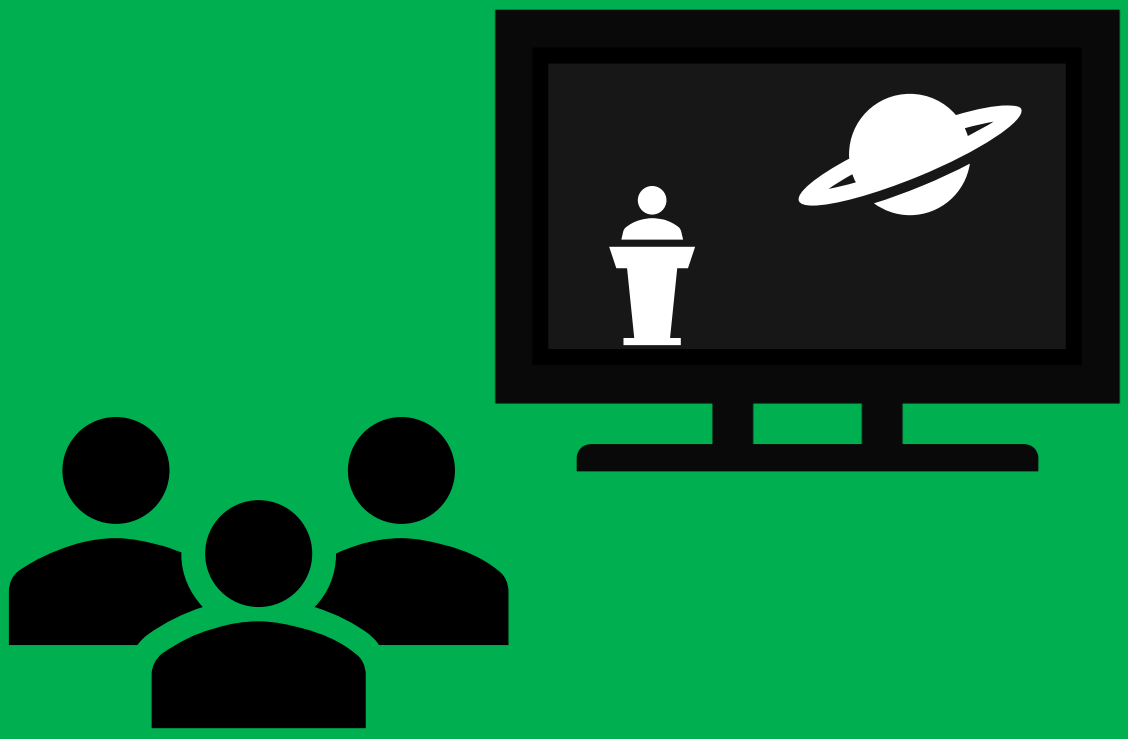


How to make Educational Videos more effective

Joshua Leach: S15126664

Module code: VIS6035

DIP tutor: Richard Schofield

Word count: 6599

The presentation of this essay deviates from formal academic literature, in attempt to be easier to understand and more engaging for the reader. Whilst researching how to make educational film more effective, I discovered several principles that could be effectively applied to literature. Where formal language and easy reading have parted paths, this essay chooses easier reading. For example, abbreviations, using 'info' over information, italicising mental processes, underlining to stress meaning and use of icons to help the reader digest new information.

Today, where screens are accessible on personal phones and laptops, E-learning videos can flexibly cater to more students, than a teacher in a classroom.

I interviewed a physics teacher, Michael Spencer, who had made videos to help his students revise. We discussed the benefits of his videos. He found them particularly helpful towards the end of the school year. When students needed to revise topics individually, he could refer them to his videos. Meanwhile, he could help in person, the students who were struggling with topics. Effectively, he duplicated his ability to teach.

He also noted that my 'generation' (born 1995+) engaged with screens more. In one lesson, his students requested to watch one of his videos, instead of him teaching them in person. While he and his colleagues were reluctant to taking the 'human' side out of teaching, it was still useful.
In the future, it seems likely that our screen usage will simply increase, as it already has done. Giving rise to phenomena such as *Double-Screening*. How then, can we make video better at educating?

The aim of this essay is to discover practical techniques and guidelines, for making successful educational videos. I will be using a mixture of educational psychology, interviews with teachers and film makers and research papers to draw up these guidelines.

So far, the research is pointing to similar central concepts. That educational video needs to be short, engaging and easy to understand.

Contents

How do we learn?

To understand how to make educational videos more effective, first we need to understand how we learn. I will examine some popular theories of learning such as Learning Styles, Multiple Intelligences, Information Processing theory and Cognitive Load theory.

The idea of 'Learning Styles' has been largely debunked by scientists[1] yet remains popular and influential in education. It's in contrast to the normalised idea of *Ability*, that students simply have varying competencies for learning.

It also contrasts the idea of *strategies,* the idea that specific strategies for tasks work better for everyone.

The LS theory is that students have a *modality,* meaning a preference for a 'channel' of information, be it *visual*, *verbal, kinaesthetic* or *emotive*. And learn better when a lesson is structured towards their *modality or learning style*.

The most common approach is to tailor lessons to student's modalities.

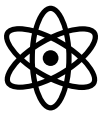
Another approach offers students a choice of independent activities, where they select the most appropriate to them. The third approach involves a special schedule, where a teacher goes through a lesson in different modalities and new students join the group as their 'preference' comes up.

However, *"The overwhelming popularity of modality theories of LS contrasts sharply with the devastating results of research on these constructs (Kavale and Forness 1987, Snider 1992, Stahl and Kuhn 1995, Yates 2000). Contrary to LS theory, students' learning preferences do not comprise a typology."*[2]

One of the problems with LS is that it places students as *Visualisers* OR *Verbalisers.* Questionnaires place visualising/verbalising on a single line, as opposing preferences. This causes a host of other problems. For example, findings show students are equally likely to say they prefer 'both visual and verbal' or neither.

And their responses to surveys, don't match up with their choices of real tasks.[3]

In Multiple Intelligence Theory, there are eight types of intelligence. Examples include, *Intrapersonal, Logical-mathematical* and *Bodily-Kinaesthetic*. MI has a similar implication to LS. The idea students have different types of intelligence and need to be taught correspondingly.



The sentiment of MI and LS can be summed up in an Albert Einstein Quote:

"Everybody is a genius. But if you judge a fish by its ability to climb a tree it will live its whole life believing that it is stupid."

