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A Conceptual Literature Review of the Memory, Metacognition and their Association

Jaya Shukla*, Ram Manohar Singh**

Abstract

The objective of the study is to gain an understanding of the concept of Metacognition and Memory; and the ways in which it is explained by different researchers. It also aims to explore the relationship between Memory and Metacognition which includes how we monitor our knowledge. Sometimes, our memory system fails to recall the target from it, at that time, metacognitive judgment of Feeling Of Knowing helps the individual to look for target by using different mechanisms namely Trace Access Account and Accessibility Model. Another objective of the study is to consider the impact of Feeling Of Knowing on accuracy of memory performance. An idea about the broad meaning of metacognition was drawn through the consideration of various conceptual definitions given by different researchers. Review was undertaken to comprehend how metacognitive judgments and abilities are understood using memory performance. It was concluded that research is required in the identification of role of contextual information on FOK, to see whether FOK is dependent on the mood of the person at the time of metacognitive judgment and is there any effect of time of encoding on FOK about subject domain information.

Keywords: Memory; Metacognition; Review; Feeling Of Knowing

Over the years, studies in the field of Educational Psychology have been successful in bringing into light several directions to the goal of enhancing and improving the ways in which human beings teach and learn. Educational Psychology has, in recent times, joined hands with Cognitive Psychology. Concepts like perception, motivation, attention, attitudes, thinking, problem-solving, reasoning, and creativity have been important in this 'inter-sub-disciplinary' field of study. One area that has gained attention in contemporary times is the concept of metacognition and its correspondence with the functions of Memory. Metacognition is a prominent concept in education literature, introduced by Flavell in 1979. It is understood asthinking about our own thinking (Nelson &Narens, 1990). We use metacognition in various activities in our daily lives without being aware of it. It is essential in every facet of school and life because it involves self-reflection on one's thought, future goals, strategies and results. We make judgments about our own memory and predict its accuracy in future performance. In the process of being aware about our own memory, components of metacognition like metamemory, Judgment Of Learning and Feeling Of Knowing come into picture (Flavell,1979).

The present study aims to understand the conceptualization of metacognition and memory and to identify the interlink between memory and metacognition through a review of literature.

Method

This study reviews the literature on metacognition and memory and how both concepts are related to each other. The articles published in peer-reviewed journals, and books were selected for review. The articles were searched on Google Scholar and the relevant articles were selected on the basis of language (English), and the availability of full paper. "Metacognition AND Memory", "Metacognition", "Feeling of Knowing AND Memory" were the keywords used for searching the database. Relevant papers were selected on the basis of their titles, keywords, and abstracts.

Result

Metacognition

The term Metacognition comes from the root word meta,meaning "beyond" and cognition meaning "to know". It refers to second-order cognitions such as thoughts about own thoughts, knowledge, or reflections about actions. Thus, perception, comprehension, and memory are the domains of cognition, and metacognition involves thinking of one's own perception, thought process, and memory.

Prior to cognitive actions, three types of metacognitive activities occur: planning, monitoring during an activity, and evaluation after an activity. The terms "Metaperception," "Metacomprehension," and "Metamemory" are used to characterize these cognitions about cognitions, with "Metacognition" serving as the superordinate term. Cognition is necessary to complete a task, and metacognition guides the decision on how to complete it (Schraw, 2001). While cognition is the awareness and comprehension of something, metacognition is the awareness and comprehension of one's own learning process in addition to learning and comprehension of something (Senemoglu, 2005).

The notion of cognitive awareness was initially introduced by ancient philosophers such as Plato, and Aristotle. However, the credit for coining and employing the term "metacognition" in an academic context goes to John Flavell (1976). He derived the term from "metamemory" and defined it as the comprehension of one's own cognitive processes and outcomes. Metacognition refers to the learners' capacity to contemplate their cognitive processes, an umbrella term that includes structures pertaining to an individual's information processing and thought processes (Leader, 2008).

