

Metacognition in the literature: the degree to which we know whether we know

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If you only read 3 things..

1. Definitions

Metacognition: "thinking about thinking." Consists of two components: knowledge and regulation.*

Metacognitive regulation: the monitoring of one's cognition and includes planning activities, awareness of comprehension and task performance, and evaluation of the efficacy of monitoring processes and strategies (Lai, 2011).

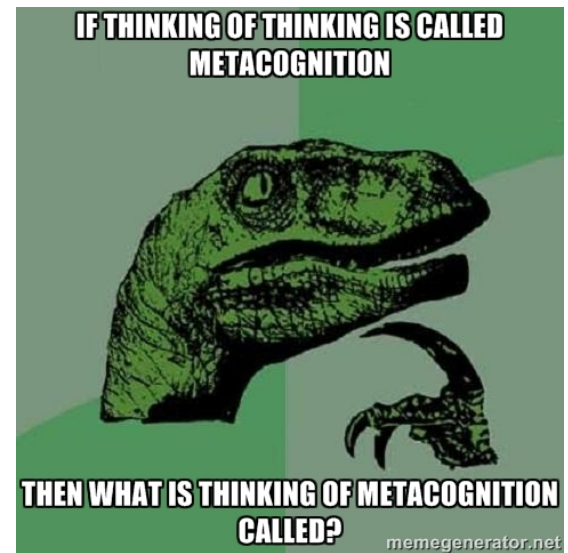
Metacognitive knowledge includes knowledge about oneself as a learner and the factors that might influence performance, knowledge about strategies, and knowledge about when and why to use strategies (Kostons and van der Werf , 2015). This form of knowledge is a prerequisite for independent learning strategies.

Learning strategies: actions directed at acquiring information or skill that involve agency, purpose (goals), and instrumentality self-perceptions by a learner. Examples of types: goal-setting, environmental structuring, self-consequences (self-rewarding and self-punishment), and self-evaluating, organising, transforming, seeking and selecting information, rehearsal and mnemonic strategies, seeking social assistance, etc. (Zimmerman & Pons, 1986)

*It is important to note that, despite what is stated here, there is not one concise definition for metacognition in the literature. This impedes the generalizability of research on the topic of metacognition as it is often referred to as different things.

2. Summary

Metacognition is the ability to reflect upon one's own learning behaviour and show awareness of one's strategies and self-regulation. Many studies have demonstrated the positive effects metacognition can have for learning. Kostons & Van der Werf (2015) demonstrated this by comparing the effects of prior topic knowledge and prior metacognitive knowledge on performance in a task. Learning capacity was found to be higher in those who had activated prior metacognitive knowledge. This has implications for the body of research which supports the idea that prior knowledge is the biggest contributor towards learning capacities.



Karpicke et al. (2009) also demonstrated that when students engage in retrieval practice this has greater positive effects on learning than does reading and attempting to memorise information. However it was shown that when students are left to study independently they show illusions of competence and believe that effective learning is taking place. As a result researchers encourage educational practitioners to inform their students of this research and encourage them to take responsibility of their own learning, which reflects the outcome stated under the new Curriculum for Excellence in Scottish schools. If effective education on the positive benefits of metacognition can occur this may help to address the concerns outlined by Dr Derek Cabrera and allow students to become reflective, adaptive and able to cope with novel stimuli.

3. Key Papers

[Metacognition: a literature review](#) (Lai, 2011)

This paper was chosen because it covers in depth the literature on metacognition up until 2011, this includes definitions, developmental patterns and applications. It also offers a critical evaluation of certain topic areas such as assessment of metacognition. Specifically, the purposes of this study were (1) to explore the ways in which metacognition has been defined by researchers; (2) to investigate how metacognition develops in young children; (3) to learn how teachers can encourage development of metacognitive skills in their students; and (4) to review best practices in assessing metacognition.