[1] Klein, P. D. (2003). rethinking the multiplicity of cognitive resources and curricular representations: Alternatives to 'learning styles' and 'multiple intelligences'. Journal of curriculum studies, 35(1), 45-81.

[2] (Klein, 2003)

[3] Graham, N. A. and Kershner, J. R. (1996) Reading styles in children with dyslexia: a neuropsychological evaluation of the Reading Style Inventory. Learning Disability Quarterly, 19 (4), 233–240.

Many psychologists agree with several points of MI, that the mind has different parts, some for specific content. That knowledge is diverse, and people have different skill sets. However, for MI to be considered valid, it needs to prove that each of the eight types exist and they work independently of each other. These claims are refuted thoroughly in an essay by Perry D. Klein[4].

The popularity of LS and MI seems to be based in some emotional comforts. The first being, it's nicer to believe our intelligence is diverse, that our incompetence in one area doesn't mean we are incompetent, or stupid.

Multiple intelligence is generally espoused by teachers. In my opinion, this is because the current educational system fails to value students as individuals. MI is seductive because it moves towards valuing learners as individuals, with unique skills and talents.

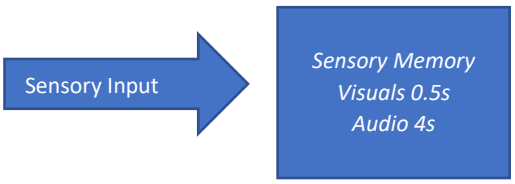
For the reasons discussed above, Learning styles and Multiple Intelligences will not be considered further.

[4] (Klein, 2003)

Information Processing Theory

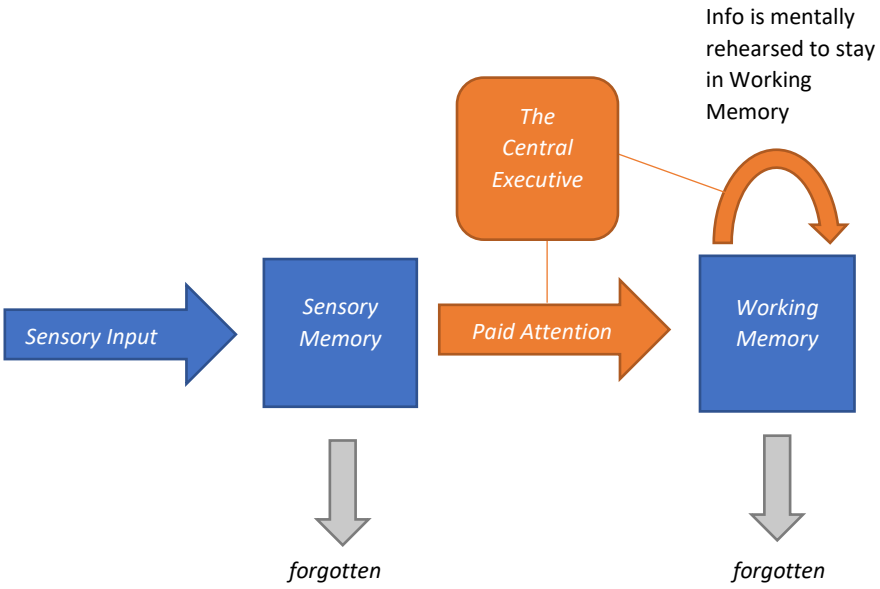
A well-known model for learning is: **Information Processing theory,**[5] which is to do with short-term and long-term memory.

The model goes like this. We take in sensory information from the world. This info goes into our *Sensory Memory*, (which can retain visuals for 0.5 seconds and audio for 4 seconds).

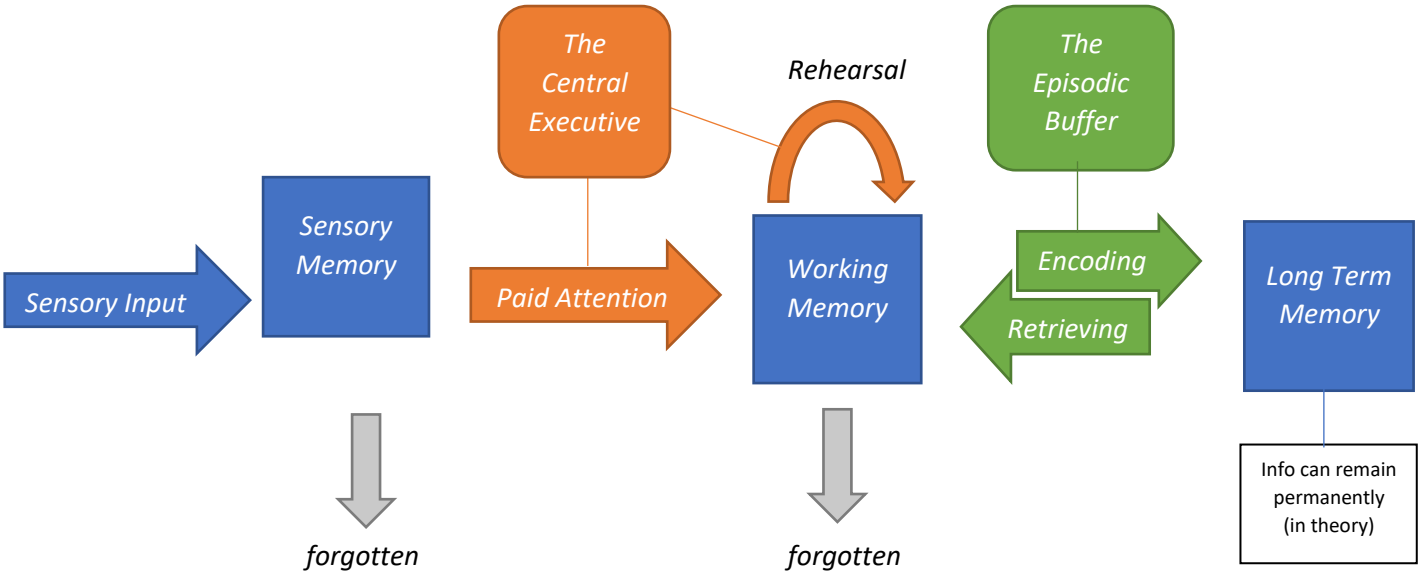


That info is either forgotten, or paid attention to by *The Central Executive,* a mental function in the model that allocates mental resources, deciding what to pay attention to.

