunking the materials into smaller, consistent, and easily understood segments, delivered in brief session and then reiterated, discussed, and clarified
- Including specific emotional triggers with each point of essential data to effect an empathetic and often sympathetic reaction, which in turn triggers memorization.

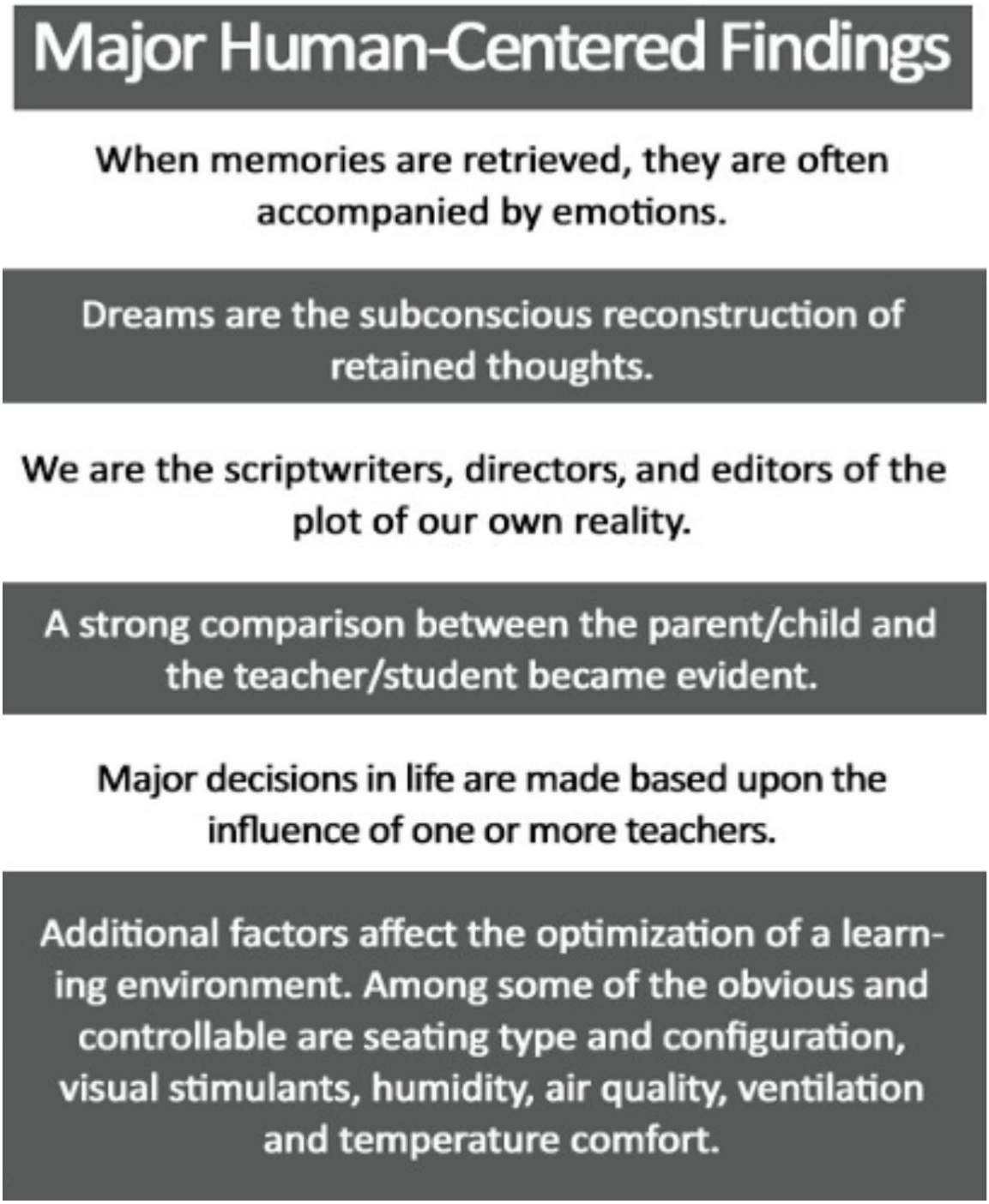
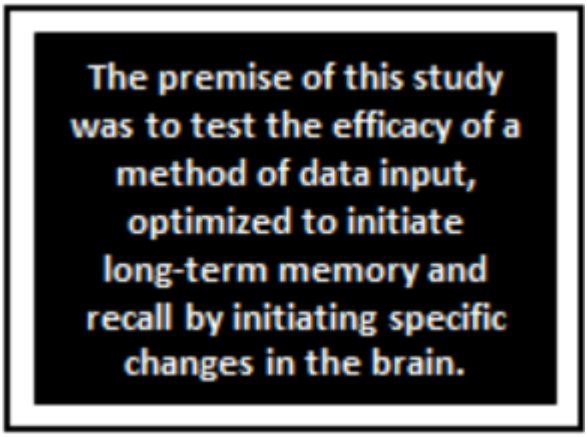


Figure 46 Major Human-Centered Findings of this Study

Premise of Study

The premise of this study was to test the efficacy of a method of data input, optimized to initiate long-term memory and recall by initiating specific changes in the brain. The changes refer to gaining better control of and strengthening the mental processes responsible for accepting, processing, storing, and recalling data. The overall goal of the study was to design a method of imparting data, based upon neuroscience, psychology, pedagogy, and human-centered research, to optimize the aforementioned mental processes.

The mind is known to respond to specific prompts and conditions that promote the biological processing of information toward the end of long-term storage and the ability to be recalled. This process results in small, potentially permanent changes in the brain. These changes are known as potentiation.

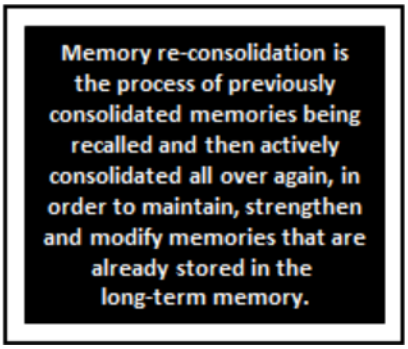


Potentiation is described as the process in which synchronous firing of neurons makes those neurons more inclined to fire together in the future. Long-term potentiation occurs when the same group of neurons fire together so often that they become permanently sensitized to each other. As new experiences accumulate, the brain creates more and more connections and

pathways, and may “re-wire” itself by re-routing connections and re-arranging its organization (The Human Memory, 2019).

If these changes become permanent, they constitute long-term memory. Long-term memory allows for storage of information over an extended period of time. Long-term memory decays very little over time and can store virtually unlimited amounts of information. Through the process known as consolidation, the mind rehearses and, associates information for storage semantically (that is, based on meaning and association) (Lumen Learning, 2020).

Memory re-consolidation is the process of previously consolidated memories being re-called and then actively consolidated all over again, in order to maintain, strengthen, and modify memories already stored in long-term memory. Several retrievals of memory (naturally through reflection or through deliberate recall) may be needed for long-term memories to last for many years, depending on the depth of the initial processing.



This study tested the efficacy of a specifically designed method of information delivery based upon aspects of neuroscience, psychology, and pedagogy conducive to optimizing the process of long-term potentiation. The method incorporates the knowledge of the neurobiological changes that occur in the human brain when forming lasting thoughts, the use of information delivery methods based upon an understanding of psychological prompts, the creation of an atmosphere conducive to optimal information acceptance, and an interactive teaching dialogue

delivered using a timed, chunking method found greatly effective as an educational paradigm.

Importance of Study Reexamined

The purpose of this study was to examine the processes most conducive to producing strong and lasting units of data in the human mind, prompting the mind's mechanisms of storage and recall of the data and improving the ability to compound and use this knowledge and increase overall intelligence. This study was also intended to provide comparable data that when analyzed should reveal the amount and quality of information retained by its participants and the relative efficacy of both methods employed.

The study also collected and applied data collected through an experimental process with the purpose of creating a new, unique approach to information distribution and to utilize the new and unique approach to facilitate a greater efficacy of general learning.