[Theoretical, conceptual, methodological, and instructional issues in research on metacognition and self-regulated learning: A discussion](#) (Azevedo, 2009)

This paper was chosen to represent relevant criticisms and gaps in the literature. The literature presented in this paper highlights several key theoretical, conceptual, methodological, and analytical issues related to the research on metacognition and self-regulated learning (SRL). Specifically, this paper examines four studies and address issues such as (1) the nature of SRL and metacognition; (2) micro- and macro- processes involved in SRL; (3) methodological issues regarding the use of self-report, and online trace methodologies in analyzing learning; (4) analytical issues dealing with the levels of granularity at which metacognition and SRL are examined and their implications for model development and (5) developmental issues regarding the emergence of metacognitive skills.

Conclusions: four implications for improving our conceptual understanding of metacognition and SRL

- 1) Develop explicit process models that explain the role and function of each of the underlying processes and how they contribute to learning, problem solving, and transfer.
- 2) Research would benefit from a detailed taxonomy of the metacognitive and regulatory processes used in various research studies (this would enhance researchers' ability to

investigate and measure the role of each metacognitive and self-regulatory process under different learning conditions, instructional contexts, etc.).

- 3) Focus on the development of metacognitive and self-regulatory skills. Understanding the development of these processes which can then be used to enhance academic achievement and design learning environments that contain the necessary instructional support to accommodate skills that have yet to develop, or are in the process of developing, or are in the process of being automated with additional practice.
- 4) Focus on the development of analytical tools such as observational measures, coding schemes, novel methodological approaches and statistical analyses, and software tools to increase the types of data compiled from self-report measures.

Metacognitive Competence in Motor Skill Acquisition

Sangster Jokic and Whitebread (2010) studied children with developmental coordination disorder (DCD) which is when the difficulties in completing motor tasks results in challenges in coping with everyday demands. Current research has seen a cognitive learning paradigm applied to reviewing the problems that are experienced by children with DCD, laying claims that these children have less developed cognitive and metacognitive skills with which to advance their motor skills (Sangster Jokic and Whitebread, 2010).

Much of the previous research made the assumption that metacognition is something which is conscious and self-monitoring which is a process which needed to be articulated effectively. However more recent research has suggested that some processes included in metacognitive control are not necessarily stored as articulated thought or are even available to conscious thought. This change in debate means that metacognition is more relevant to studying children than ever before (Sangster Jokic and Whitebread, 2010).

This research concluded that children with DCD experience substantial challenges when self-regulating motor performance but an effective way to address such difficulties can be seen through the development of metacognitive competence during motor skill acquisition (Sangster Jokic and Whitebread, 2010).

4TED Talks

Ted talks provide excellent and accessible introductions to complex areas of science and education including Metacognition, or thinking about thinking. This paper will summarise two excellent TED talks in the area of metacognition. The first considers young children and the benefits associated with early signs of effective meta-cognition.



[Metaphor and metacognition in young children](#) - Alis Shafer

Alise Shafer discusses the advantages childrens' minds have when it comes to invention and creativity as a result of their ability to be imaginative and unencumbered with the restrictions that come with knowledge of rules and facts, "you can't be spontaneous within reason".

Throughout her talk she shows several video clips of discussions she has with young children of 3 and 4 year olds about how they "think". Adapted from Swartz and Perkins (1989) she also presents the "Awareness Continuum", which begins at tacit knowledge (that which we innately know), travels through awareness and strategy before ending in reflection. To illustrate this she showed how a young girl named Cora, who was the best at catching butterflies at her nursery, demonstrated each of these points. Cora had a knack for knowing when to approach the butterfly, when to crouch, when to spring and when asked to explain her method she showed increased awareness of it. With respect to her strategy, she was able to demonstrate, explain and adapt this strategy through discussion (hands have to be gently clasped as not to hurt the butterfly, but this finger has to be here so they can breathe). Shafer believes that because children, such as Cora in her discussion, are able to demonstrate awareness and reflective skills that at some point in later life they will be able to employ this in a variety of contexts.

