UNIVERSITEIT TWENTE.

FINAL PROJECT THESIS

Developing a Tool for Learning Concept Maps

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Part I

Introduction

Context

As can be read in the previous chapter, the aim of this study is to develop and evaluate a tool designed for the purpose of meaningful memorisation. However, why is it actually important to memorise? This question has historically been debated since the days of the early Greek philosophers, and still remains relevant today. Therefore, before delving into the effectivity and specifications of the tool itself, it seems important to briefly reflect on this question first. This chapter does not aim to answer this age-old question, but rather tries to provide both some philosophical and historical context, for better understanding of the relevance of a better memorisation tool, and what 'better' generally entails. Furthermore, it more specifically will relate these questions specifically to the tools investigated within this study.

Five educational philosophies

Curriculum theorisers have proposed many different systems of categories (Marsh & Willis, 1999), of which the aim is to investigate which goals people involved with education have, and which aspects they therefore regard as being important. Apps (1973) differentiates between the five philosophies of education *Perennialism*, *Essentialism*, *Progressivism*, *Reconstructionalism*, and *Existentionalist education*, which have also (at least partly) been acknowledged by other authors (Brameld, 1971; Ozmon & Johnson, 1967; Yilmaz, Altinkurt, & Cokluk, 2011; Howick, 1971). Furthermore, Yilmaz et al. (2011) have found these categories to be sufficiently valid and reliable upon measuring their prevalence among teachers. Therefore, these categories will be discussed further individually in order to provide philosophical context towards the function of knowledge.

Perennialism

According to perennialism, there is no alteriar motive for attaining knowledge, but rather that attaining knowledge is a purpose on itself. This is along the words of Socrates, who concluded that knowledge is the only virtue. This he concluded based on that wisdom is the same as knowledge (Meno, 2000), that wisdom is one of the five cardinal virtues, and that all other virtues (e.g. justice) are merely derived from the virtue of wisdom.

The perennialists are mainly based on either the general philosophy of idealism or of realism. The most notable idealist perennialist are the scholastics, who focused on teaching the great classical and religious works in order to better understand their supreme being. Realist perennialists believe the classic works still have much implications today, and therefore should be taught to the next generation.

Methods generally practiced by are considered to be rather traditional, example of these are memorisation, reading, writing, drill, and recitation. It is also the only philosophy which has

many of its followers believing that education should be directed towards the intellectually gifted, and that other students should only receive vocational education.

Perennialism has been the leading philosophy in academics before the enlightenment. In the classical era, Greek students had to memorise and recite famous poetry, such as the Iliad and Odyssey by Homer, because these were believed to "provide great moral lessons and taught them what it meant to be a Greek" (Renshaw, 2008, p.139). This academic tradition was then perpetuated throughout the middle ages by the scholastics, who used the rationalism of the Greek philosophers to defend christian doctrine – most notably in the *Summa Theologica* by Thomas Aquinas. Scholastic instruction consisted of four elements: *lectio*, the reading of an authoritative text; *mediatio*, a reflection on the text; *quaestio*, questions from students about the text; and *disputationes*, a discussion about controversial *quaestiones*. With the coming of the enlightenment, academics transisted from using classical idealism as a source of truth and instead used experimentalism as a source of learning about the material world and verifying truth claims, and humanism as a means to a better understanding of the human endevour. Nonetheless, perennialism remained a prominent philosophy in education until the industrial revolution in the 19th century, and still has a place in modern society in the form of for example the Great Book program proposed by Hutchins, albeit in a far lesser degree than before the enlightenment.

Essentialism

Essentialism is generally seen as a child philosophy of perennialism, and is more goal oriented than its parent. Its purpose is to pass on knowledge to new generations in order for them to be able to function in society, and focuses on subject matter. It is also a very teacher oriented approach to education.

This philosophy also is based on both idealism and realism, whereas the idealists think the content comes from history, language and the classics, and the realists think it comes from the physical world, including mathematics and the natural sciences.

Just like perennialism, essentialist teaching methods are rather traditional, and include returning to the three R's, reading, lectures, memorisation, repetition, audio-visual materials, and examinations.

The earliest form recognisable as essentialist is the factory model of education (Stokes, 2013), which was a means to deliver education to the general public for the benefit of the whole society. This model was improved upon by introducing aspects of behaviourism with the introduction of reinforcement and repetition in order to shape the behaviour the teacher wanted. Furthermore, it introduced the audio-lingual method, where the whole class as a group chanted correct answers or key phrases. Furthermore, because of the importance of high-quality instruction, cognitivism contributed towards a better understanding of how to present materials more effectively. Essentialism still remains a popular philosophy in the form of people wanting to go 'back to basics' or wanting more order in the classroom.