The overall purpose of this thesis is to find the best paths toward improving the mind's ability to accept, understand, retain, recall, and use information, to develop valuable and useable knowledge and, ultimately, to change the quality of intelligence and future of mankind for the better.

Limitations

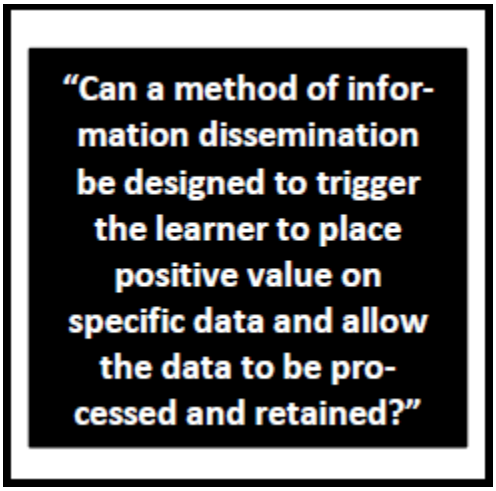
Certain limitations were encountered in the process of compiling this thesis. The COVID-19 pandemic necessitated a major change in the design of the human-centered research. The original plan was to conduct a workshop and two independent classroom sessions in classrooms at St. John's University that were approved for use through a complex IRB process involving both Radford University and St. John's. These classrooms were to be arranged according to research into the effects of environmental design upon learners, meant to be a section of this thesis.

Due to quarantine rules imposed nationwide, the sessions were redesigned using an online (Zoom) format. This change in format negated the relativity of environmental factors and subsequently the chapter dedicated to environmental design, since it could not be tested.

Another limitation arose in the inclusion of myself as the instructor of the Study group classroom session that employed the experimental method, which may have suggested a bias toward the success of said method. I wish to assure all that my role was carefully arranged and conducted in a manner designed to eliminate any unethical or bias that may have threatened the results. Recordings of all online sessions are available upon request.

Chapter 5 Conclusions

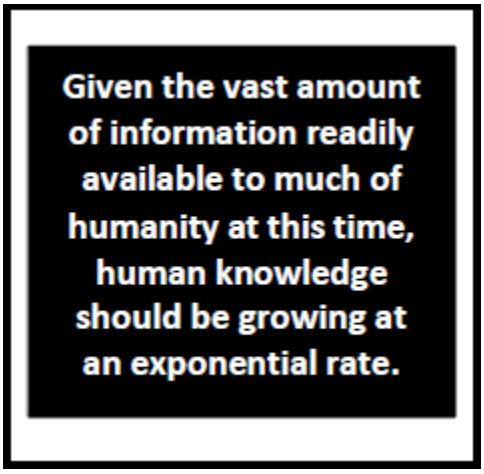
The central question to this thesis is, “Can a method of information dissemination be designed to trigger the learner to place positive value on specific data and allow the data to be processed and retained?”



In search of the answer, the areas of neurobiology, psychology, pedagogy, and human-centered research were researched and pertinent findings from each field are assembled here. Each area contains a unique perspective into the most complex single unit of humanity and the human mind. The material has been specifically chosen to create a simplified map of the unique function of creating knowledge.

Knowledge is the collection, retention, compilation, and usage of data increased over a human’s lifetime. Knowledge depends upon the viability, clarity, and retrieval of massive data. Knowledge is necessary to create understanding, empathy, innovation, creativity, and faith.

Given the vast amount of information readily available to much of humanity at this time, human knowledge should be growing at an exponential rate. Because of the complexity of the mind’s process of accepting and retaining data, and the existing paradigms of cognition and pedagogy and habitual human behaviors, the majority of humanity cannot profit from the immense tide of information. This thesis proposes methods to reveal the habitual problems of the typical teaching and learning paradigms and suggests new combinations of triggers, environments, relationships, and approaches to deal with those impediments.



Research involving human participants caused many of the revelations of the first four areas of research to attain practical meaning and clarity. A workshop employed human-centered design methods to observe and attain understanding of how a diverse demo- graphic of participants, sharing the common experience of 12 years of formal education, viewed the learning process. Their revelations were enlightening and directed the design of a method created to com- pare this with the standard method of instruction widely employed in both public and private schools throughout the United States. The comparison took place during the classroom sessions as described previously. The findings of those experiments gave shape and description to all of the research preceding them in this thesis.

The findings are as follows:

- The acceptance of information requires the expenditure of energy by the individual, described by Daniel Kahneman in *Thinking Fast and Slow* as System 2 thinking.
- The expenditure of energy must be consciously or subconsciously voluntary on behalf of the individual.
- Only data that has been assigned value triggers the voluntary expenditure of energy to begin the mind’s task of processing.
- Once the retention process begins, it requires additional expenditure of energy to create a repetition process within the brain. If this process is not engaged, the data
- can only be held for a short period of time and is eventually lost.

- Once the data has been repeated, it is stored in long-term memory areas of the brain along with related information that may be triggered by a variety of stimuli, allowing it to be recalled upon demand.
- Once information is recalled, it goes through another process of repetition to either strengthen, edit, or distort the data before it returns to a stored state.
- When bits of data are combined with others, they form complex thoughts and concepts. The combination, affirmation, perfection, and retention of more complex thoughts and concepts becomes the foundation of knowledge.

We learn because we want to learn. We resist learning because something repelled us from learning. Information must have some value to the individual before that individual will engage the necessary effort to accept and process that information. Value is assigned when information in some way stimulates the learner. Due to the rapid flow of information, these evaluations are made almost instantaneously. Psychological triggers guide the evaluations. These triggers can include curiosity, the perception of benefit, arousal, and emotional response.

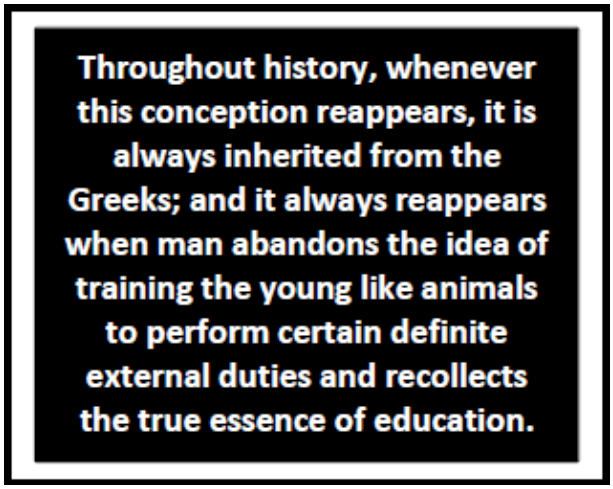
The current paradigm of teaching is based upon lecturing, reading, and providing data based upon frequent testing. It is imperfect because it is based upon the rote memorization required to optimize test scores and lacks the interpersonal aspects needed to create psychological triggers. This is not to say that new methods of instruction designed for greater interaction and emphasis upon defining terms and concepts are beginning to be implemented in public and private institutions. While there is a cognizance of the value of these innovations, the existing paradigm is based upon an instructor providing data for a group of learners and this system is designed to store data for the short-term purposes of testing.

In his famous book *Paideia*, Werner Jaeger stated that the Greeks thought the main

purpose of education was the creation of man:

> They were the first to recognize that education means deliberately molding human character in accordance with an ideal…Throughout history, whenever this conception reappears, it is always inherited from the Greeks; and it always reappears when man abandons the idea of training the young like animals to perform certain definite external duties and recollects the true essence of education. (1946, pp. 22-23)

The major finding in this thesis is that the manner in which information is disseminated in this era of humanity has become institutionalized, standardized, and modified to the point of near inefficacy. Education has strayed too far from the shaping of an individual. It has become a mass-produced staple meted out in equal portions, regulated and codified for the masses.



