The Effects of Cognitive Overload:

A Music Education Study

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Abstract

This paper will explore the ways in which music students take in information from their instructors and the ways in which instructors can adapt their teaching styles to best fit the student for enhanced cognitive retention. The three types of memory that will be analyzed include working memory, long-term memory, and sensory memory. These memory types are affected by differing learning and teaching styles which include lecture format, demonstration format, and an independent learning format. A mix of each differing format of teaching can lead to successful learning with the least amount of cognitive load on the brain. The most effective teaching styles that fit the needs of every student include a demonstrative teaching style as well as student centered learning.

Music requires learners to master multiple skills. When sequentially presented, students master beginning level skills before attempting to learn more complex musical tasks. If a learner is asked to engage in tasks of great complexity before they are actually ready to do so, information overload will take place. Students will begin to lose focus and possibly an interest in learning. This essay will explore the ways music students take in information from their teachers, and the ways teachers can change their teaching styles to best fit the student for enhanced cognitive retention. I will accomplish this by researching different memory types such as sensory memory, working memory, and long-term memory, and at what point during the learning process does each type of memory begin to fail causing cognitive load. I will then take this information and apply it to different teaching strategies, finding the best methods to reduce cognitive overload.

Cognitive overload can appear in every stage of the learning process. It occurs when the amount of information being received is overwhelming or is too great to process. According to David Kirish, a Professor at the University of California San Diego, there are 4 main causes of information overload (Kirsh 2001). These include, "too much information supply, too much information demand, constant multitasking and interruption, and inadequate workplace infrastructure." Three of these four which include excessive information supply and demand, and constant multitasking and interruption all relate to music cognition and retention (Kirsh 2001). Kirish relates these three causes of information overload to the work environment, but they are concepts that can easily relate towards cognition and retention in musical learning.

For example, according to Kirish, too much information supply in the work environment can be caused by *pushed* or *pulled* information. Pushed information is information that is forced and unavoidably given, while pulled information is information that takes active seeking (Kirsh

2001). Pushed information relates to music cognition and retention when a teacher usually provides a plethora of information, directions, and tips to improve a students' playing. On the other hand, pulled information relates to music cognition and retention when searching for outside supporting material for musical advancement. This may include watching videos online to understand the correct methods to play an instrument or reading information to gain a greater understanding of musical concepts. The abundance of information available as well as the number of methods for achieving a high level of musicianship and musicality can thus cause the learner to feel overwhelmed and cause problems in musical cognition and retention. This loss of retention and musical cognition is due to the failing sensory memory, working memory, and long-term memory.

Similar to information overload, information demand is another key element in the ability to retain information in working memory that can cause cognitive overload. Too much information demand occurs when the brain cannot distinguish what is important and what can be ignored while taking in information. Again, during a lecture, a professor may not emphasize the general key concepts, leaving the student unable to distinguish between important concepts and little details that do not need to be stored in short term or long term memory.

Constant multitasking and interruption is another cause of cognitive overload. While a student is attempting to learn all the concepts being taught, working memory can only retain around five to nine items of information (Mastin 2019). If a music student was to learn the violin, he or she would be taught many different concepts at one time. Often there are more than five to nine concepts that a teacher will explain to the student thus affecting student memory retention. For example, remembering the correct bow hold, left hand position, as well as finger patterns all require multitasking to remember these instructions as well as the ability to repeat

them correctly. This overuse of working memory in the form of multitasking and regurgitating of information causes cognitive overload. Distractions for learners are also another key element that can cause cognitive load. When too much information demand, overload, and constant multitasking occur, it is extremely easy for a learner to become distracted as well as to begin not paying attention. For example, in a large ensemble or classroom learning setting, students might begin to lose focus and can become distracted on mobile devices or with classmates. These distractions cause working memory to inadequately take the information it needs to store the material being taught in the classroom causing cognitive load.

Cognitive overload exists partly because of the failure in the memory. There are three types of memory, which interact in the process of cognitive overload. First, working memory, also known as short-term memory, takes information received and converts it to long-term memory (Lewis 2016). Working memory can be compared to being online, constantly reading new information, or a computer's RAM memory that stores data, which can be forgotten or lost if not saved to the computer's hard drive. Long-term memory is information that is stored for an extremely long period of time and can be recalled after short-term memory has lost the information (Malamed 2015). Information is stored in long-term storage by compartmentalization or *schemas* (Malamed 2015). This makes it easier to store and recall information quicker. One final type of memory is sensory memory. Overall, sensory memory is a key factor in learning, especially for music. Sensory memory is the memory triggered by sensory receptors by the five senses of sight, hearing, taste, touch, and smell (Knowlton n.d). These memories transfer to storage in short-term memory. An example of how sensory memory builds musical cognition and retention is as follows. While learning from a music instructor, visual and auditory cues and memories are mainly stimulated when the instructor models an example of

what the student should remember to do on his or her instrument. The sound coming from the instrument as well as the visual example being generated by the teacher both contribute to a student's sensory memory later leading to storage in short-term memory and finally long-term memory. These sounds or vibrations can stay in short term memory for an average of 10 to 15 seconds with an average of five to nine bytes of information being stored at once (Knowlton n.d). Thoughts in stable long term memory occur when short term memories are repeated multiple times. This causes the brain to turn the memory into an important memory, which then becomes likely to be unforgotten in long term memory.