*Senior Research Scholar, Indian Institute of Technology Roorkee, Roorkee, 247667, India, Email: jshukla@hs.iitr.ac.in
**Associate Professor, Humanities and Social Sciences Department, Indian Institute of Technology Roorkee, Roorkee, 247667, India

Metacognition has been developed as main area of research in developmental psychology, experimental psychology and educational psychology. This field is also being investigated in clinical psychology and neuropsychology, which links metacognition to executive processes and pre-frontal brain regions. Research has also established a connection between metacognition and social cognition, as well as behavior and cognition management.

To summarize, metacognition entails organizing strategies prior to task initiation, monitoring learning and comprehension throughout task performance, managing and regulating thought processes, and assessing the task upon completion (Scott, 2008).

Models of metacognition-

Flavell's Classical Model (1979)

Figure 1 presents the classical model of metacognition given by Flavell, 1979.

1. Metacognitive knowledge - Consists of beliefs or knowledge that are retained in long-term memory after being acquired via experience. The stored knowledge is in the form of declarative (knowing that) and procedural knowledge (knowing how). Metacognitive knowledge consists of 3 variables:- person variable, task variable and strategy variable.

Person variable encompasses things that we might believe about ourselves and other people. It is further divided into three categories: universals of cognition, intra-individual differences, and inter-individual differences.

Knowledge on the task's nature and the kinds of processing demands it will impose on the person are included in the task variable. Ex- It is easier to learn the gist of the story than to learn the exact wording of it.Strategy variable includes knowledge about both cognitive and metacognitive strategies and when and where it is appropriate to use such strategies.

2. Metacognitive experience – It is affective or cognitive conscious experience an individual faces while doing any cognitive task.
3. Metacognitive goals –The intended results or objectives of a cognitive endeavour. The objectives and assignments involve understanding, memorizing information, and retrieving specific items, such as a written piece of writing or a solution to a mathematical problem etc.
4. Metacognitive strategies: These are techniques for managing one's cognitive processes and ensuring a cognitive objective has been attained. For example, goals could be finishing a math problem or comprehending a book. Individuals possessing strong metacognitive abilities and awareness employ various techniques to enhance their learning and make appropriate plans.

Memory and its association with metacognition have been a line of research that has gained impetus among researchers.Knowing the boundaries of our own memory is an example of metacognition since it relates to our perception and understanding of memory. Sometimes, we come across situations when someone comes to us and we know his/her name but still we cannot recall. It gives us the feeling that "yes, I know his/her name but cannot recall". This is where metacognition comes into the picture and this feeling is termed feeling of knowing (FOK). The typical metacognitive emotions thoroughly examined in metamemory research are the feeling of knowing, familiarity, and confidence.

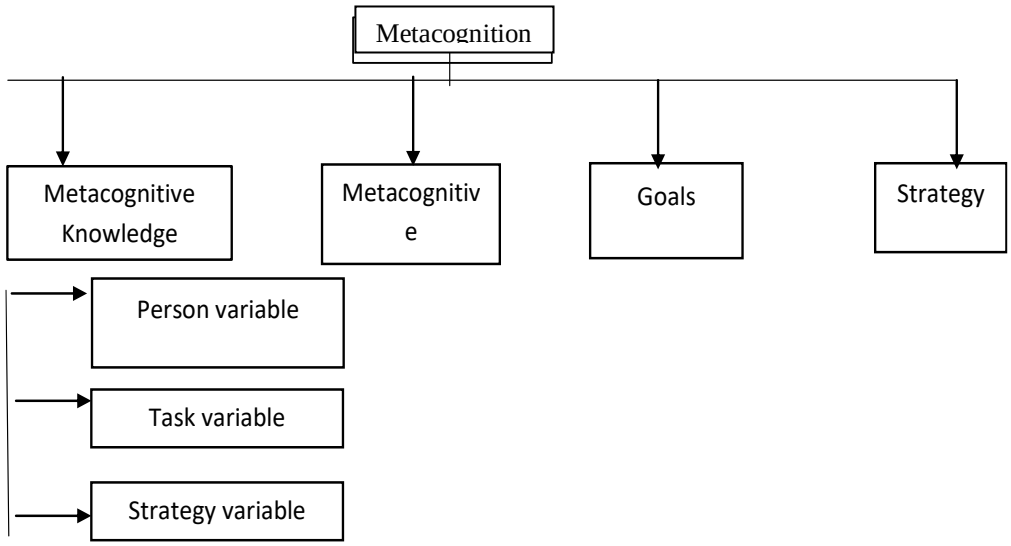

Figure 1: Classical model of metacognition (Flavell, 1979)

Memory

Memory has been defined in various ways. Some researchers have defined it as the storehouse where information is kept; some define it as a mental representation that holds the different experiences the person goes through. Thus, memory refers to the mental processes utilized to gather, organize, and

recall information and integrate it into one's ongoing cognitive processes. Memory is often referred to as dynamic, constructive and about which we are most aware.