Oleg Donskikh posits that the current state of education is woefully inefficient when compared to the methods used by Aristotle:

> This is, firstly, the victory of the pedagogical concept, which places the interests of the individual above the interests of society and, accordingly, approves the need to choose individual trajectories of education. Yet, the person has to become a member of society and, therefore, to be an obedient taxpayer sharing norms and persuasions of a particular

social milieu. These two goals of education are not easily compatible; moreover, they are quite contradictory. This contradiction can be found in the saying by Alain Touraine, taken as the epigraph for the book: 'Democracy serves neither society nor individuals.

Democracy serves human beings insofar as they are subjects, or in other words, their own creators and the creators of their individual and collective lives.' The problem here is that collective life is guaranteed by the state, and only law (also executed by the state) guarantees the possibility of individual life. At the same time, the law is implemented by the power of the state. This means that the state has to shape future citizens to be obedient, passive, and dependent. It is exactly what Chomsky says in his interview: "If kids are studying for a test, they're not going to learn anything. We all know that from our own experience. You study for a test and pass it and you forget what the topic was, you know. And I presume that this is all pretty conscious. How conscious are they? I don't know, but they're reflections of the attitude that you have to have discipline, passivity, obedience, the kind of independence and creativity that we were shown in the '60s and since then – it's just dangerous. (2018, pp. 1-2).

Secondly, teaching now occurs in conditions where information is always fully available. This means that information does not become real knowledge. It seems that bits of information appear out of nowhere. Accordingly, the very value of knowledge is undermined, because it appears to be so easily gained. This forms a second contradiction: we are living in an informational society, but information is losing its value…teaching now occurs in conditions where information is always fully available. This means that information does not become real knowledge. It seems that bits of information appear out of nowhere. Accordingly, the very value of knowledge is undermined, because it appears

to be so easily gained. This forms a second contradiction: we are living in an informational society, but information is losing its value. (2018, pp. 1-3)

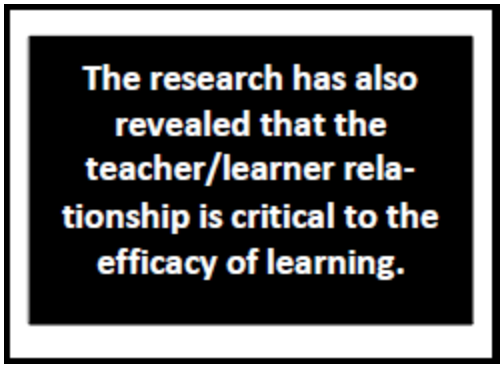
Effective delivery of information intended to optimize retention and utilization needs to be modeled more closely to the Socratic approach. The starting point of the approach to education espoused by Socrates and Aristotle was the civilization of the individual in order to make him a socially valuable person. Education is a necessity that must be afforded to each individual and not as a mass-produced staple.

The method proposed in this thesis is to provide instruction utilizing the more engaging roles of storyteller and audience. This process reflects the values and beliefs of the great civilizations of the ancient world.

The method proposed in this thesis is to provide instruction utilizing the more engaging roles of storyteller and audience. This process reflects the values and beliefs of the great civilizations of the ancient world. Education is dialogue where the learner is active in the process. The research informs this theory that dialogue is filled with psychological triggers, emotional prompts, empathy, interaction, and a close relationship between teacher and learner. All of these factors lead to a value system whereby the individual assigns the necessary value to data necessary to begin the willful exercise of thought processing and retention.

The research also reveals that the teacher/learner relationship is critical to the efficacy of learning. This relationship is compared earlier in this paper to the parent/child relationship and its effect upon the trajectory of an individual's life. The teacher/learner relationship became central to the findings in the human-centered workshop and through many anecdotal observations that followed. The learner is either encouraged or discouraged to learn a specific topic based upon their relationship with his or her teacher. If it was a fearful, apprehensive, or

disconnected relationship, the learners expressed little or no retention of the subject. The obverse was also ex- pressed. “Great teachers” were distinctly remembered along with the subject matter of their instruction. “Great teachers” were overwhelmingly described as those who exhibited care for the learner’s success, who engaged each student, who maintained a positive relationship with their students and conducted learning as a dialogue, in which students asked questions and were encouraged to express their views and understanding. These teachers were described as “the reason I have loved history all of my life” or “the reason I went into the arts.” These instructors went beyond the role of data providers and reached the level of storyteller/mentor. This is the effective role model for the method described in this thesis.



Education is an exchange either accepted or rejected by each individual. Learning is a voluntary process requiring the assignment of value to each bit of data. Willingness is required for success. Inclusion, participation, and confidence in the process produce willingness and therefore are necessary elements.

Memory is the retention of data and the triggers needed to recall and utilize that data. The term “voluntary” in this case means the instantaneous decision made by the human mind to process and retain data. “Voluntary” is not solely associated with calm engagement but with the imprinted neurobiological triggers present in our genetic code. For example, a negative piece of data, such as the danger posed by lightning or identification of a noxious odor, are usually perceived to have value through negative stimulus. These triggers are hard-wired in the human mind for the purpose of survival.

In conclusion, data assigned value is voluntarily and energetically processed by the hu-

man mind. Value is assigned to data through emotional triggers and voluntary acceptance, which also prompt the retention of data. The greater the value assigned, the longer and more clearly the data will be retained. Some of this stored memory becomes virtually indelible, never fading from memory, never beyond recall. The value assigned to data is proportionate to the human mind's ability to retain it. Data must be delivered based upon the awareness of how and why it will be accepted.

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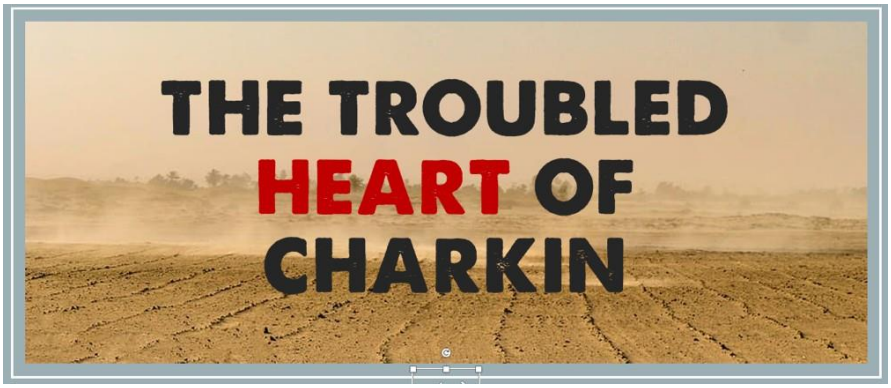
Appendix A: Study Group Classroom Presentation

This presentation given by William Castello was designed to impart the narrative utilizing elements of neurological, psychological, and pedagogical methods discovered in research. These elements have been found to optimize the learning experience. They include chunking of information, the inclusion of images, sound and music that multiply the sensory input when ac- companying information, and the inclusion of verbal triggers in the narrative known to produce emotional responses which have been found to improve memorization. The following presentation was in a PowerPoint format and also contained sound effects and background music which are not included herein.

Slide 1



INTRODUCTION

Welcome and thank you for joining me.

Your participation in this exercise is of tremendous value, not just to me but to the future of learning. You will be given a lesson about a place, a time and a people that do not really exist. I had to use these fictional circumstances to insure that not one of you could have any more

knowledge about the material than anyone else. It may sound familiar. The names of places and people have roots in several languages spoken today.

You will see a presentation and hear the story narrated by me. If you wish, you may take notes. Just know that in one week and in two weeks you will receive two short quizzes based upon this material. It is imperative that you fill out and return these quizzes because your answers will provide me with the essential data that I require to complete my thesis.