She believes that metacognition, thinking about thinking, is a significant predictor of success. In the famous "marshmallow self-discipline test" where children are left alone with the marshmallow and told if they do not eat it by the time the researcher returns they will receive two marshmallows as a reward. Shafer identified that of the 30% or so of children that were able to resist employed strategies to help them to do so. These included twirling one's hair, singing a song, turning their back on the marshmallow or tapping their feet to help distract them. Shafer believes that developing good strategies as these children were able to is in fact "a metacognitive feat" and to think about thinking is to assess one's strategies.

[How Thinking Works](#) - Dr. Derek Cabrera

In a second Ted Talks presentation Dr. Derek Cabrera, a professor from an Ivy League college, where the "cream of the crop" go to be educated, discusses the extent to which children are encouraged to continue "thinking about thinking" as their education progresses. As expected his students were able to take any test or structured assignment he could throw at them and achieve an A grade. However he noticed that whenever he gave unstructured assignments, or asked them to solve novel problems, they had great difficulty in accomplishing this task.

He came to the conclusion that his students were not knowledgeable, but in fact simply "good at doing school", but "couldn't think". In order to be truly knowledgeable, Dr. Cabrera believes that students must be skilled in several different types of thinking: Critical, Creative, Systems, Scientific, Interdisciplinary and Emotional/ pro-social thinking. He criticized American schools for neglecting each of these types of thinking, and although it is also a problem that occurs in schools, it has global implications. Dr. Cabrera details a fascinating metaphor where he compares "old-school" Lego to the modern day version. Old-school Lego came in a bucket, and it was the child's job to construct something out of the pieces available. However, Lego today is themed and branded, and the aim is not to be creative with the Lego but instead to replicate the Star Wars spaceship or the Harry Potter castle as per

the instructions. So although tremendous thinking and creativity is occurring by the creators of the product, the same cannot be said of the receivers. He believes the same is true of those whose responsibility it is to design and deliver the educational curriculum, and that less thinking is occurring on the part of the receivers.

Both talks highlight the benefits of effective metacognitive strategies at all stages of learning. This document will critically evaluate some of the key papers associated with metacognition and having an awareness of one's learning in order to evaluate the bold claims of both TED presenters.

Critical evaluation of other key papers

[The effects of activating prior topic and metacognitive knowledge on text comprehension](#)

[scores](#) Kostons and van der Werf (2015)

Summary

Research on prior knowledge activation has consistently shown that activating learners' prior knowledge has positive effects on learning. This is because when learners activate prior knowledge, this serves as a framework for establishing relationships between the knowledge they already have and the new information. This study investigates the effects of both prior topic knowledge activation (PTKA) and prior metacognitive knowledge activation (PMKA) on text comprehension scores. The results show that activating PMKA has beneficial effects on text comprehension, whereas activating prior topic knowledge, after correcting for the amount of prior knowledge, does not. The implications of this are that students who have prior metacognitive knowledge can use this knowledge (when activated) to increase their learning capacity.

Criticisms

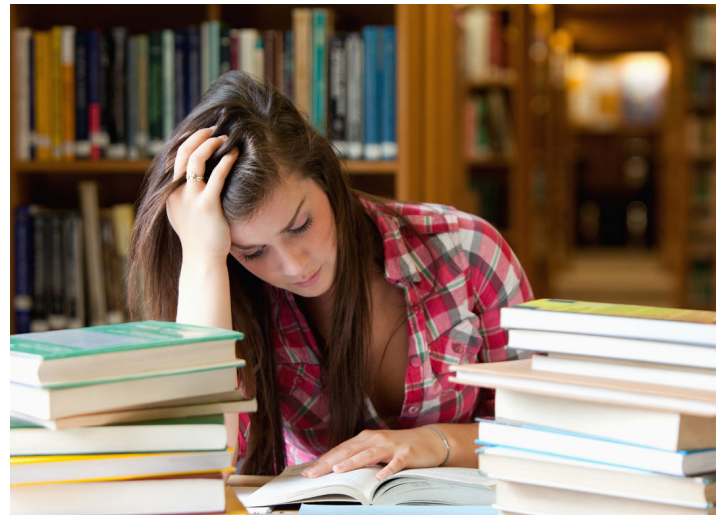
- 1) Limitation in the methodology: prior knowledge was activated by getting students to write down key words linked to their prior knowledge, however, these words were assumed to be correct and were not checked for accuracy. Therefore, it is possible that students unknowingly activated prior knowledge which is not correct and this likely affected the scores of text comprehension.
- 2) This investigation was carried out in the primary school sector, however, little is known whether these findings apply to a higher education setting.
- 3) In this study students in the PMKA group were instructed to only think and write down strategies they had used in the first text, however, this may have led to implicit activation of prior topic knowledge, as thinking on the meta level necessarily requires something to be "meta" about (Kostons and van der Werf, 2015)