Progressivism

Progressivism go one step further than essentialists in a sense that new students should not only be taught to function in society, but to go beyond and improve society. This might seem like a small step, but is rather involved for it has its base in opposing authorianism instead of conforming to it.

It also has its root philosophy in experimentalism, where truth is not constant such as in idealism or realism, but rather is constantly in transition to a better understanding. Therefore,

a progressivist curriculum focuses itself not on teaching already existing knowledge, but rather on the methods existing to discover knowledge such as the scientific method. This does not mean however that knowledge has become irrelevant. Students still have to be brought up to date with the newest developments in their field of interest, and thereby there is still some knowledge transfer necessary. The only difference is that this knowledge is never taught to be final, and the focus still lies within the transition and the parts still unknown.

Progressivists generally use more generative methods for instruction, such as enquiry learning, the scientific method and problem solving skills.

Starting from the philosophy of pragmatism of Peirce and James, progressivism became a serious contender for perennialism and essentialism in the 1920's, opposing their extreme authoritarian positions. As an educational practice, they grew larger with cognitivism and constructionism, where enquiry learning developed further and proved to be a more meaningful way of education. Yet, this approach was also criticised by the traditionalists, because it lacked rote learning and therefore could not be controlled, and was deemed highly inefficient for the students had to find out the wheel over and over again. However, progressivists argued that discovering truth is a very important part of learning, for it makes it meaningful and independent of an authoritarian truth. This idea of knowledge transmission also sprouted the idea of constructivism, a movement very close to progressivism.

Reconstructivism

There are a lot of similarities between progressivism and reconstructivism, such as both subscribing to experimentalism, moral and epistemological relativism, and the goal of improving society instead of conforming to society. Yet, reconstructivists differ from progressivists in the sense that they are more concerned with the ends than the means. Their goal is not to teach problem solving, but rather problem solving itself, and that society should be repaired. This emphasises the idea that the current society is broken, and focuses on social problems such as inequalities.

One might conclude that reconstructivism is thereby not different from the traditional perennialism and essentialism, because these philosophies also focus on the ends rather than the means. However, these philosophies still assume that the truth is absolute, unchanging, and provided by previous generations, whereas reconstructivism is still rooted in experimentalism and thereby states that the truth has to be discovered using the scientific method.

Reconstructivism stems from critical pedagogy, which is again based on postmodernism, anti-racism, feminism, and queer theories. This was first described by Paulo Freire, who was an educator and philosopher fighting for the less fortunate against the Brazilian dictatorship. Critical pedagogy was also applied in other countries with problems of social injustice and poverty, such as the Philippines and South-Africa during the apartheid. Reconstructivism was then created by Theodore Brameld, who advocated for using it in the US for avoiding facism and fighting the still prevalent institutionalised racism.

Existentionalism

Out of all described educational philosophies, existentionalism differentiates itself the most. Its core direction is towards individual self-fulfillment, and views education as an instrument for encouraging individual choice and autonomy. Not only does it oppose current authority, but it even goes far enough to state that there should be no authority, and that nobody should decide for students what to learn. It also states that what a person is capable of knowing and experiencing is more important than what he knows.

Educational Philosophy	Perennialism	Essentialism	Progressivism	Reconstructivism	Existentialism
Function of knowledge	As a purpose on itself	In order to function in society	In order to improve society	In order to change society	In order to discover oneself
Purpose of education	Preserving knowledge	Supplying knowledge	Supplying tools for discovering knowledge	Supplying tools for discovering inequalities	Encouraging maximum individual choice and autonomy
Philosophies	Classical idealism, realism	Idealism, realism	Experimentalism	Experimentalism	Existentialism
Subject matter	Classical literature	Three R's	Scientific method	Social problems	Personal reflection
Methodology	Memorisation, reading, writing, drill, recitation	Reading, lectures, memorisation, repetition, audio-visual materials, examinations	Problem solving	Problem solving	Subjecting students to crises
Authority	Ancient works	Teacher	Science	Socialists	Student

Table 1: A comparative summary on the five educational philosophies (Apps, 1973)

The main method of existentionalism is to put students into situations where they have to make meaningful choices, and to let them confront them alone in order to overcome personal crises so he develops selfreliance and overcomes despair. These are completely different from the methods used by other philosophies, since they do not rely on values preexistent to actions and thereby merely waiting to be discovered.