If the info was paid attention to, it enters our *Working Memory* (sometimes known as *short term memory*). It can hold a limited amount of info consciously in our minds. Exact estimates vary on the amount that can be stored but it was first suggested around 7 'chunks'. That info is then either forgotten, rehearsed, or encoded into *long term memory*.

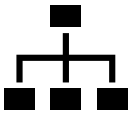


[5] Yue, C. (2013, october). Information processing model: Sensory, working, and long term memory | MCAT | Khan Academy. Retrieved from https://www.youtube.com/watch?v=pMMRE4Q2FGk



When information is stored *in long term memory*, it can be retrieved indefinitely, in theory. *The Episodic Buffer is* the function representing encoding and retrieving info from *long term memory* to *working memory.*

Eventually, when things are encoded into our long-term memory, they are stored into knowledge-structures called ***Schemas,***[6] meaning we don't have to think about them consciously anymore. And they are no longer a strain on our working memory. They can be *Automated.*



Schemas can be used for concepts, such as a*nimals, plants* and *buildings*. And they can be used for behavioural knowledge, for example, swimming, reading and writing or table manners.

For example, a child may develop a schema for a chicken. They know a chicken has two feet, wings and feathers. They could potentially misidentify any bird as a chicken, as the child in this viral YouTube clip does (pictured)[7].

After all, the geese pictured matched her schema for *chickens*.

She would then learn chickens are a type of bird with an orange colour and certain shape. And she would adjust her *Schema.*

"Look at all those chickens!"

When schemas are adjusted they go through either *Assimilation* or *Accommodation.* In *Assimilation*, new information is taken into a schema you already have.

In *Accommodation*, a new schema is made, or an old one is rewritten.

Notably, as we grow older our schemas grow more complex and sophisticated, and help us 'divide' up the world more efficiently and increase our understanding. Small children's schemas are often over-

[6]Cherry, K. (2017, May 16). Retrieved from www.VeryWell.com: https://www.verywell.com/what-is-a-schema-2795873

[7] Bernforever. (2013, April). Look at all those... Retrieved from https://www.youtube.com/watch?v=F-X4SLhorvw

encompassing leading to a simplistic level of understanding, illustrated beautifully by Karen in *Outnumbered*.[8]

Schemas can prevent us from learning new information too. Prejudice, being an example. When new contradictory information appears, we may seek alternative explanations, to bend and twist the facts to uphold our pre-existing schema.

The point of Education, is to learn and adjust our schemas, so that we can apply them functionally to the world.

Having mentioned **Schemas** and **Information Processing theory,** this brings us to **Cognitive Load Theory.** [9]

It was first articulated by J. Sweller to help design education material. It focuses on our working memory being limited. If a learning task needs too much capacity, learning will be hindered.

There are three types of cognitive load to consider: *intrinsic*, *germane* & *extraneous*.

Intrinsic load

Subject difficulty

The first, **intrinsic load,** is about how complicated the new subject is. Subjects with lots of connections have high intrinsic load. For example, when learning the German language, the number two = zwei. As a word pair, this has low intrinsic load. But learning the different sentence structures for future and past tense, with conditional words, has high intrinsic load.

However, intrinsic load isn't just about subject matter, but prior-knowledge the learner has. A recommended approach for managing intrinsic load, is to teach simple-to-complex material.

Germane load

Cognitive effort needed

The second, **germane load,** is how much cognitive-effort you need to achieve the learning outcome. For example, making comparisons and analysing. The goal of learning outcomes being to take knowledge into a functional schema. When we 'enhance' germane load we help the learner assimilate the information.

Extraneous load

Distraction & Confusion

The third, **extraneous load,** is the cognitive-effort you put in that doesn't help you achieve the learning outcome. It comes from poorly designed lessons (with confusing instructions or too much information).

This raises the question, how much extraneous load we can remove? Is it possible to create a learning environment without extraneous load? Student misbehaviour can create extraneous load in a classroom setting but the benefit of videos is they can be watched (or re-watched) in various environments, perhaps at home where there may be less distraction.

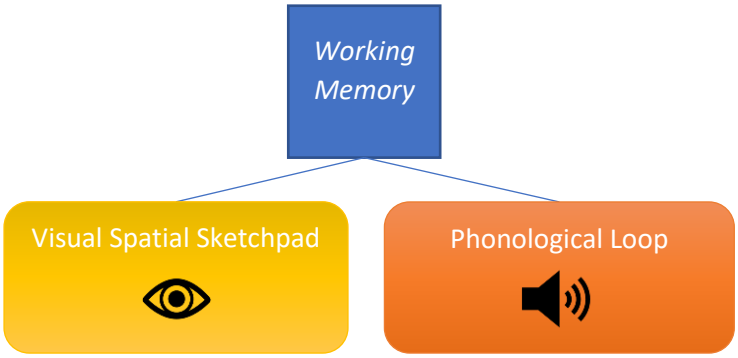
Extraneous load can occur when a student has no schema-knowledge on a subject. For example, its pointless teaching a student how a knight moves if they have no knowledge of the game of chess. Extraneous load also occurs when only one subset of working memory is utilised (See page 14). Working memory has two subset components. Visual & Auditory.

[8] Karen writes to Barrack Obama, *Outnumbered*, Series 3 Episode 2, https://www.youtube.com/watch?v=M1HC5HpYMCI

[9] Mind Tools Content Team. (n.d.). www.MindTools.com. Retrieved November 2017, from https://www.mindtools.com/pages/article/cognitive-load-theory.htm

Working Memory components

Working Memory's two components, called *Slave systems*, are the *Visual Spatial Sketchpad* that works to retain visual info. And the *Phonological Loop* that works with audio and verbal information.



There is a body of evidence that the brain deals with visuals and audio separately. Baddeley & Hitch did dual-task studies, showing that overloading one channel of information can reduce your ability to perform a task. For example, it was difficult for participants to rub their tummies and pat their heads. They 'overloaded' the visual-spatial sketchpad. But they could easily recite the alphabet whilst patting their heads.

In a case study of a man 'KF', who suffered a motorbike accident. His verbal memory was impaired, but not his visual memory. Which supports the notion: 'memory' isn't located as one function happening in one part of the brain. Processing visual and verbal information are distinct cognitive functions, and in different parts of the brain.

How does this apply to educational video?

What this means is: we should be careful not to overload one channel of information, be it visual/pictorial or auditory/verbal.

For example, if a video had an animation showing how *lightning* worked, it would be a bad idea to use subtitles to explain it because this could create the *Split-Attention* effect.