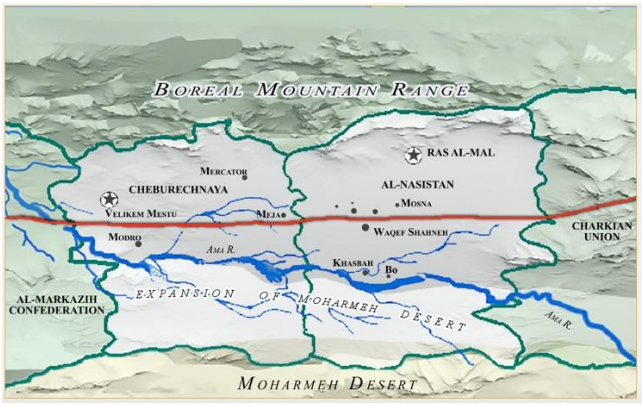
There is no marking system. No one will know how they did. You should only identify yourself by gender and age. For example, if you are a 40-year-old female, identify yourself as “F40”. If you are a 63-year-old male, identify yourself as “M63”.
Now sit back, relax, pay close attention and we will proceed to the lesson.

The events that you will learn about are pure fiction. The following is a story of simple people whose lives were changed by politics, money and nature. It is the story of ancient cultures that who’s customs remained constant until the modern world intruded into their traditional world. throughout this story try to put yourselves in their position. What if your way of life was disrupted? What if your freedoms, customs and certainty of survival were challenged? What if your survival depended on a foreign power? What if your future became uncertain?

So, sit back, listen and consider this story of unexpected, uncontrollable change. Put yourselves into the narrative. Put yourself in their shoes. The names may seem strange, the politics may be confusing but remember, this is a story of human beings and how circumstances can change everything.

Slide 2

Slide 3



CHUNK 1

This is the story of a land far from our own. A story of two small young countries and a highway through them that link two great world powers. A land of basic people leading simple lives. ***People now in imminent threat of starvation and losing their sovereignty.***

A people who may lose their very identity. .....In central Charkia, two of the world's newest

nations, Cheburechnaya and Al-Nasistan, face growing tensions created by an extreme change in climate and two ambitious and powerful neighbors.

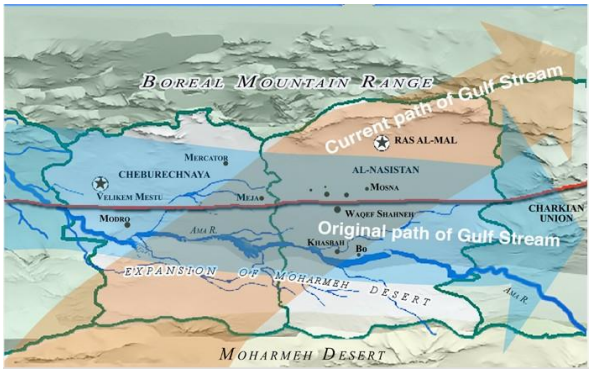
Both nations, former regions of the now-collapsed Unified Communist Republic, claimed their sovereignty, in 2120, when the UCR's economy failed. The UCR had absorbed the vast regions of northwestern Charkia at its formation. The twenty-six formerly occupied regions became free to claim their own sovereignty. Following the collapse of the UCR, Cheburechnaya and Al-Nasistan enjoyed a peaceful and advanced lifestyle.

That all changed in the spring of 2123. The jet-stream that pumped moist, warm air into the fertile fields between the Boreal Mountains and the Moharmeh Desert, altered course. Weather and wind patterns were pushed to the north of the mountain range by the frequent high-pressure patterns triggered by the growing heat from the desert to the south.

The once thriving agricultural southern regions of both new nations are now threatened by rising temperatures, sandstorms and encroaching desert sands. The once mighty Ama River and its hundreds of tributaries withered to one quarter of its original flow. Many of the tributaries have dried to dusty ravines and path A critical trade route, the mighty A01 Superhighway, running east and west through the center of both nations, was built by the powerful Unified Communist Republic at the height of its power. It is the only overland route connecting the Union of Free States in the East, to the oil rich Al-Markazih. Confederation, 780 miles to the west.

Slide 4

Slide 5



CHUNK 2

The roadway carries tanker trucks full of oil from the Al-Markazih Confederation to fuel the vehicles and factories, farms and homes of the central Charkian nations to the east. Huge freight liners from the multitude of factories in the Charkian Union have poured manufactured goods to the hungry consumers of the wealthy Al-Markazih Confederation to the west. For the last two centuries it brought prosperity to the primarily agrarian populations of both Cheburechnaya and Al-Nasistan. When both regions became independent nations, they enjoyed many years of trade and growing prosperity. Their farms grew prosperous and bountiful. Urban areas sprung up along the edges of the road where all manner of industry and hospitality businesses blossomed while supporting the needs of the thousands of transport truckers.

Maintenance and protection of the 485-mile-long trade route, once provided by the UCR military, passed into the hands of the two new nations with its fall. Neither Cheburechnaya nor Al-Nasistan have the assets or expertise to assume the tasks.

Encroaching desert sand now spreads northward daily. The fertile farmlands south of Route A01 are shrinking as the continuous migration of sand turns black, fertile soil to clay. The desertification of their southern provinces threatens not only to ***starve the populations*** but deny intercontinental overland trade. The road is now subject to blinding sandstorms, rising temperatures and a declining roadbed.

Their powerful neighbors, the Al-Markazih Confederation and the Charkian Union are currently assisting the nations that physically divide them.

Cherburechnaya receives aid from the wealthy members of the Al-Markazih Confederation with whom they ***share heritage*** and several ethic/tribal groups. The aid consists primarily of fresh-water shipments, financial aid and now, amidst growing tensions, military assistance.

Slide 6

Slide 7

Slide 8

Slide 9

CHUNK 3

The local economy of both nations is primarily based upon their once abundant wheat and cotton crops and a growing cattle industry which began with the gift of tens-of-thousands head of cattle provided by Naland as a tangible form of financial aid and to generate good-will and trade with the nations of the wealthy western hemisphere. This act opened diplomatic relations with the west in a region previously isolated within the Unified Communist Republic.

These regions have been home to members of two predominant ethic groups. The people know as the Matjoulon are known for their vast herds of sheep and goat and the highly prized breed of horse called Sarie, that they developed for speed and endurance in their traditional arid lands. This race of equestrian herders is renowned for their swift, compact mounts and their prowess as the greatest horsemen in history. The Matjoulon people are descendants of the migratory tribes of the Morhameh desert whose darker complexion and compact frames are genetic adaptations that allowed them to prosper in the savanna’s and grasslands surrounding the vast desert.

The other predominant ethic group are the Drugoy, farmers who perennially sought and

developed the fertile fields of the southern regions of the Charkia continent. Their origins are lost in history, but it is believed that they grew grain crops throughout the isolated Charkian plains. They are a tall, fair race of people credited with the development of agricultural methods that have been successfully adopted throughout the world. Their culture is generally peaceful and homogenous. Their genetic trace has been identified in a great many subgroups throughout Charkia.

Slide 10

Slide 11

Slide 12

CHUNK 4

For many years UCR troops were posted throughout the region to enforce strict laws of cooperation imposed by the central government. These laws were meant to keep internal peace and maximize productivity.

To the east, Al-Nasistan depends upon shipments of food provided by the Charkian Union. Al-Nasistan accepted an offer by the Charkian Union to deploy Charkian troops to defend its sovereignty.

Currently, AMC military personal and convoys carry fresh water and food to towns and cities throughout Cherburechnaya, setting up distribution centers manned by their troops. The Charkin Union is establishing Civil relief stations throughout Al-Nasistan, supplying fresh water, food, electric generators and fuel. In addition, a quasi-military force has been deployed to protect the A01 and the Ama River and observe and consult upon the northward spread of the desert sands. They have deployed civil engineers to build barriers and a system of water cisterns to re-

tard the desertification and redirect water resources.

The water and food stocks of the rural provinces of Cherburechnaya are so depleted that the population is threatened by starvation. Children are the most vulnerable. The able-bodied men and women are openly recruited as volunteers with the AMC Missionary Forces. For their work, they receive all the benefits and services afforded AMC military personal. Many families have packed their possessions and traveled north to find work and a new life in the cities and towns to the north or in the AMC, abandoning their beleaguered farms and communities. Many of the southern regions are dotted with ghost towns, totally abandoned in a sea of the desert sands.