Existentionalism has seen the least progress in comparison to the aforementioned philosophies, both because of its relative novelty and its radical difference in methodology. It is also the philosophy which is most difficult to implement in current schools. One could even argue that existentialists are opposed to institutionalised education, since it revolves around self discovery and has a very anti-authoritarian viewpoint in the sense that no one should have the authority on deciding what students have to learn. One might argue that democratic schools are a form of an existentionalist curriculum, since here the students get to vote on the content they get to learn, and this school teaches democracy not from theory, but by experience. However, it is not a full realisation, for students do not learn by overcoming personal crises. Another form could be the Dutch *Iederwijs*, a school where students are placed together in a learn-friendly environment and are allowed to do whatever they please. However, this *laissez-faire* method of education still does not challenge the students in any way, which still would be part of existentionalism.

Discussion

Table 1 shows a comparitive summary on all above mentioned philosophies, giving an indication on the growing perspective on knowledge and learning methodology throughout history. In general the older philosophies, perennialism and essentialism, are labeled as the traditional philosophies, whereas the other three, progressivism, reconstructivism, and existentionalism, are often labeled as the modern philosophies. These two groups have the most apparent clashes: traditionalists place most trust in the current authorities where the modernists oppose them; traditionalists emphasise rote memorisation where modernists emphasise enquiry; and traditionalists want students to conform to society where modernists want students to change it.

Comparing these two general paradigms with the tools investigated within this thesis, the

drill and practice used by the flashcards is most advocated for by the traditionalists, whereas the constructionist concept mapping technique fits mostly to the enquiry practice of the modernists. Flashcards are used by perennialists to memorise data such as dates and reproduction questions, and even more so by essentialists for drilling facts such as multiplication tables and spelling. Concept maps however would be used to shift the attention towards the meaning behind the surface concepts: progressivists use them to discover the ever expanding scientific body of knowledge, reconstructivists for demonstrating historical causality behind social inequalities and how these could be countered, and existentialists to let students map out their own experience and knowledge. However, this preference is not absolute, perennialists could for example also use concept mapping in order to let students figure out the arguments of Socrates in a philosophy assignment (an argument map), and a modernist could still use flashcards for drilling vocabulary.

It is important to consider the five educational philosophies when attempting to succesfully develop the new learning tool flashmaps which combines the flashcards and concept maps. For example, one might ask themselves the questions 'what are the benefits of concept map visualisation of flashcards for essentialists' or 'why would an existentialist want to memorise the concept map', but also more practical questions such as 'should the concept map be provided to or constructed by the students' or 'in which order shoud the student traverse through the map'. These are questions which have to be addressed during the design and development of the new tool.

Theoretical Framework

Modal model of memory

Although the whole brain is involved in storing memories, the frontal lobes, medial septum and the hippocampus are the most prominent areas facilitating the process of memorising (Anderson, 2015) (see figure 1. The prefrontal regions are responsible for the creation and retrieval of memories, whereas the hipocampal and surrounding areas are responsible for permanent storage of these memories. Because of this dynamic, Atkinson and Shiffrin (1968) conceived a modal theory of memory, displayed in figure 2. In this model, information is perceived as sensory input, and is then shortly stored in the sensory memory. If the perceiver has paid enough attention to the input, it is then transfered (or encoded) into short-term memory. When the input is strong enough, that is, rehearsed often enough within short term memory, it can be more permanently stored in long-term memory. If not, the input fades away from memory and is forgotten. When a memory exists in long-term memory, it has to be retrieved into short-term memory in order to be remembered and used.

This model was heavily influenced by developments in electrical engineering and computer sciences. Rather than thinking about memories in the form of physical neurons in the brain, Cajal found in the late 19th century that memories were patterns of electricity through neurons by means of synapses, which were thought to function like electrical wires (Bliss & Collingridge, 1993). The later modal model can be thought of as functioning like a complex computer, where data is written on a hard drive (the long-term memory), and can be used by first retrieving it into working memory (or short-term memory) and later be transferred to the hard drive again. However, the way the brain works is different from a computer in the sense that a brain has to put effort into memorising data, and that a brain forgets data over time. Therefore, instead of
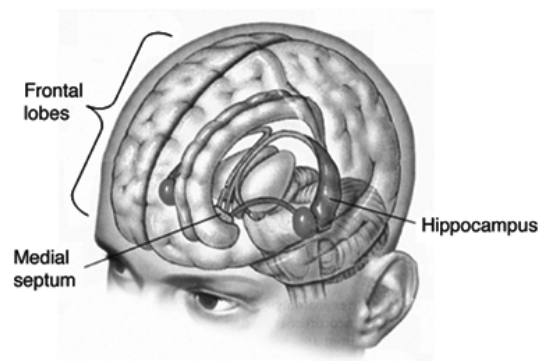
Figure 1: The brain areas mainly involved in storing and retrieving declarative knowledge (White, 2003)
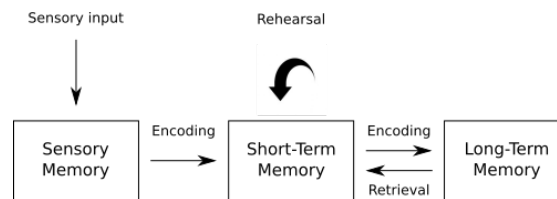
Figure 2: The modal model of memory proposed by Atkinson and Shiffrin (1968)

merely inputting the data, learning requires a more rigid approach.