Evaluation

This study calls for a reevaluation of past literature which has consistently shown that activating learners' prior knowledge has positive effects on learning, as it may be that activation of the metacognitive parts of prior knowledge that caused the positive results, rather than the topic knowledge.

[Metacognitive control and strategy selection: deciding to practice retrieval during learning](#) (Karpicke, 2009)

Practicing retrieval is an extremely effective technique for enhancing learning, however this study has found that students do not always choose to practice retrieval when they regulate their own learning. Four experiments were carried out where the participants learned foreign-language words over various study and test intervals. After word pairs (the foreign word and the English translation) were recalled for the first time, they were assigned to be repeatedly tested (retrieved), repeatedly studied, or removed. Repeated retrieval



generated strong positive effects on learning and retention. However, when participants were given control over their own learning and could choose to test, study or remove items, many chose to remove items instead of practicing retrieval, consequently leading to poor retention. Additionally, inserting tests into the learning phase, and hence attempting retrieval, improved learning by enhancing subsequent encoding throughout the study. Despite this, when given control over their learning, participants did not try retrieval (by choosing not to test the word pair) as often or as early as they should do in order to achieve optimal learning. This study identifies a pervasive metacognitive illusion which occurs throughout self-regulated learning: after recalling a piece of information once, students tend to believe that they have “learned it”. Consequently, students choose to end further practice rather than practice retrieval, which ultimately leads to poor retention.

For more information on the 4 experiments please see the [In Depth](#) attachment.

[Metacognitive Strategies in student learning: Do students practice retrieval when they study on their own?](#) Karpicke, Butler and Roediger (2009)

Summary

Karpicke, Butler and Roediger (2009) set out to explore the extent to which students practice retrieving information as part of their study strategies in real-world educational settings. The foundation of this research stems from a phenomenon known as the testing effect which shows that the very act of retrieving information only based on memory, has a significant impact on learning. The result is superior long-term retention of the information that has been tested. Researchers claim that repeated reading is considerably less effective on learning than practising retrieval of information. Karpicke et al (2009) looked to find out if students that engaged in the retrieval practice did so as they are aware of the benefits or because they would like to determine what information was known and what information is not known.

177 college students from Washington University were asked to (1) list study strategies that they had used for exams and (2) to choose to either practice recall or reread after studying a chapter in a textbook. This was

conducted initially through an open ended free report question and then the participants were asked to rank strategies in order of frequency that they would use them. The results demonstrated that the majority of students chose to repeatedly read over their notes and relatively few chose to engage in retrieval practice while studying. The authors propose that the reason for this selection is down the students experiencing illusions of competence. This is when students feel that they know the information better than they actually do. The researchers suggest that the implications of this study is that teacher/ instructors should inform students of the substantial benefits of self-testing and that they should base study strategies on evidence based theories of what strategies promote the most effective long term retention and learning (Karpicke, Butler, Roediger, 2009).

Criticisms

Issues with Self-Report

The self-report of strategies used should be approached with caution as it is open to imprecision and bias (Schoeller, 2000). The experimental design would have benefited from independent methods assessing the validity of the responses (Schoeller, 2000). Although all self-report measures trade some external and internal validity, the arguments put forth in this research represents a viable argument to explore student's strategies of learning in more microlevel detail (Duncan, 2005). The self-report method by very nature entices an interpretive and critical paradigm, this subjective approach leaves vast room for error (Schoeller, 2000).