Slide 13

Slide 14

Slide 15

Slide 16

CHUNK 5

The global monitoring group, World Without Boarders (WWB) has expressed its concerns They fear that the financial and strategic interests of Al-Markazih and CU may increase tensions between of Cheburechnaya and Al-Nasistan. The friendly neighbors both face a period of crisis from within and political problems in the region. Currently all parties strive to feed and protect the populations, to keep the A01 open and oil, produce and manufactured goods flowing.

Slide 17

Slide 18

Slide 19

Appendix B: Control Group Classroom Presentation

By Christopher Volk

Christopher Volk (NJDOE Certified Teacher of Social Studies-Secondary)

Lesson: "Growing Desert Threatens New Nations: Desertification and the Charkian Conflict"

Time: 90 minutes
April 18, 2020

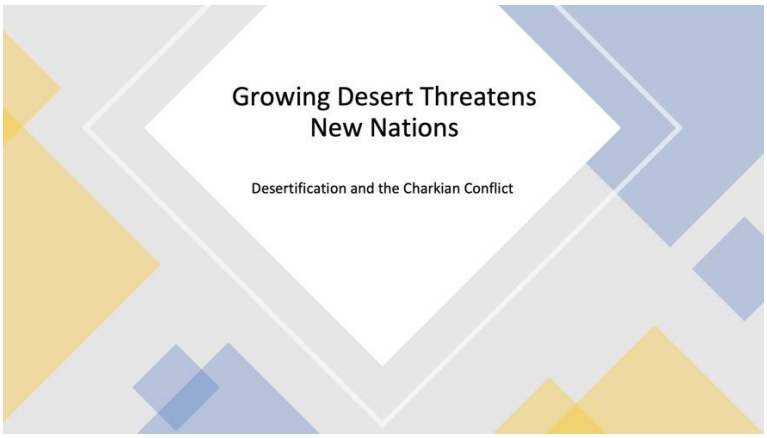
Lesson Plan

Learning goal: By reviewing the causes and effects of desertification, students will apply established knowledge of ancient civilizations to generate an understanding of the conflict arising on the continent of Charkia.

1. (Anticipatory Set) Do Now: List at least 5 entities (ranging between geography, resources, economics, politics) that are essential for the survival, stability, and success of a civilization.
    a. Students will share their lists with the class. Students will put a plus sign next to items that are similar to others student's lists.
2. Ancient and Classical Civilizations
    a. Teacher will name 6 commonly known civilizations from history: Mesopotamia, Egypt, China, Indus Valley (Harappa), Ancient Greece, Ancient Rome
    b. When naming each civilization, the teacher will display a map of each region, and students - using prior knowledge and the displayed map - will mark the first letter of each civilization's name on their "Do Now" lists next to each entity where the named civilization has benefited.
    c. Teacher will ask the class about their observations and conclusions from the list.
3. Introduce "Desertification"
    a. Ask students if they are familiar with the term and to provide a working understanding for the class.
    b. Show nature video about Namibia's deserts: https://www.nationalgeographic.org/me- dia/desert-created-water/
    c. Ask class what key ideas were targeted in the video
    d. Class discussion about which entities on their "Do Now" lists would be affected by desertification
4. Desertification: Human Impact
    a. Show video about effects of desertification on a civilization: https://www.internetge-ography.net/topics/what-is-the-impact-of-humans-on-desert/

   b. Students will point out key concepts presented by the video: Climate Change, Removal of trees for fuel, Overgrazing, Over-cultivation, Population Growth
5. Lesson Focus: After reviewing key concepts and terminology, students will now be introduced to the situation on the Charkia continent.
   a. Provide glossary to students
   b. Distribute PDF reading
   c. Teacher will read aloud the text, as students follow along and take notes. Teacher will instruct students to look for these key categories: Cause and Effect, Reliance on Resources, Economics, Militarization, Global Response, Culture
6. Class discussion: teacher will ask several questions to the class
   a. What conclusions could you make about the situation?
   b. How has desertification impacted the geographical, economic, political, cultural relations of the two nations?
7. Open forum if necessary.
8. (Closing) Kahoot game
   a. Students will be asked to join a Kahoot review game, hosted by the teacher.

GROWING DESERT THREATENS NEW NATIONS



Narrative of lesson as delivered:

An extreme change in climate and the ambitions of two powerful neighbors, have sparked tensions between the young nations of Cheburechnaya and Al-Nasistan, both formerly regions of the collapsed Unified Communist Republic.

When the economy of the vast Unified Communist Republic failed in 2119, it could no longer control the vast regions of northwestern Charkia. The twenty-six unique regions that were

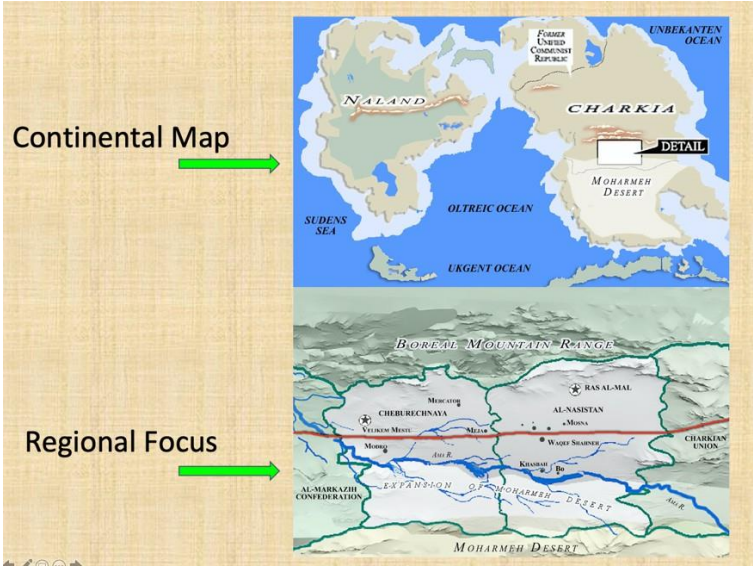
absorbed at its formation, became free to claim their own sovereignty in 2120, after its collapse. As a result, Cheburechnaya and Al-Nasistan have enjoyed a peaceful and advanced lifestyle since claiming sovereignty.

The marked climate change of the spring of 2123 caused the jet-stream that pumped moist, warm air into the region between the Boreal Mountains and the Moharmeh Desert to alter course. Existing patterns of weather and wind shifted to the north of the mountain range.

Rising temperatures, sandstorms and an expanding desert are drastically altering the climate in the agricultural regions in the south of both young countries. The Ama River and its hundreds of tributaries which brought natural irrigation to the farmlands have withered to one quarter of their original flow.

A superhighway (the A01) built by the Unified Communist Republic at the height of its power, running east and west through the center of both nations, remains the only overland route connecting the Union of Free States in the East, to the oil rich Al-Markazih Confederation, 780 miles to the west.

The vast oil reserves of the member states of Al-Markazih Confederation have fueled the vehicles and factories, farms and homes of the central region currently occupied by these new Charkian nations for the last two centuries. This region enjoyed many years of the trade and development this trade route brought to them under the protection and wealth of the UCR, until its fall and dissolution.



When the region became two independent nations, they enjoyed 3 years of trade and growing prosperity. The maintenance, security and access to this overland link between east and west remains critical to the economies of all the Charkian nations. The placement of the A01, resulted in the modernization, urbanization, and wealth of the former UCR regions.

The 485-mile-long roadway, once maintained and secured by the Unified Communist Republic military, came under the control of the two fledgling nations in 2120 after the UCR's dissolution.

The desertification of their southern provinces threatens not only to starve the populations but deny intercontinental overland trade. The road is now subject to blinding sandstorms, rising temperatures and a declining roadbed.

The once arable lands, south of the roadway, now produce a fraction of their once abundant crops. Sand now infiltrates the once black and fertile soil. Acreage, once producing bountiful produce for the regional populations, and great surpluses for profitable export now yield the bare minimum necessary to sustain the local farmers.

Their powerful neighbors, the Al-Markazih Confederation and the Charkian Union are currently assisting the nations that physically divide them.