What should the student pay attention to? The subtitles or the animation? When the student reads the subtitles, they cannot look at the animation.

Using a narration, would avoid the strain on the visual spatial sketchpad, and the student in choosing where to allocate attention. Since the pictorial/visual channel is overloaded moving some of the information over to the auditory/verbal channel balances this out.

Working Memory Capacity & Intelligence

An important thing to consider is that some people appear to have greater working memory capacity than others. In a talk on Working Memory, Alan Baddeley, (a psychologist who helped introduce the working memory model) discusses an experiment which looked at working memory and language comprehension[10]. Students were asked to read aloud a series of sentences and at the end of each sentence repeat the final words of each sentence before. It was testing the ability to do processing (reading aloud) and storage at the same time.

For example, *'the sailor came from home with a parrot. Iceland is cold in the winter.'* And then recall parrot and winter. Typically, beyond 3 sentences the exercise became difficult and 4-5 was considered a high span. Surprisingly, to Baddeley, performance on the task predicted the students' ability on reading comprehension tests. And beyond that lots of studies have shown ability to process and store, predicts ability in a wide-range of tasks such as programming skills, taking adequate notes and performing on standard intelligence tests.

Is intelligence simply a high working memory capacity? In the States, Dr. Randy Engle and others have done studies to try and understand. They have found working memory training doesn't seem to improve intelligence.[11] But in general, they agree that intelligence seems to be a cluster of executive processes. One of which is the ability to inhibit irrelevant material from our surroundings or our own memory. That is, filter extraneous load, which would take up space in our working memory.

Depending on the students' familiarity to the subject, some information that is crucial for a beginner's understanding could be mundane extraneous information to an expert. To make effective educational films, consider the level of prior knowledge of the intended audience.

[10] Gocognitive, 2010, 'alan baddeley: individual differences and intelligence', retrieved from https://www.youtube.com/watch?time_continue=10&v=30QgoVqjkxc

[11] (Michael J. Kane, 2013)

The Phonological Loop and memory

Baddeley, also conducted an experiment, with a temporary store and a rehearsal method[12]. In which people remembered digits and then spoke them aloud. It was easy to do with 3 digits repeated over and over but harder with 9 digits. They tested it against word-length as well, and decided to look at words with more syllables, the idea being, with longer words, more time would pass as they were spoken aloud and they would be harder to recall, because participants would need to store them for longer. For example, 'cat' vs 'hippopotamus'. The results were clear, that monosyllables were easier to recall. The long words caused about 50% more errors. And the word-length effect has been repeated across different languages.

The findings had spin offs, of studying digit memory in other languages. And found that there are differences in different languages for the average span of recalling. For example, English is around 6, Italian less and Hebrew even less. Chinese, has the longest digit span recall. Because some of their bigger numbers are monosyllabic and thus less of a strain on working memory, allowing them to use working memory more efficiently and spend less time speaking aloud, so the numbers didn't need to be mentally stored for as long, before being called upon.

For educational video this could apply to scriptwriting. If the speaker takes a long time to explain something it may take up more storage in working memory, because it needs to be retained for a longer time.

The longer it takes to explain something, the more chance extraneous load could arise from the learner's surroundings or from their own long-term memory. But then If a speaker talks too quickly it could be difficult to follow what they are saying.

[12] Gocognitive, 2010, Alan Baddeley introduction of the phonological loop, retrieved from https://www.youtube.com/watch?v=2zF15C3vnIw

Engagement

In a huge study of 6.9 million video watching sessions, Guo *et al* set out to discover what makes student learners engage with videos.[13] They made several findings, one of which was speaking quickly and with enthusiasm helps to promote student engagement. Within the range of 185-254 words per minute.

Guo, measured 'Engagement' using two factors. *Engagement time*, a standard metric (used by YouTube & others) of how long the video played for. However, this doesn't measure whether the student was actively learning or just left the video playing in the background.

The second factor was *problem attempt*. In some videos it pauses, allowing the viewer to click to solve a multiple-choice problem. Moving on without clicking after 30 minutes was considered less engaged.

1. The most significant factor was video length. **Videos need to be short to be engaging**. 0-3 minute videos had the highest engagement. And after 6 minutes engagement begins to fall off.

To account for inter-course differences, Guo plotted the results separately and found identical trends.

There could be several explanations for this. The most likely would seem that students become bored, and the time spent teaching goes beyond working memory capacity, as the information needs to be stored for longer, and so students need to take a break.

In informal interviews, between Guo and the video-producers for the courses, they came to a hypothesis that shorter videos have higher engagement because their content is better quality. The idea being it takes lots of good planning to explain a concept succinctly.

2. **Talking head videos were found to be more engaging**. Videos where the instructor was interspersed with educational slides, over videos with just educational slides.

Although, this would be wasting the pictorial/visual channel, because watching the instructor doesn't provide additional information. (See point 5.)

In another study, Guo found that visual transitions between instructor and material onscreen could lead to student's replaying parts of the video[14], presumably out of confusion at not having enough time to comprehend what was being shown before-hand. A solution to fix this could be to use the video of the instructor in frame as the educational slide. Perhaps against a green screen like a weatherman.

3. In one example, it was found **production value might not matter**. Between two videos it was shown that where the lecture was filmed in his office and gave several points of eye-contact to the camera. It was more engaging than a video of a lecture taken in a very expensive Tv studio, where there was no eye-contact given to the camera.

13 Guo PJ, Kim J, Robin R *L@S'14 Proceedings of the First ACM Conference on Learning at Scale. New York: ACM; 2014. How video production affects student engagement: an empirical study of MOOC videos; p. 41-50.*

[14] (Juho Kim, 2014)

When Guo spoke to the video producers they believed it was down to a 'personalisation' effect, that made the video more engaging, which ties in with the finding that speaking quickly with enthusiasm and making the video feel informal, and helps people to learn. After all, formal language style is something which has arisen out of writing and academia, prior to that humans have an evolutionary history of aural-storytelling passed down. Something which is still practiced in cultures of aboriginals today.

4. Pre-production improves engagement. In one example Guo compared two highly regarded lecturers' videos, recorded in an identical style of classroom lectures. Except one had been pre-planned for an online format, and the other had been chopped up from older lectures.

The results for engagement showed that the prepared format had higher engagement even retaining its high engagement level beyond 6minutes for 9-12 minutes in.