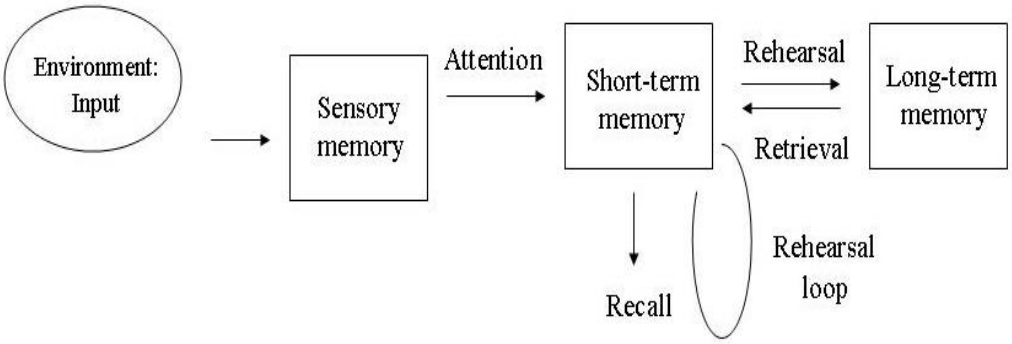

Figure 2: Modal model of Memory (Atkinson & Shiffrin, 1968)

Models of memory-

Numerous scholars have expounded upon the processes involved in memory formation. While some theorists refer to memory systems as processing, others believe many memory systems handle different kinds of information and carry out distinct activities.

Modal model- In 1968, **Atkinson and Shiffrin** proposed that human memory is a system comprised of a series of stores. It explained how memory works and how information is stored in memory. He described components through which information enters into Long Term Memory.

Sensory register- Information from the environment is first admitted into the sensory register to assess if it warrants further examination. Short Term Memory stores the information that is further processed.

Short-Term Memory-Information is stored in short-term memory for less than a minute. At this point, several control mechanisms work to alter data stored in short-term memory. Rehearsing material to transfer knowledge to or from long-term memory is part of this. These are metacognitive control mechanisms.

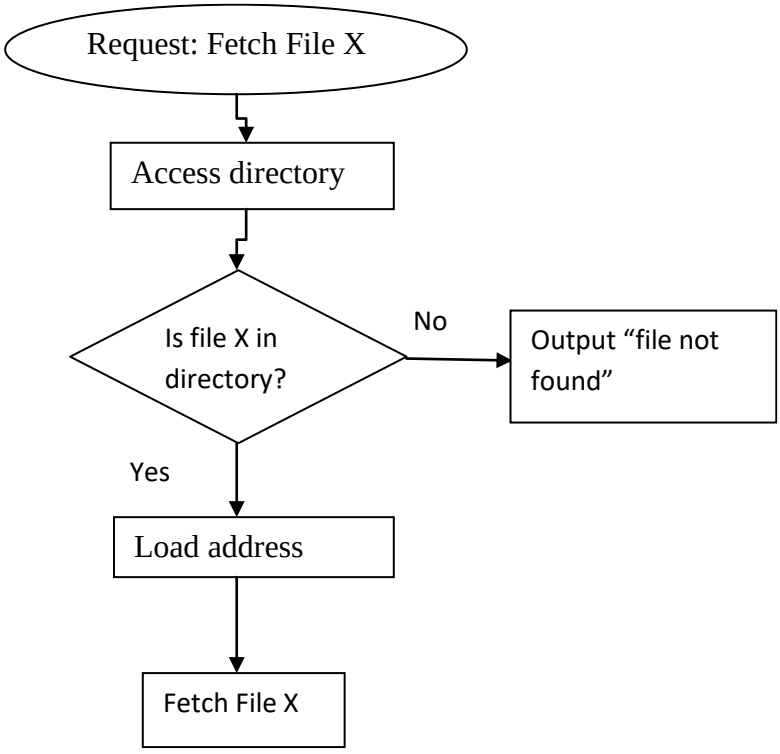

Figure 3: Trace Access Account model by Hart (1965)