Cherburechnaya receives aid from the wealthy members of the Al-Markazih Confederation with whom they share heritage and several ethic/tribal groups. The aid arrives in the form of fresh-water shipments, financial aid and now, amidst growing tensions, military assistance.

The economy of both new nations is primarily based upon their once abundant wheat and cotton crops and a growing cattle industry. Naland provided tens-of-thousands head of cattle as financial aid, intended to generate trade and to establish good- will. This represented an attempt to establish a foothold for nations of the wealthy western hemisphere in a region formerly part of the Unified Communist Republic and off limits to western diplomacy. The inhabitants of these regions have occupied this isolated part of the world for hundreds of generations. They are representative of a combination of ethnic groups that are either native to this land or migrated there in search of fertile lands to farm. Both groups remain some- what segregated along ethnic lines yet, over the centuries, there has been a degree of intermarriage and inclusion.

The two dominant groups are the Matjoulon, a formerly nomadic people who raised sheep, goats and horses in the savannahs along the edges of the Morhameh desert, and the Drugoy, an agrarian people whose origins are lost in history but who have settled in many of the fertile regions throughout southeastern Charkia.

The UCR imposed strict laws of enforced cooperation within the region.

Government troops were posted throughout the region to quell any ethnic tensions that might arise. It was the intention of the central government to assure ethnic peace and optimize the out- put of crops and cattle from this agricultural region.

Al-Nasistan has become dependent upon the foodstuffs from the Charkian Union. A diplomatic agreement was forged assuring Al-Nasistan can depend upon the combined forces of the Charkian Union to defend its sovereignty.

Currently, AMC military personnel and convoys carry fresh water and food to towns and cities throughout Cherburechnaya, setting up distribution centers manned by their troops. The Charkin Union is establishing Civil relief stations throughout Al-Nasistan, supplying fresh water, food, electric generators and fuel. In addition, a quasi-military force has been deployed to protect the A01 and the Ama River and observe and consult upon the northward spread of the

desert sands. They have deployed civil engineers to build barriers and a system of water cisterns to retard the desertification and redirect water resources.

Although ‘conscription’ has not become an official practice of the AMC military, all able-bodied men and women of Cherburechnaya are being encouraged to voluntarily work with the AMC personnel. Those that comply are issued military clothing, training and rations. They are provided access to temporary medical facilities constructed by the AMC military. They are considered adjunct personal assisting the AMC Missionary Forces, made up solely of the military forces of the Al-Markazih Confederation.

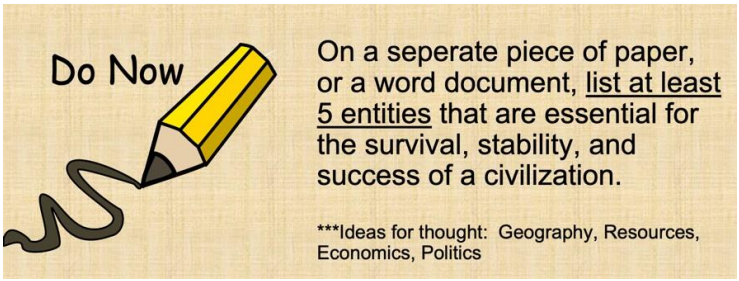
The global monitoring group, World Without Borders (WWB) has expressed its concerns They fear that the financial and strategic interests of Al-Markazih and CU may increase tensions between Cheburechnaya and Al-Nasistan. The friendly neighbors both face a period of crisis from within and political problems in the region. Currently all parties strive to feed and protect the populations, to keep the A01 open and oil, produce and manufactured goods flowing.

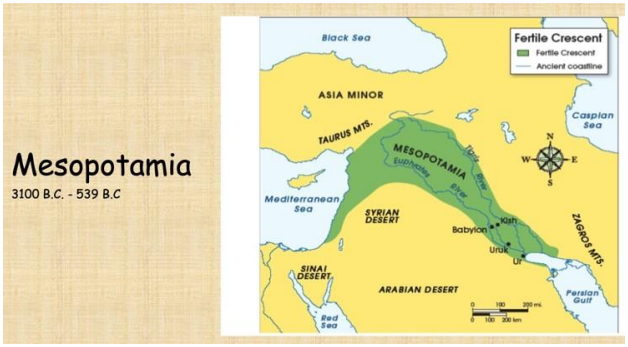
The Charkin Union military in Al-Nasistan has the primary mission of securing and maintaining the A01 highway for both relief efforts and commercial traffic.

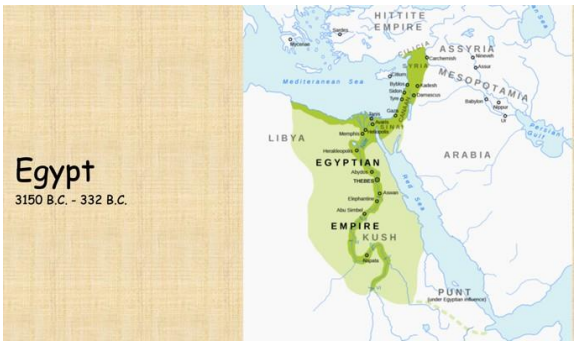
Other former UCR nations have perceived the danger of the scenario unfolding to the south of the Boreal Mountains and have collectively petitioned for representatives of all the nations involved to be invited to the WWB headquarters in Mediopolous in an effort to begin a dialogue. They fear that both the armed forces of Al-Markazih Confederation and Charkian Union will occupy Cheburechnaya and Al-Nasistan and fight a surrogate war for possession of the A01 superhighway and strategic control of interregional trade and defense.

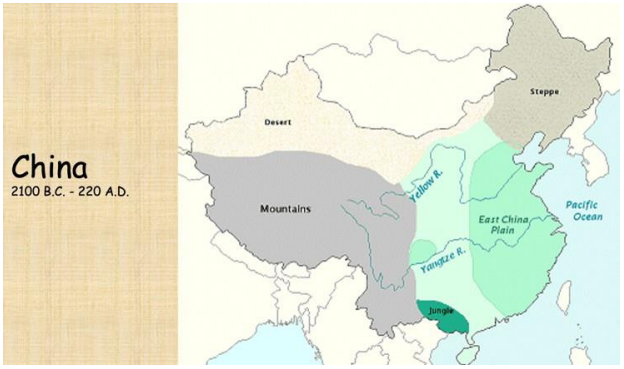
The WWB also fears that Cheburechnaya and Al-Nasistan may be absorbed by their powerful neighbors, losing their sovereignty and cultural identities. The balance of power and the lives of 1.5 million people in the Charka continent is at risk. Possession of the A01 is critical to all overland trade and commerce in south-Charka. A change in the current delicate balance of power is of global concern and may produce a worldwide shift of trading partners and alliances.

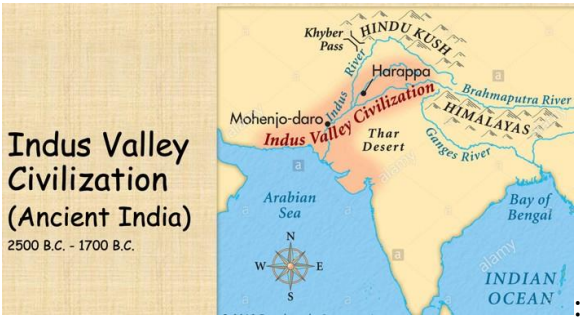
Exercises following lecture:











Ancient Greece

1100s B.C. - 600 A.D.