The instructor who worked on the pre-planned lectures, made sure to plan each hour as a series of short, discrete chunks that could be re-edited for online. Whereas the video producers found using the old footage difficult, as there was sometimes no clear distinction between concepts. And Info was presented out of order, and remarks referencing time and place broke the 'flow'.

5. **Tutorials using a digital tablet are more engaging**. In a style which has been widely popularised by Khan Academy. The instructor draws images related to the concept they are explaining.

The videos considered best were made by instructors with clear hand writing, good drawing who had planned out the video so as not to overcrowd the page.

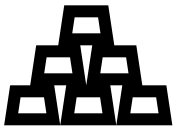
The video producers agreed with the finding. And noted that it placed the Lecturer on a 'similar level', with the learner, and took them out of 'lecture mode' making it more personalised.

Three other techniques to manage cognitive load

Signalling or cueing, where an onscreen change highlights important info. For example, onscreen text to help highlight keywords or new information.

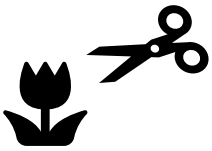
Visual symbols directing attention to part of the screen, for example arrows or circling.

A change in colour or contrast can also signal relations between concepts, enhancing germane load (helping the learner understand).



Segmenting, breaking up the information into manageable chunks, manages intrinsic load. By making shorter videos, it gives the learner more control of the flow of information.

It can also enhance germane load, by emphasising the structure of information.



Weeding, the process of removing interesting but extraneous information. This can help reduce distraction to achieve the learning objective.

Remember: some information is extraneous depending on whether the learner is a beginner or familiar to the topic.

'How to win a chess game in 5 moves' is extraneous information to a beginner for chess if they don't know the rules. Whereas, telling a chess grandmaster 'the king can only move one square at a time' is extraneous information that won't help them get better at playing chess. They already know.

Why utilising only one channel can increase extraneous load

If a video only makes use of one channel it may result in extraneous load arising. For example, if a video only uses visuals, any noise from the learner's environment must be filtered, rather than the learner having a narration to latch their attention on to.

Equally if a video only uses audio or pauses on an image for a long time, whilst discussing new subject matter it can leave the learner unsure where to direct their eyes, or worse wondering if the video has frozen which is going to create a lot of extraneous load.

Mnemonics

A Mnemonic device or **Memory Device,** is a learning technique that helps people to remember info from their long-term memory.

The ancient Greeks were the first to develop mnemonics.

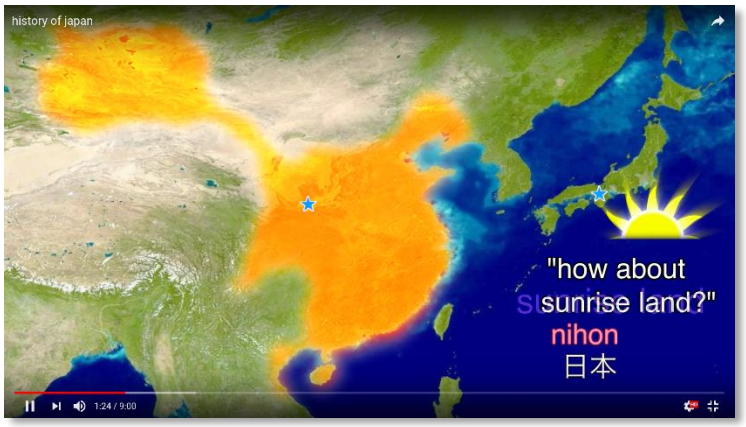
Human memory seems to remember things better when they are: spatial, personal, surprising, musical, sexual or humorous. Rather than impersonal or abstract.

For example, in biology, the taxonomy of life, '***K**ingdom, **P**hylum, **C**lass, **O**rder, **F**amily, **G**enus, and **S**pecies'*. Can be remembered by the -phrase *'**K**ing **P**hillip **C**ame **O**ver **F**or **G**ay **S**ex'*.

One of the first Mnemonic devices we learn today is the alphabet. Encoding it to the tune of 'Twinkle-Twinkle Little star'. Because Mnemonics focus on coding information, it can be harder to recall without them.

Consider the fact you know all the characters of written English, but you recall them in the arbitrary order of the alphabet. Recalling the alphabet backwards is difficult because we haven't encoded it that way.

Making use of mnemonics for educational video requires a lot of planning and creativity.



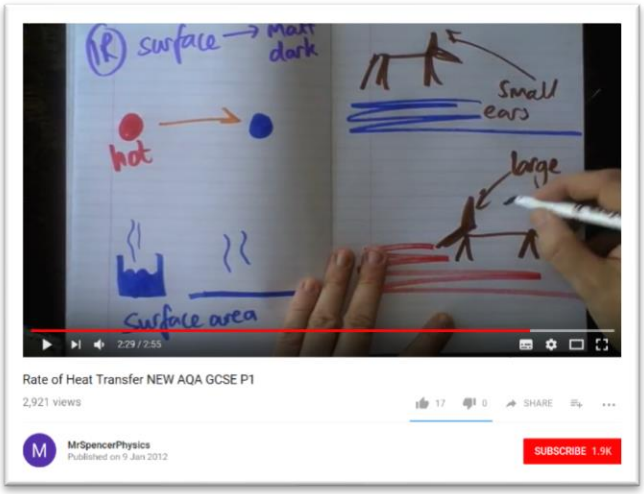
In 'history of japan'[15], Bill Wurz, rushes through Japan's history focusing on developments and conflicts. He uses jingle-music (a mnemonic device) to deliver some lines, and choral harmonies to emphasise words, before quickly returning to a more monotone classic narrator voice. It makes for comedic and engaging viewing. At 34,445,141 views with 906k likes.

[15] bill wurtz, 2016, history of japan, retrieved from: https://www.youtube.com/watch?v=Mh5LY4Mz15o

Interviews with Practitioners

Michael Spencer

I interviewed Michael Spencer[16], a physics teacher who taught me, about videos he made to help his students revise. Which many students found very helpful.



The structure of his videos involved a birds-eye view of a work book, which he would illustrate in, whilst explaining the concepts. Much like a Khan-Academy video. His videos were relatively short. [17]

He would also point out when there was extra information he wasn't explaining. To leave a point for the student to pick up on later. In his class generally, he would help students prepare to revise by getting them to make a **'concept-tree'** or map. Joining up all the subject areas, rather like a mind map or brainstorm. And getting them to judge how well they knew each area, to plan revision.