These different types of memory systems also interact with different methods of teaching, which can contribute to cognitive overload. There are many different methods of teaching, which include learning through lecture, demonstration, learning independently, or a mix of all three (Sullivan 2016). Learning through lecture is heavily based on information being taught to a learner without much interaction between the teacher and student. The lecture format gives benefits to auditory learners, but makes it difficult for visual learners to understand concepts unless given visual cues like a PowerPoint presentation or video to explain the subject. Lectures are useful when teaching information to large groups , but many times, the amount of content presented can not be completely understood by some learners and thus the student becomes lost or confused as the teacher explains the subject matter. This can cause cognitive overload.

Learning through demonstration is another teaching style that can be helpful or detrimental to information retention. Demonstrative learning is showing by visual example (Abbott 2014). This method is extremely useful for visual learners. When a visual learner watches an example of the task they must complete, they are able to retain in their working memory a time lapse of visual memory, thus making it easier to transfer the memory into long-

term memory. For example, in musical instruction, explaining with an instrument and actively placing fingers on an instrument as well as playing or singing the exercise gives students another form of mental stimulation to retain information in short term memory. The method of demonstration can have negative effects if the teacher does not pace the learning or demonstrate tasks that are at the level or slightly above the level of the students. This can be exemplified through teaching of the cello. A teacher may explain shifting, but if a student does not know how to correctly hold the cello, cognitive overload can take place because of the confusion of previously un-mastered material as well as the addition the new material that includes shifting.

Independent learning is another form of learning that is useful for the learner who works at his or her own pace, learning the material they think is necessary by themselves (Scholarly Project 2014). Although this method can be tailored directly to a learner's needs, if the learner has no direction, a student can become overwhelmed again with information if they do not have a guide as to the specific material they must learn. For example, a cook may need to learn how to cook a simple piece of meat, but upon further research, the cook realizes that there are many methods to cook a steak, with many combinations of seasoning and temperatures. This example can be applied to any type of independent learning and can cause working memory to fail with an over stimulated working memory, trying to process and store too much information at once. Learning through lecture, demonstration, or independently can all affect working memory, long-term memory and sensory memory, causing cognitive overload.

Overall, to best fit the need of the learner and to correctly re-enforce material, it is best to learn with a combination of both methods including lecture learning, demonstrative learning, and independent learning. Each professor or teacher, teaches with a different style and each student in return learns with a different style. Both teaching styles and learning styles interact and when

they are not compatible, it leads to failures in the memory chain. This then causes cognitive overload. For example, a student may attend lecture but not understand information being taught by the teacher because the pace and information is too great for the learner to retain. A student can resort to demonstrative and independent learning by independently researching the information missed in class (Makokha & Ongwae 1998).

Each of these examples that include differing teaching and learning styles also relate to music (Makokha & Ongwae 1998). Cognitive overload in music occurs in a classroom when a music teacher provides too much information at once. For example, in a private lesson or ensemble, a teacher may ask to fix errors in styling, phrasing, or counting, if a student is presented with too many errors to fix at once, the working memory in the brain cannot retain all of the information needed to be fixed. Therefore the short term working memory cannot compartmentalize the requests and changes to the music and the memory in the brain begins to fail. There are many ways teachers can fix this for differing types of musical learners. Although lecture based classes, demonstrations, and independent learning can all be manipulated to try and fit the learning needs of each music student, according to professor Dave S. Knowlton at Southern Illinois University Edwardsville, a more effective method for musical learning is to have students, rather than professors engage in understanding course content(Knowlton n.d). For example, in a classroom setting a professor may ask the students to learn a song on the guitar by only listening to an audio recording. Instead of the professor explicitly stating the necessary chords to play the song, the students would work together to audiate the music and hear the chord progressions and solidifying them on their individual instruments as a class. This method is stronger than the classic lecture, demonstration, and independent learning, because it allows the students to constantly re-affirm what they know, constantly ask questions without

interrupting the class, and struggling with the learning process. This reduces cognitive overload and helps retain information stored in working memory because students are constantly forced to affirm and re-teach the information at a pace that is both understandable to the advanced knowledgeable learner as well as the learner who knows little about the subject.

Although eliminating the use of the classic teacher-instructor model may seem extremely beneficial, it has its drawbacks. Moreover, there are other methods to help reduce cognitive overload in music learning that include a teacher. According to Frank Heuser, Music Education professor at the University of California Los Angeles, "students learn well when the teacher demonstrates" using visual, auditory, and tactile approaches (Heuser 2017). The less a teacher explains the information, the more a student can focus mental capacity on learning the material at their own pace without constant step by step interruptions of what to do, which at times can be overwhelming. This also reduces information supply as well as the demand for information because a visual memory of what to repeat is simpler than a long explanation of the task to complete. This method also reduces information demand because it eliminates the need to distinguish what is important or not. The visual memory remembers the tasks to complete, making adjustments to what is important or what is not depending on what the learner is struggling with (Abbott 2014). For example, if a student was to learn how to play a chromatic scale on the clarinet, it would be most efficient and beneficial in working memory for the teacher in real time to demonstrate what the students must know. In this way students can hear the correct pitches and tone quality, as well as the fingering and correct posture needed to complete the task. Students can then interpret all of the auditory and visual cues that the teacher demonstrated and automatically distinguish what important information must be focused on (Abbott 2014). This lessens the risk of cognitive overload by eliminating the teaching or verbal

explaining part of instruction, which allows for more focus in other areas of the learning process such as listening, and visualizing, all of which give working memory a chance to store information.

Overall, there are many different learning styles that affect memory and cause cognitive overload. Teachers must understand students differing and preferred learning styles and adapt to their needs. In music education, teaching while demonstrating and accommodating for student to student learning, are the most successful ways to achieve a high memory retention rate and cause less cognitive overload in music students.

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