Ancient Rome

753 B.C. - 476 A.D

Class Discussion 2

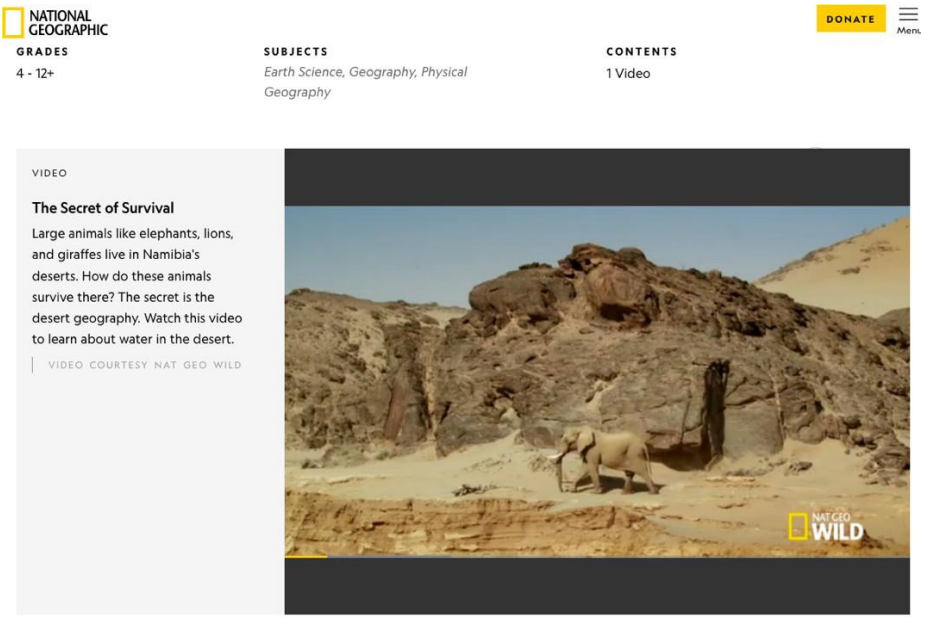
Observations and conclusions from the lists.

Desertification

- Definition: the process by which fertile land becomes desert, typically as a result of drought, deforestation, or inappropriate agriculture.

- Video 1
- Video 2

(The following videos were presented to clarify the meaning and effects of desertification.)



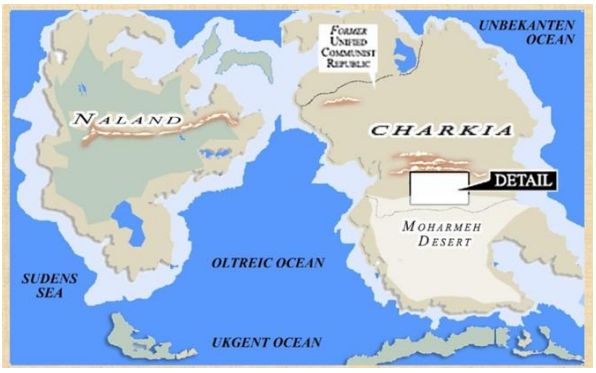
The video below explores the issue of desertification.

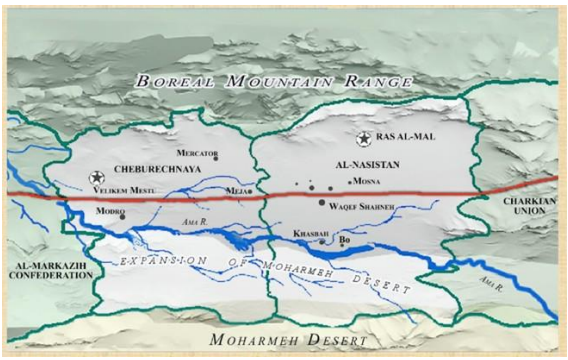
WHAT IS THE IMPACT OF DESERTIFICATION?

The Sahel region of Africa has been suffering from drought on a regular basis since the early 1980s. The area naturally experiences alternating wet and dry seasons. If the rains fail it can cause drought.

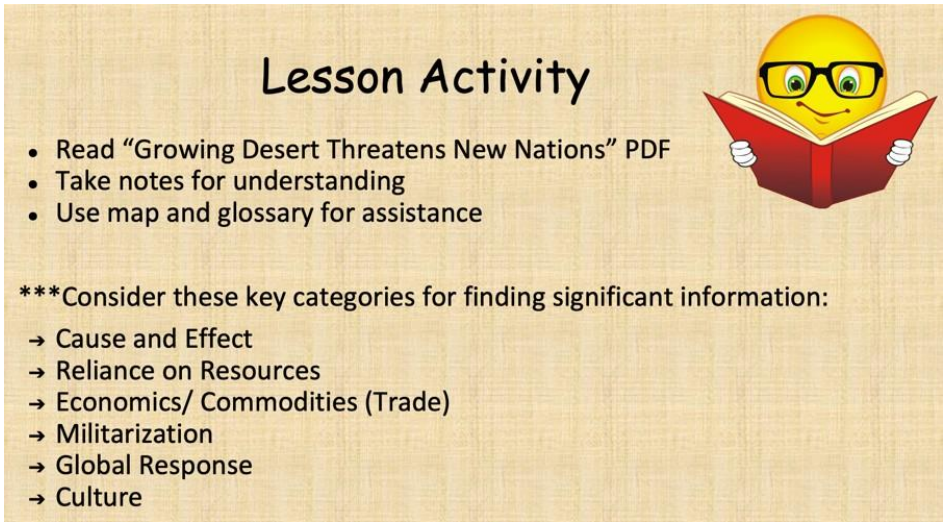
The result is crop failure, soil erosion, famine and hunger: people are then less able to work when their need is greatest. It becomes a vicious circle and can result in many deaths, especially among infants and the elderly. In 2012 a large-scale drought-induced famine occurred in the Sahel. It affected over 20 million people. You can read more about this on the Huffington Post site. In these cases, people rely on food aid from the international community. Click here to see a video from the BBC highlighting the issues.

(Maps were presented to clarify the location of the geography discussed in the narrative)





(The following activities were briefly conducted to reinforce the lesson. They took the form of a question-and-answer session)



Class Discussion 3

- Conclusions from the text.

("Kahoot!" platform was designed and employed to further reinforce the lesson)

Kahoot! is a game-based learning platform, used as educational technology in schools and other educational institutions. Its learning games, "Kahoots", are user-generated multiple-choice quizzes that can be accessed via a web browser or the Kahoot app.

Appendix C: Test Questions Administered to Classroom Session Participants

WEEK 1 QUIZ

1. What is the name of the oil rich nation to the west of Cheburechnaya:

a. Saudi Arabia, b. Al-Markazih Confederation, c. Charkian Union d. Massoud

2. How long is the A01?

a. 1,000 miles, b. 240 miles, c. 485 miles d. 18 miles

3. To what super-power did Cheburechnaya and Al-Nasistan belong to prior to their independence?

a. Unified Communist Republic, b. The Soviet Union, c. The Charkian Union, d. The Union of Soviet Republics

4. Who built the superhighway?

a. Cheburechnaya, b. Naland, c. Unified Communist Republic, d. The Charkian Union

5.What were two threats to the two small countries in the lesson?

a. destruction of farmlands and takeover by other nations, b. war with each other and widespread disease, c. the threat of mass destruction and starvation, d. depleted population and economic ruin

6.What area of both Cheburechnaya and Al-Nasistan are agricultural regions?

a. North, b. South, c. East, d. West

7.What direction does the A01 Superhighway run?

a. east, west b. north, south c. northwest, southeast, d. southwest, northeast

8. What natural event led to the extreme change in climate?

1. wildfires, 2. global climate change, 3. change in the gulf stream winds, 4. atmospheric warming

9. Where does aid for the two small nations currently come from?

a. The United States and Russia, b. Cheburechnaya and Al-Nasistan c. Naland and Unified Communist Republic, d. the Al-Markazih Confederation and the Charkian Union

10. What happened to the fertile farmland?

a. flooding, b. desertification, c. excessive heat and drought, d. nothing

11. What are the main agricultural products of Cheburechnaya and Al-Nasistan?

a. soy, rice and poultry, b. corn, tobacco and sheep, c. wheat, corn and horses, d. wheat, cotton and cattle

12. What occurred that allowed the two small countries to become independent nations?

a. revolution b. they always were independent, c. a world war, d. the breakup of a giant union of nations due to a failed economy

WEEK 2 QUIZ

13. What are the results of the changes in the two nations agricultural regions?

a. failed crops and starvation, b. economic problems and political upheaval, c. war and disease, d. changes in crop production and produce transport?