If we are making a series of effective videos, with maximum 6 minutes engagement per video. It might be good to have a visual concept tree, showing the learner's progression throughout the series. Shown at the start and the end of the video. Particularly if the concept-tree needs to fork off in different areas of subject matter rather than a linear structure. This would help the learner assess and assimilate info into their schema.

In my discussion with Michael Spencer, he asked if placing music in the background of his videos would have helped or hindered learning. An immediate answer is unclear, the music may have provided extraneous load for the narration, but it may also have worked to filter out background noise in the viewer's environment. The music used was instrumental, but with a singer's voice, lyrics could have likely created extraneous load, by competing for attention with the narration. Thus, overloading the phonological loop.

[16] Michael Spencer, Bablake school, 07791 692343, info@bablake.coventry.sch.uk
[17] MrSpencerPhysics, 2012, Rate of Heat Transfer NEW AQA GCSE P1, retrieved from https://www.youtube.com/watch?v=lD31QtBPq7A

Carl Homer

I spoke with Carl Homer, director and founder of production company Cambridge TV.[18] In the early days of Cambridge TV, he created some educational videos for their science magazine programme *Elemental Ideas*. Which focuses on working with scientists to turn their research into a 'meaningful narrative'. His 'angle' to creating educational content was focused on the idea of storytelling.

To paraphrase his ideas: When scientists publish their articles it's just data, it needs to be ascribed a beginning, middle and an end.

Newspapers don't publish the data or the scientist, they publish a story, often with a headline with an astonishing claim that can be later tempered in the rest of the article. For example, by reminding the reader of the small sample size of the study.

He also introduced me to a concept of including 'dopamine-hits' in films, (which after researching, seems to be a loose pseudo-scientific term) meaning, that you 'reward' your audience for watching and give their brain a pleasurable 'hit'.

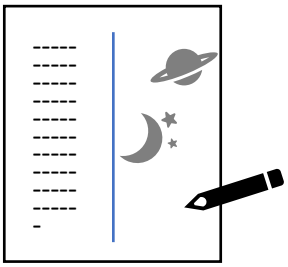
A technique he recommended was posing a question to the audience. If they answer correctly, they feel a small moment of pleasure that they're correct. But if they're wrong, the answer surprises them and gives them an 'oh, so it's that -that's interesting' feeling or realisation.

So, for educational videos a practical application of this might be: framing new information with a question.

Another thing he mentioned was the importance of the presenter. For example, is the presenter famous or well known? How much do you get for free by choosing that person? There are plenty of documentary topics that are more interesting having a presenter you know and like.

I spoke about how I found this to be the case with Michael Spencer's videos. And out of our discussion, we hypothesised it would be interesting watching a famous cartoon character teach a course. For example, I believe there could be a market for higher-education videos on nuclear physics taught by *Homer Simpson* in the nuclear plant.

The idea of Homer going into high detail of nuclear physics, could go one of two ways. The complexity of the subject, could undermine Homer's stupidity which is central to his character, and our suspension of willing disbelief, resulting in a lot of extraneous load.. Or Homer's stupidity, would lend itself to a funny, ironic and engaging educational video. After all, the joke in *The Simpsons* is that Homer is incompetent and in charge of an extremely high-level dangerous job. Though it might be easier to imagine a more intelligent character successfully teaching in his place, such as mad scientist Rick Sanchez from *Rick & Morty.*



Carl recommended a scriptwriting process for documentary, or non-fiction scripts. In which the page is divided down the middle. With script on the left and a plan for visuals on the right.

This is a good technique to ensure the audio/visual channels are not being overloaded. Carl also vaguely recalled going to a lecture about using reflection in film and media. The gist being: providing time to let the audience 'breathe' and pause for thought, allows the consolidation of information. And is very important.

18 Carl Homer, Director, Cambridge TV, carl@cambridge-tv.co.uk, 07977 105379, www.cambridge-tv.co.uk

Developing a video course: designing learning outcomes

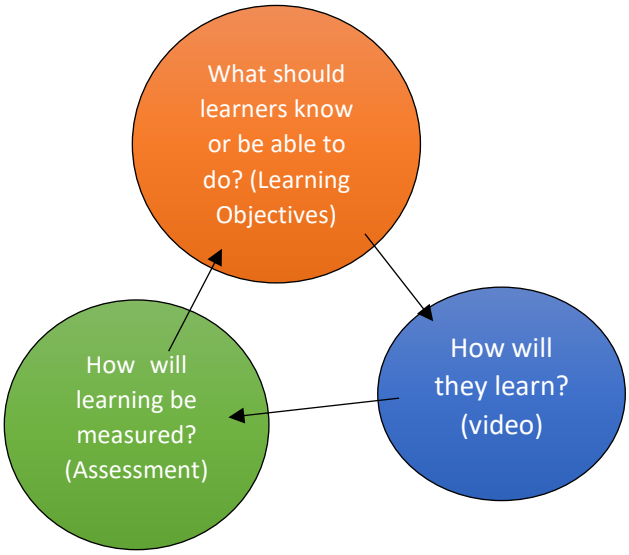
As a film maker or educator, approaching your subject, knowing where to start for educational videos can be difficult. Doing a concept-tree or map of the subject may help.

It may be useful to create learning objectives, to structure the video content. In designing a course consider, the learning outcomes, the learning tasks and the assessment.

Learning outcomes should be specific, realistic and measurable.

The learning task, is to watch the educational video. Perhaps with an activity devised around it, such as a worksheet.

Unless you are working for an examining body, you won't need to define the learning assessment. But if you are designing the videos with a specific course in mind, you may want to check how the learning objectives are assessed.