Long Term Memory- At the last stage, the attended information enters into Long Term Memory where it is stored for a longer period of time. The pictorial

presentation of the process involved in transferring information is presented in figure 2.

Approaches to study memory-

Various approaches have been used to study memory. Two significant approaches developed by the researchers are- Quantity oriented approach and Accuracy oriented approach (Payne & Blackwell, 1998).

TheQuantity-Oriented Storehouse Conception- This approach emphasizes how much of the items are remembered by the individual. The content of the memory is assumed to be discrete items and measured in terms of the number of recovered units. Using this method, one starts with the input and calculates the amount retrieved in the output. Forgetting is described as an item lost from memory. These features of the list-learning paradigm represent a memory method where memory quantity is the primary focus of research. (Schacter 1989).

The Accuracy-Oriented Correspondence Conception – Correspondence between the individual's narrative and the actual events is the main emphasis of this method (Winograd 1994; Payne & Blackwell 1998). In contrast to the quantity technique, in this case, the subjects are asked to recall the event or specific details after initially witnessing a staged event (Fisher et al., 1994). It emphasizes the reliability or faithfulness of memory, which means things we recall are similar to what happened. The following characteristics were used by Koriat& Goldsmith (1996) to explain a correspondence metaphor of memory:

1. Aboutness: According to Conway (1996), memory is thought to be about past occurrences. Thus, memory retrieval is not just a collection of retrieved objects but a narrative of previous events.
2. Focus on accuracy: The extent to which memory reports are reliable and accurate.
3. Forgetting: The inability to reconcile the memory account with the factual occurrence. Memory distortion may also occur when an individual cannot recall things correctly. Some of the distortions are confabulation, fabrication, simplification etc.
4. Content: Here, the event's content, recalled and misremembered is the main focus (Conway, 1996).
5. Output-boundedness: In a correspondence view of memory, the focus is on the output (such as an eyewitness report), and the output is examined towhat extent it accords with the input (e.g., a witnessed event). This contrasts with a quantity-oriented approach, where the assessment is based on how much information is represented in the output. essentially, one can only evaluate someone's accuracy based on what they report, not what they conceal.
6. Memory as the perception of the past: According to the correspondence viewpoint, memory is seen as how we perceive past experiences, and the accuracy of this perception can vary between being authentic (truthful) or deceptive (Roediger et al., 1996).

Given that the examination of memory accuracy focuses on the content of reported information and encompasses subjective characteristics, the accuracy-oriented approach employs specific dependent measures for memory assessment. This is in contrast to the quantity-oriented approach, which relies on global measures of memory assessment to compare research findings. Consequently, global memory measures are less applicable in accuracy-oriented memory assessment.

Many contemporary studies on memory accuracy incorporate metrics like vividness, perceptual-contextual detail, and other subjective qualities akin to those utilized in imagery research (Conway, 1996; Johnson, 1997; Lampinen et al., 1997). Additionally, metacognitive aspects such as subjective confidence, feelings of familiarity, feelings of knowing, and feelings of recall imminence are also considered in these studies (Benjamin & Bjork, 1996; Koriat& Levy, 1999).

The conception of memory has witnessed a shift from mere reproduction of what has been learned to the more active form of retrieval, where recalling is a deliberate, goal-directed attempt to rebuild or create what has been learnt. There has been a vast amount of accuracy-oriented research emphasising assimilation and integration of information into cognitive structures like schema and later recreating from those structures. Furthermore, a growing body of research has examined how individuals actively participate in the retrieval process and the metacognitive processes related to control and monitoring that underpin accurate memory performance.