The small number of 177 participants does not seem to be applicable or representative of the general population. It is also worth noting that all participants studied at Washington University. Thus they would most like be exposed to similar study technique seminars/ hand-outs etc, this could demonstrate sampling bias (Pannucci, Wilkins, 2010)

Vague options

In question two of this study, students were asked to imagine studying a chapter in a textbook for an exam (Karpicke, Butler and Roediger, 2009). "They were asked to choose one out of three alternatives (1) repeated reading of the chapter, (2) practising recall of material from the chapter (with or without the opportunity to reread the chapter, in different versions of the question), or (3) engaging in some other study activity" (Karpicke, Butler and Roediger, 2009, page 474). The study claimed that the choices from students indicated their preferred strategies for exam study. However it is apparent that option (3) could be deemed as less desirable due to its vague description, perhaps indicating observer-expectancy effect from experimenters. Borgers, Hox and Sikkel (2002) claim that completely labelled response options benefit the participant when selecting an option. Vague quantifiers significantly impact on the quality and reliability of responses (Borgers, Hox and Sikkel, 2002). This study would benefit from a strategy that would optimize more realistic and balanced options to allow some insight into preferred study strategies.

Validity Claims

This study set out to explore student's exam study strategies in real world settings, however, the study took place in a laboratory. The potential impact of this setting could enhance reputational concerns, encouraging participants

to select strategies which are seen as more dedicated or motivated behaviour (Bateson, Nettle, Roberts, 2006). Burnham and Johnson (2005) argue that humans are strongly attuned to even subconscious cues that can indicate reputational consequences of their behaviour. Mook (1983) maintains that investigations in the laboratory are not intended for to make generalizations to the real world, as the 'artificial results' are interesting because it demonstrates what can occur in a laboratory. Therefore the artificial sample and setting could not be used to make a prediction in real world settings but to inform of laboratory responses (Mook, 1983). However controversially Karpicke et al (2009) made claims that this sample bias could be generalized to real world setting of exam revision.

It has been proposed in this research that students seem to gravitate to particular study strategies, however the conventional standards of validity and reliability of results in this article have been compromised through the experimental design. The self-reporting method, along with bias response options in an experiment which took place in laboratory settings seems to impact on the external validity.

Applications: learning to learn

Learning made easier...

Students can enhance their learning by becoming aware of the way that they learn (Paris, Winograd, 1990). Understanding their own thinking while they write, solve problems and read can be an effective way to advance optimize their learning capacity. Teachers can help to develop and promote this awareness directly by providing information on effective strategies and discussing motivational and cognitive characteristics of thinking (Paris, Winograd, 1990)

Ways to enhance metacognition

Attitudes to learning is crucial, positive and negative experiences of learning can stay with us for a lifetime (Cottell, 2012). Awareness of the optimum conditions for learning is important to effectively enhance our learning. An awareness of the basics of how our brain functions at the highest capacity is also imperative. For example the brain works well when the brain is:

- ❑ **Rested-** getting enough sleep is crucial for any performance
- ❑ **Hydrated-** Drinking water benefits the electrical connections in our brain
- ❑ **Unstressed-** When we are stressed, it will use energy elsewhere rather than being able to focus on learning. Attempting to read journals or write an assignment will be less productive if stress levels are high.
- ❑ **Fun-** It is important to explore avenues that we feel interested in or stimulates us. Sometimes this requires imagination if it seems like a topic we are not interested in.
- ❑ **Several exposures-** The brain copes better when it has seen something often and for small periods rather than attempting to understand something in one sitting. This is not necessarily productive.

The effectiveness of which we study is more important than for how long. We will now explore how to study effectively. Firstly identify what is required, look at course documentation to allow yourself to build a clear picture of what is being asked of you. Preparation time can be well spent. Work towards targets and goals ensuring achievement is made in small but manageable stages

Look for meaning in how things function rather than attempting to memorise information. Try to piece together the literature and how it relates to each other. It makes reading the material easier and more understandable from a holistic perspective. This helps to progress your understanding resulting in more efficient memory retention.