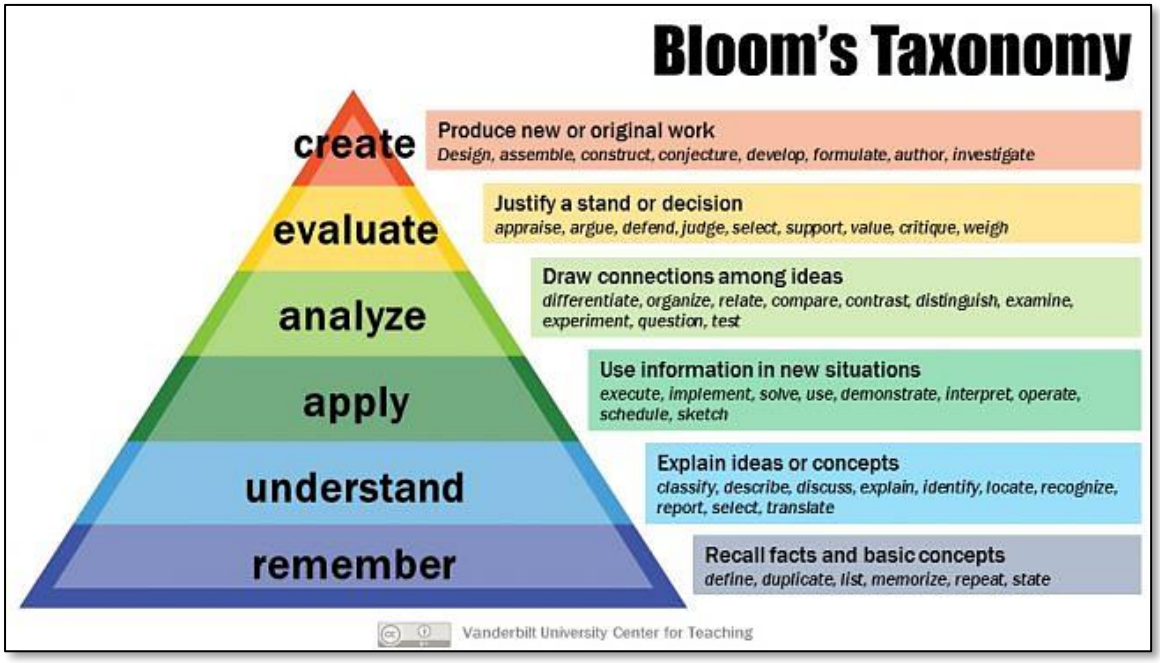


A bad example of a learning objective would be *'students should understand Pythagoras theorem.'* It isn't a measurable learning objective.

A good example would be '*students should be able to apply understanding of Pythagoras theorem, by working out the size of angles and lines in triangles when only some values are given.'* It's specific, realistic, and measurable.

Bloom's Taxonomy of verbs is helpful for devising learning objectives.

This pyramid of lower-order-thinking-skills to higher-order-thinking-skills may help articulate what skills we want the students to use. The idea of this pyramid being that the skills are hierarchal.



[19]

[19] Bloom's pyramid graphic, retrieved from https://cft.vanderbilt.edu/wp-content/uploads/sites/59/Blooms-Taxonomy-650x366.jpg

This comprehensive graphic of verbs may also be useful.

20

[20] List of Blooms taxonomy, Global digital citizen foundation, retrieved from https://solutionfluency.com/en

Importance of context

It is very important to give context to information. For example, read this passage and try to understand it:

> *The procedure is quite simple. First you arrange items to different groups. Of course, one pile may be sufficient depending on how much there is to do. If you have to go somewhere else due to lack of facilities, that is the next step; otherwise you are pretty well set. It is important not to overdo things. That is, it is better to do too few things at once than too many. At first the whole procedure will seem complicated. Soon however, it will become just another facet of life.*

It was written about washing laundry. Now re-read the passage with that in mind. What was once a frustrating exercise with high extraneous load, is now processed much more easily.

If students don't understand the context, they won't understand how the info is relevant, or where to assimilate it into their schema.

If introducing a new process or topic, it may be worth explaining its wider relevance at the beginning of the video.

Putting it all together

The basics of what we have learned so far are:

- The video should be 6 minutes maximum
- Our working memory can only hold a certain amount of info
- Overloading the visual or audio channels is bad for learning
- Underutilising a channel creates extraneous load -bad for learning
- Having complimentary info on both channels is good for learning
- We need to know the base level of knowledge our audience has - since this changes the intrinsic load and extraneous load (somethings they will need to know whilst others are interesting but distracting information).
- Khan-academy style tutorials are more engaging than PowerPoint slides.

When you approach the subject that you want to make a video for:

- Make a visual concept-tree or map, briefly outlining the relationships between the subject-content.
- Decide which topics need videos to be explained.
- Be mindful of the subjects' intrinsic load, and make the germane load (learning outcomes) manageable in each video; create learning objectives for the chosen topics. Learning objectives should be specific, realistic and measurable.

- You could use a visual of the concept tree at the beginning of the video, with the topic being highlighted, so the learner can see the video's relation and relevance to the other topics. This will help them *assimilate* the information into their schema.
- Consider forewarning the viewer on how complex the subject matter discussed will be.
- Ask: Is there a simple reason why the information is important? Telling the viewer at the start adds context as to why they should pay attention, reducing extraneous load.

- Know your target audience, how much prior-knowledge do they have?
- Ask: Can this content have a beginning, middle and end? Can it be made into a meaningful narrative? Where do you need to begin for this audience? Do you need to recap?

- Write a script, using simple, concise sentences (remember the word-length effect, big words and long, complex sentences will take up lots of working memory).
- If it helps, record yourself explaining the topic to a friend, for script ideas. It may help you articulate the lesson in an informal friendly way, shown to increase student engagement.
- Consider using 'Dopamine-Hits' rewarding your audience for watching, pose a question and pause to let them consider before answering for them.
- Consider trying to use a mnemonic device, or planning a creative way of making the information more memorable.
- Make a draft audio recording of the script, speaking at a quick enthusiastic pace, avoid the temptation to slow down to explain complex topics.

- Divide a page in two and put the script on the left side, and plan the visuals on the right.
- Listen to the recording, and sketch any visuals that may be helpful, or come to mind.
- Look for natural pauses to allow the viewer thinking time, to process what you have said.
- Consider if your video needs any animation or visual sequences to help visualise a concept.
- Use 'Highlighting'. The technique where new keywords are shown onscreen.

Case Study

In the initial research stage for this essay, I analysed a lot of educational videos from BBC bitesize.

I identified some useful techniques, which later came up again through further research. For example, **signalling,** highlighting key words.

I am going to revisit this video clip on *Photosynthesis* presented by Jon Chase[21], analysing it through the lens of cognitive load. I will later attempt to make a more effective educational video. By applying

what I have learnt through research.

When I first watched the clip, I found it difficult to follow. But I found it hard to explain why. The video had made clear efforts to be engaging. Notably, Jon does a rap about Photosynthesis. My first reasoning was: I didn't find the rap 'catchy' so I didn't find the info memorable.

This is a relevant criticism, given what we know about mnemonics. Revisiting the clip, I consider the rap to be extraneous load. When Jon, starts to rap, I don't focus on the lines he is saying, my first thought is '*oh, he is rapping*'. The change from speaking to rapping feels sudden and jarring. And Jon starts to move onscreen a lot, in addition to the appearance of subtitles.