Relationship between memory and metacognition

Two characteristics of memory are shown in both laboratory and real-world settings. Initially, the data we recall at any given moment represents only a fraction of our actual knowledge. Tulving and Pearlstone (1966) suggested that the contents stored in memory extend beyond what is immediately accessible. The second characteristic is that memory is not a binary variable (all or none). As a result, we could still remember something about the information even if we could not recover it.

When an individual attends to any information and tries to learn and memorize it, metacognitive judgments come into picture. The individual monitors the likelihood of remembering information and allocating resources for learning material. Memory and metamemory, or the degree to which they assess the current level of knowledge and adjust their time and effort accordingly, are critical components of learning success. People use metamemory to determine if a piece of information is in their memory. They put effort into retrieving the material based on their feeling of knowing.

Feeling of knowing and judgment of learning are two important aspects of metacognition related to memory. Various research on metacognitive judgments reveals that we sometimeswithhold certain information from reporting when unsure about its accuracy. Therefore, the correctness of a report depends not only on memory recall accuracy but also on an individual's ability to manage his reporting and distinguish between accurate and inaccurate cues regarding the event being recalled. Various studies regarding metacognitive judgments have revealed that people can accurately monitor their memory. Sometimes, we come across a situation when we cannot recall something at that point in time, but when we are provided with options, we easily recognize the correct answer. This phenomenon explains a positive correlation between the judgment of feeling of knowing and performance in recognition. Nelson and Gerler (1984) described feeling of knowing as based on two sources of information – **Domain-specific knowledge and Subjective experience**.

Domain specific knowledge is often described as a judgment of knowing in which the person,based on his information, engages in effortful thinking. It is an information-based judgment in which he relies on educated guesses. It is based on an inferential and analytic mechanism, which means the person analyses different types of information and then judges whether the target is available in memory.

Subjective experience is often described as the feeling of knowing because, here, the person engages in a heuristic way of problem-solving. It relies on nonanalytic inferences.

We provide two types of information for an unrecallable target. The first judgment is the Feeling of Knowing (FOK) judgment, which expresses our subjective opinion that we have enough knowledge of the target to remember or identify it in the future. The second is general or incomplete target information. Example: We might be able to identify someone's voice even if we cannot remember their name. Partial information and the feeling of knowing are usually accurate. Feeling of Knowing is reliable for estimating the future memory accuracy of the target or distinguishing it from distractions (Nelson &Narens, 1990; Schacter, 1997; Hart, 1965).

According to research by Brown and McNeill (1966), information that is remembered when in the tip-of-the-tongue (TOT) condition is typically accurate, even when it is incomplete. Consequently, participants may sometimes make guesses about various elements of the inaccessible word, such as its initial letter or the number of syllables. The subjective belief that I know the answer and the objective inability to find it are combined in memory blockage states like TOT and FOK.

Association between the Feeling OfKnowing and memory

We can occasionally evaluate two different kinds of knowledge on a target, even when we cannot recollect it. We first form a FOK judgment, which denotes that we have subjective knowledge of the target's existence in memory. Second, our knowledge about the target can be partial. There are two approaches to understanding how we know that we know the answer but cannot retrieve it **– The Trace access account approach and the Accessibility account approach.**

Trace access account-

This model explains the basis of FOK judgments and their accuracy. It was proposed by Hart in 1965. This approach is associated with recall aspect of memory, where we try to judge whether the target is available in memory. According to this approach, a unique memory monitoring module must identify the target in the store by itself. As a result, the monitoring module is triggered anytime someone tries to recall a target. It then verifies that the target is in store before attempting to retrieve it. Thus, this module saves time and effort while searching for a target not in the store. This approach is analogous to computer directories. Two basic assumptions of the trace access modelare:

1. The presence of a unique monitoring module that enables immediate identification of the target's presence in memory storage.
2. It is a two-stage process where monitoring precedes retrieval.

The procedure that the memory monitoring module follows is depicted in figure 3. Initially, the directory checks to see if the file name is present. The computer may respond with "file not found" or "I do not know" if the name cannot be discovered. No further search for the target occurs when this response is made.

In 1990, Nelson and Naren reported that when the initial FOK is high, we search for a target for a longer period of time than when it is low. According to this concept, if FOK observes a trace in memory directly, it is a reliable indicator of actual memory performance.