One of the leading researchers in this area is Stella Cottrell, author of many books in this area (Cottrell, 2012).

- She believes that people should set SMART-F targets:
 - Strategic: they assist to achieve goals
 - Measurable: You are aware of when they are completed
 - Achievable: They must be within reach or can lead to success
 - Realistic: It must be realistic within your individual circumstances
 - Time-bound: You should create your own deadlines or realistic timeframes
 - Flexible: They can be adapted if there is a change in your circumstances.

Plan in advance how many words are needed for each section, not only does it make the work seem bite size but it helps us to focus how much energy is needed for certain sections. One of the key factors is to look after yourself while learning. Take rests when it feels right, plan breaks regularly to allow your brain to continue creative thinking. Change of scenery could sometimes help too (Cottrell, 2012).

Scottish Schools and the Curriculum for Excellence, the importance of self-assessment

Learning to learn was coined by many Scottish schools and served as the name of a new “reflexive learning” module under the Curriculum for Excellence (Education Scotland, 2008). Following a radical review of traditional PSE (personal and social education) lessons by HMIE (2004) a number of weaknesses were highlighted including PSE lessons becoming too repetitive, irrelevant, not considering pupils prior knowledge. One of the main weaknesses highlighted however was the neglect of key areas such as study skills.

The curriculum for excellence is committed to enhancing learning and encouraging ownership of learning by the learners through successful dialogue with teachers. This enables teachers to personalise their students learning to suit the individuals needs. This can only happen if the pupil is educated on how to assess their own learning strategies.

The marshmallow self-control test

As described in the first TED talk earlier in the document the Stanford Marshmallow study assessed young children of around 4 years old on their ability to be disciplined and resist the opportunity to eat a marshmallow in the 1960s (a more modern version can be found [here](#)). Follow up studies have revealed that those who were able to delay the

gratification of the marshmallow for a full 15 minutes less likely to have problems with behavior, drug addiction or obesity by the time they were in high school, compared to those who were unable to (Mischel et al., 2010).

Although being unable to resist the temptation to eat a marshmallow seems a fairly trivial event, the implications of poor self-regulation, i.e. the ability to assess ones strategies in response to discipline tasks and demonstrate effective metacognition, has been shown to negatively impact future wellbeing.

Future Directions for Metacognition

Barden and Tormala (2014) argue that metacognitive variables can be seen as direct determinants of attitude strength. This study refers to elaboration as the extent to which an individual directs thoughtful processing towards an issue or object. This also includes the scrutiny of information that is contained in messages which can be seen to be persuasive, retrieved or even generated from our memory. The authors put forth that future directions for metacognition that should be explored are the structural mechanisms which are proposed as the impact of elaboration on attitude strength. This would allow researchers to determine if the processes of metacognition also play a role on attitude strength. They suggest that exploration of meta-level variables would provide a more comprehensive understanding of the role in the amount of processing in determining strength in attitudes and lead to fascinating insights into persuasion. There is claims of a dynamic interplay between various modes of processing, however it is not yet clear what the implications are for metacognitive processing (Barden and Tormala, 2014).

Further Reading

[The effects of activating prior topic and metacognitive knowledge on text comprehension scores](#) (Kostons and van der Werf, 2015)

[Effectiveness of learning strategy instruction on academic performance: A meta-analysis](#) (Donker, De Boer, Kostons, van Ewijk & Van der Werf , 2014)

[A conceptual analysis of five measures of metacognitive monitoring](#) (Schraw, 2009)

[Metacognition and learning: conceptual and methodological considerations](#) (Veenman, Van Hout-Wolters & Afflerbach, 2006)

[The development of two observational tools for assessing metacognition and self-regulated learning in young children](#) (Whitebread et al., 2009)

Metacognitive calibration—An extended conceptualization and potential applications (Pieschl, 2009).

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