My central executive must decide what to pay attention to. The words rapped are highlighted for attention but then Jon shakes his head to the rhythm, drawing my eyes away from the information.

There are also parts where the rhythm manages information poorly. In this segment, the line:

'The by-product is oxygen we need to breathe'.

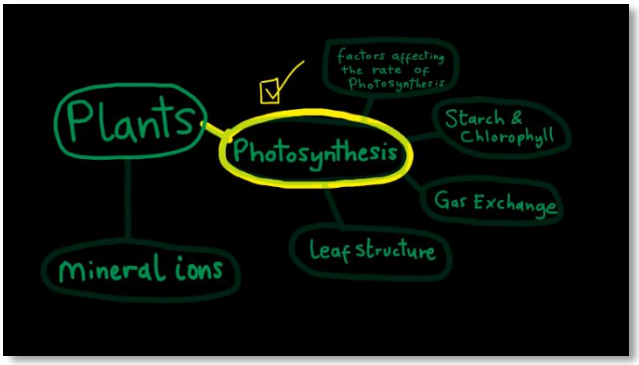
Is delivered more like:

'The by-product is oxygen -We need to breathe.'

The effect is *funny*. *'We need to breathe'* is such an obvious statement. Given the clip is aimed at key stage 3 students. And as the last line of the rap, it isn't lost from working memory, by being buried under new information.

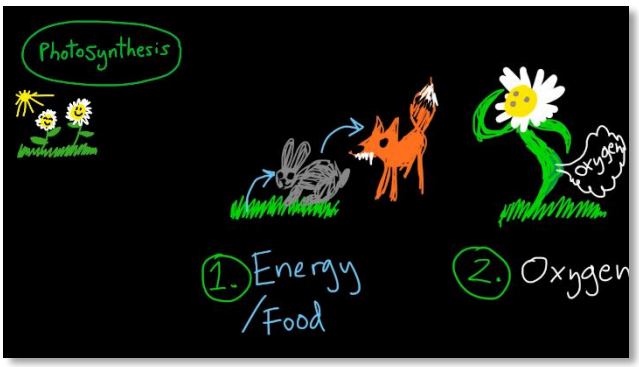
In attempting to make a more educational video, I have taken the clip transcript and made note of the info relevant to photosynthesis. I will attempt to convey this information more effectively.

[21] Photosynthesis, presented by Jon chase retrieved from https://www.bbc.co.uk/education/clips/zmnjxnb



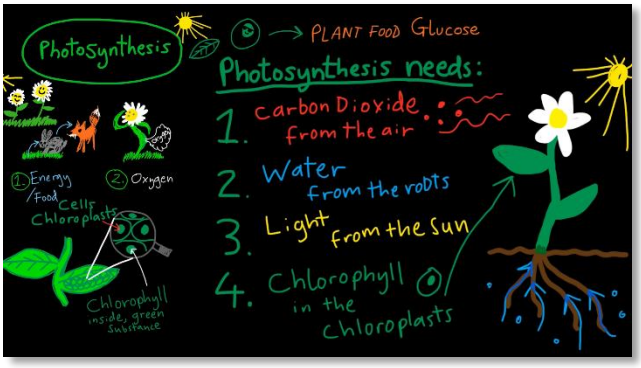
The video begins with a brief animation[22] showing photosynthesis being highlighted on the concept-tree. It was based on the topics for plants from the BBC bitesize website on GCSE Biology.

At the end of the video, photosynthesis is 'ticked off' showing the learner that they can now learn about the other topics beyond it.



I illustrated pictures on photoshop, using a graphics tablet. And recorded the screen using a feature on Microsoft PowerPoint.

I made a last minute creative decision to illustrate against black to emulate Khan Academy videos.



I recorded segments of video which I sped up using Adobe Premiere Pro. As it might take a minute to draw an image, that only needed to be shown for 5 seconds.

Using Premiere pro meant I could shrink the drawings I had made onscreen, so I didn't need to pre-plan the page to avoid overcrowding.

When I recorded the script, I adjusted the visuals to match the talking speed. Having greater access to technology makes creating a video easier.

I personally consider the video to be effective. I've shown the video to my peer group who remarked that it was shorter and clearer than the BBC Bitesize video.

My video could perhaps be improved by recapping the new words Glucose, Chloroplasts and Chlorophyll. Creating a jingle could have made the words easier to remember utilising mnemonics. The video also pauses for a long period towards the end so as the learner can consolidate the information without having to pause and rewind. However, it only makes use of the visual channel which led to one peer experiencing extraneous load, as they were expecting to receive new information. They didn't realise the lesson had finished. If 'elevator-music' was used in the beginning and end of the video it would signal the narrated part of the lesson was over.

But overall, I am satisfied with the outcome. Particularly the use of the concept-tree before and after the video.

[22] Dissertation video on photosynthesis, https://vimeo.com/246149114

Bibliography

Bernforever. (2013, April). Look at all those... Retrieved from https://www.youtube.com/watch?v=F-X4SLhorvw

Cherry, K. (2017, May 16). Retrieved from www.VeryWell.com: https://www.verywell.com/what-is-a-schema-2795873

Graham, N. A. (1996). Reading styles in children with dyslexia: a neuropsychological evaluation of the Reading Style Inventory. *Learning Disability Quarterly*, 19 (4) 233–240. .

Juho Kim, P. J. (2014). Understanding in-video dropouts and interaction peaks inonline lecture videos. *Proceedings of the first ACM conference on Learning@ scale conference* (pp. 31-40). ACM.

Klein, P. D. (2003). rethinking the multiplicity of cognitive resources and curricular representations: Alternatives to 'learning styles' and 'multiple intelligences'. *Journal of curriculum studies, 35*(1), 45-81.

Michael J. Kane, R. W. (2013). No Evidence of Intelligence Improvement After Working Memory Training: A Randomized, Placebo-Controlled Study. *Journal of Experimental Psychology, 142*, 359-379.

Mind Tools Content Team. (n.d.). *www.MindTools.com.* Retrieved November 2017, from https://www.mindtools.com/pages/article/cognitive-load-theory.htm

Yue, C. (2013, october). Information processing model: Sensory, working, and long term memory | MCAT | Khan Academy. Retrieved from https://www.youtube.com/watch?v=pMMRE4Q2FGk

Appendix

1. Film on Photosynthesis https://vimeo.com/246149114