Karpicke (2012) describes two seperate learning practices based on the modal model of memory, namely encoding and retrieval practices, where encoding practices are focused on meaningful encoding or construction of knowledge, and retrieval practiced are more focused on the reconstruction and rehearsal of knowledge. He states that both practices are essential to enhancing learning. Flashcards are a famous retrieval practice, emphasising drilling the same facts over and over again by means of pairs by association, whereas concept maps are known to be an encoding practice where the student has to connect diverse concepts within one topic by meaningful relations.

Flashcard system

In the context of language learning, Nakata (2011) defines a flashcard system as "Target items [...] presented outside meaning-focused tasks, [where] learners are asked to associate the L2 [foreign] word form with its meaning, usually in the form of a first language translation, L2 synonym, or L2 definition" (p. 17). In a generalised form, a flashcard system contains pairs by association, where the student is presented by one member of the pair and has to recall the other. This pair can indeed consist out of words in different languages, but can also consist out of a picture and a word for learning spelling, or a question with an answer for learning history. Traditionally, these pairs were presented as small cards (hence the name), and students would spend each day going through the stack of cards, preparing themselves for their exams. There are two main reasons for learning pairs in this form. The first is that students can repeat more difficult cards until they have answered them correctly, by putting the falsely answered cards on the bottom of the stack again and the correctly answered cards away for the next day. The second reason is a cognitive effect called the *spacing effect*.

Spacing effect

The spacing effect is a well known effect occuring within paired-associate learning, and demonstrates that repeated items are better remembered when both occurences are seperated by other events or items than when they are presented in immediate succession (Verkoeijen & Delaney, 2008; Logan, Castel, Haber, & Viehman, 2012; Siegel & Kahana, 2014; Xue et al., 2011; Karpicke & Blunt, 2011), which is demonstrated with diverse populations (Verkoeijen & Delaney, 2008; Logan et al., 2012), under various learning conditions (Verkoeijen & Delaney, 2008; Logan et al., 2012), and in both explicit and implicit memory tasks (Verkoeijen & Delaney, 2008). Items in immediate succession are called massed items, and items in seperated succession are called spaced items. Within flashcards, this effect is achieved by the student going through the deck on a card by card basis, interleaving each card by all other cards in the deck.

One can test the spacing effect either by using pure lists or mixed lists. When using pure

lists, one compares the effect of learning a list containing only massed items with a list containing only spaced items, and using mixed lists one measures the effect of learning both massed items and spaced items in one list, comparing their individual retentions. Verkoeijen and Delaney (2008) states that the vast majority of studies are conducted using mixed lists and found that spaced items where consistenly better recalled than massed items, yet studies using pure lists are relatively rare and have produced contradictory outcomes. They conducted a study providing participants first with an all-massed list, then letting them write down as many words as they could remember, and repeat an identical procedure for an all-spaced list with a 2 minute break inbetween. They conducted this experiment with short-lagged spaced items (with 1-4 items in between) and long-lagged spaced items (with 4-13), and found only a spacing effect in the latter experiment. However, ? (?) adds to this that repetition is only increases when a student detects the repetition of an item, and therefore the lag should not be too long.

Two theories have been presented explaining this phenomenon, namely the contextual variability theory and the study-phase retrieval theory (Siegel & Kahana, 2014). The first theory entails that because context is not static but continuous, and that therefore spaced items are studied in a greater variety of contexts and therefore easier to recall in yet other contexts than massed items due to the so-called encoding-specificity principle (Anderson, 2015). This principle entails that the probability of recalling an item depends on the similarity of the context during the encoding. The study-phase retrieval theory entails that additional retrieval cues for the repetition of an item are generated by earlier occurences and their associated contexts being associated with the repeated item. These theories are not mutually exclusive (Siegel & Kahana, 2014).

Although the findings of the spacing effect are consistent, students do not judge their learning to be improved by it, even when they demonstrated a significantly higher recall rate (Logan et al., 2012).

Long-Term Potentiation

Part II

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Part III

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Part IV

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Appendices

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