14. What are the main items of trade that depend on the A01 superhighway?

a. crops and cattle, b. coal and lumber, c. oil and manufactured goods, d. oil and weapons

15. Which agricultural industry began with a gift from another nation?

a. growing corn, b. raising cattle, c. growing cotton, d. breeding horses

16. What is the name of the international group that oversees the affairs in Cheburechnaya and Al-Nasistan?

a. The United Nations, b. Doctors Without Borders, c. The World Commission for Refugees, World Without Borders

17. What happened to all able-bodied men and women of Cherburechnaya?

a. they are forced to work at gunpoint, b. they are openly recruited as volunteers with the AMC Missionary Forces, c. they are assigned to clean and repair the A01 superhighway, d. they are put into prison camps to prevent them from defending their country

18. What are the greatest concerns of the international oversight group pertaining to Cheburechnaya and Al-Nasistan?

a. that the two nations will be absorbed by more powerful nations, b. that the two nations will bankrupt, c. that the two nations wish to war with each other, d. that the two nations will suffer from disease and massive loss of life

19. What is the primary mission of the Charkin Union military in Al-Nasistan?

a. To take over the country and its highway for themselves, b. To bring relief to the people,

c. To secure and maintain the A01 highway for both relief efforts and commercial traffic

d. To prepare for war with the Al-Markazih Confederation

20. In a short paragraph, summarize the basic story of what happened to Cheburechnaya and Al-Nasistan.

21. The Matjoulon, a formerly nomadic people who raised sheep, goats and horses in the savannahs along the edges of the Morhameh desert are most closely related to the population in which country?

a. Jordan, b. Al-Markazih Confederation, c. Charkian Union, d. Russia

22. the Drugoy, farmers who perennially sought and developed the fertile fields of the southern regions of the Charkia continent, are most closely related to the population in which country?

a. Jordan, b. Al-Markazih Confederation, c. Charkian Union, d. Russia

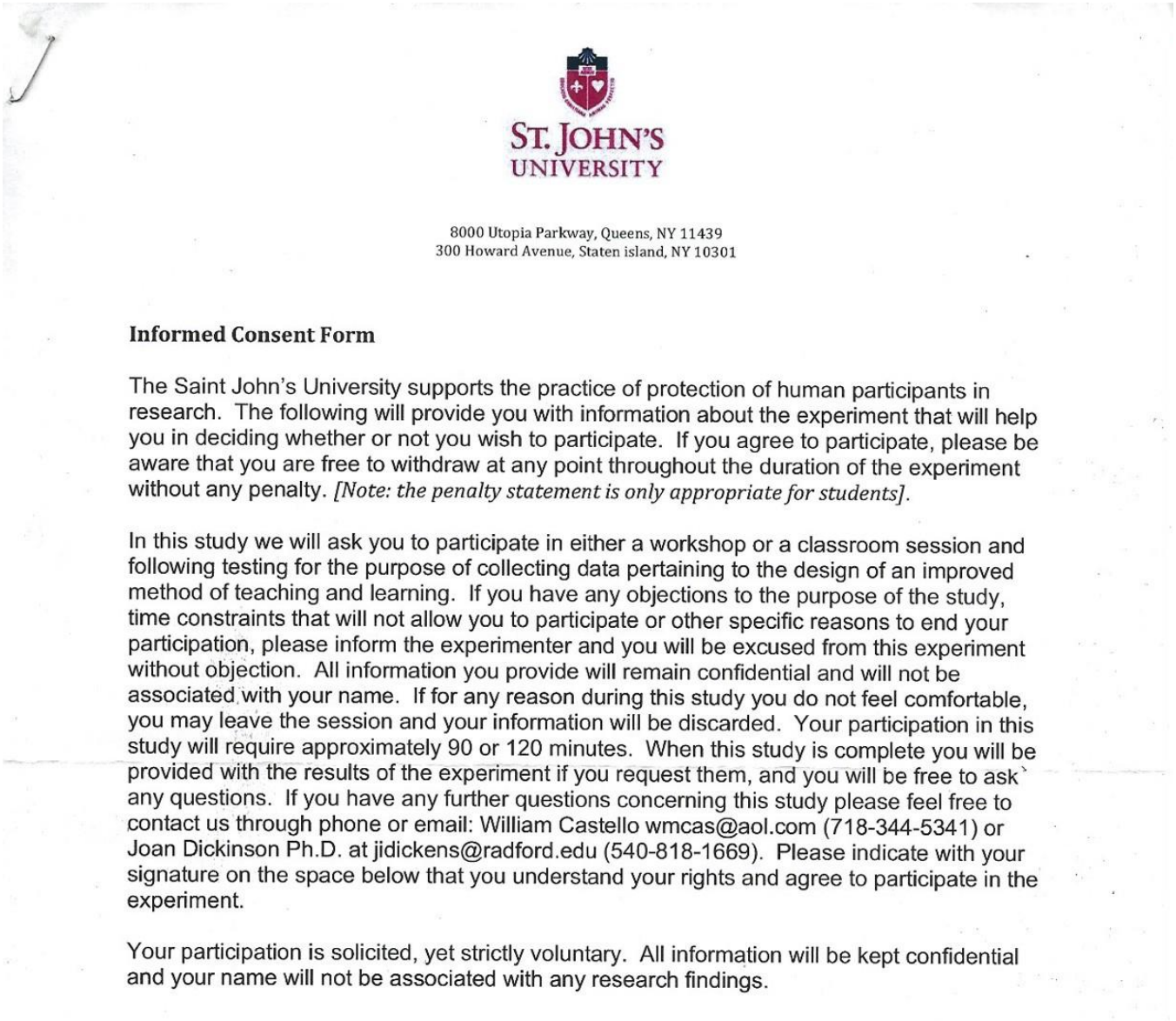
23. How did the Unified Communist Republic maintain peace between the different ethnic groups before their collapse?

a. thought strict laws, b. threats and violence, c. promoting patriotism, d. they did nothing

24. Cheburechnaya and Al-Nasistan both face a period of crisis from within and political problems in the region. What are the two goals of both small nations and their powerful neighbors?

a. to feed and protect the populations and to keep the A01 super-highway open, b. to conquer other neighboring nations and take their farmlands, c. to leave the stricken lands and find a home in other lands, 4. To expand absorb the two smaller countries into the larger neighbors and jointly administer to the A01 super-highway

Appendix D: Institutional Review Board (IRB) Consent Form



ST. JOHN'S UNIVERSITY

8000 Utopia Parkway, Queens, NY 11439
300 Howard Avenue, Staten island, NY 10301

Informed Consent Form

The Saint John's University supports the practice of protection of human participants in research. The following will provide you with information about the experiment that will help you in deciding whether or not you wish to participate. If you agree to participate, please be aware that you are free to withdraw at any point throughout the duration of the experiment without any penalty. *[Note: the penalty statement is only appropriate for students].*

In this study we will ask you to participate in either a workshop or a classroom session and following testing for the purpose of collecting data pertaining to the design of an improved method of teaching and learning. If you have any objections to the purpose of the study, time constraints that will not allow you to participate or other specific reasons to end your participation, please inform the experimenter and you will be excused from this experiment without objection. All information you provide will remain confidential and will not be associated with your name. If for any reason during this study you do not feel comfortable, you may leave the session and your information will be discarded. Your participation in this study will require approximately 90 or 120 minutes. When this study is complete you will be provided with the results of the experiment if you request them, and you will be free to ask any questions. If you have any further questions concerning this study please feel free to contact us through phone or email: William Castello wmcas@aol.com (718-344-5341) or Joan Dickinson Ph.D. at jidickens@radford.edu (540-818-1669). Please indicate with your signature on the space below that you understand your rights and agree to participate in the experiment.

Your participation is solicited, yet strictly voluntary. All information will be kept confidential and your name will not be associated with any research findings.