Accessibility account model –

This model was given by Koriat (1977). According to this model, various clues come to our mind when we try to retrieve any information. Clues can include bits and pieces of the target, semantic characteristics, episodic information, and other types of information. When these clues are clubbed, we have a subjective feeling that the target is there and can be recalled. Thus, positive FOK is generated. This approach is associated with the recognition aspect of memory, where we try to recognize the target with the help of clues that come to mind. While some clues come from outside sources and are referred to as inaccurate partial information, others are generated by the target and are called correct partial information. Clues that are both right and wrong improve the FOK.

The fundamental premise of the model is that whether or not incomplete information is accurate, FOK is

dependent upon its accessibility. There are two components to accessibility: the quantity of information that can be found and its intensity, or how quickly clues can be thought of. It is predicted that when correct and incorrect partial information becomes more accessible, FOK increases. Subjects cannot independently verify the accuracy of partial information because they are not aware of the difference between accurate and inaccurate partial information. Because of this, only the information's general accessibility is considered.

An extensive understanding of FOK can be obtained by memory pointer analysis. Memory pointers are any cues that include word definition questions intended to specify a particular memory whose retrieval is called for. When an individual is presented with a pointer such as word definition, he/she responds in any of the three ways: s/he knows the target word and can provide it, s/he is unable to reproduce the target immediately but has a feeling that s/he knows the target (TOT) or that s/he does not1. know the target word. Research shows that individuals reporting a TOT state had a higher FOK than those reporting a "Do not know" state because they are more successful in collecting accurate partial information. It also implied that people's subjective assessments track the accuracy of the information2. they retrieve (Koriat&Lieblich, 1977).

Thus, Feeling Of Knowing has a tremendous effect on memory performance and this is the reason why research in contemporary times has been directed3. towards assessment of metacognitive judgment and its accuracy by using memory performance tests.

Inferences drawn from student performance observations, student interviews, or self-report questionnaires are used to evaluate metacognitive skills. Two main methods are used to do this: employing self-report inventories and monitoring student performance on cognitively demanding tasks. The labour-intensive nature of the observation technique, which involves meticulously observing and documenting students' learning and grading the observations for metacognition, limits the number of study participants (Schraw &Impara, 2000). Self-report scales of metacognition are inexpensive to develop and score but possess a threat to validity. When students are asked to self-assess their metacognitive processes while learning, their introspection might be inaccurate, and they might be reluctant to admit their ineffective metacognitive skills. So, honesty and judgment accuracyare always issues with self-report measures (Tobias,2006).

Researchers focus on the differences between students' knowledge and ignorance in various academic areas. These studies are carried out to determine whether students can use more advanced metacognitive strategies, such as evaluating their learning and using effective learning strategies to enhance their learning if they cannot distinguish between what they already know and what they do not know.

In order to determine the accuracy of knowledge monitoring, Tobias and Everson (2002) compared the accuracy of students' metacognitive estimations with their performance on subsequent tests. They were first presented with an academic task consisting of mathematical word problems and asked to estimate whether they knew the material presented. After making the estimates, they were given multiple-choice questions on the same content and were asked to solve them. The findings indicated that pupils who possessed more metacognitive skills—those who could accurately check their knowledge—also demonstrated higher levels of success. This measurement approach is widely used in metamemoryresearch.

After going through the existing conceptual as well as review literature, specific research questions have been formulated:-

What is the role of contextual information on FOK? If one group of students is provided with contextual information and another with non-contextual information and later at the time of recall, will metacognitive judgment about the target be influenced by the type of information?

Is FOK dependent on the person's mood at the time of judgment? It has been found that when people are in a good mood, their FOK tends to be higher (Sidi et.al., 2018). So, what is the underlying mechanism for this?

Is there any effect of time of encoding on FOK judgement on different subject domains? If the time of encoding is kept as morning, post lunch and evening and different subjects are taught at different times, so is there any effect of encoding time on FOK about subject knowledge?

Conclusion

This paper aimed to enhance the fundamental understanding of Metacognition and Memory as separate phenomena and how both are linked with each other. The amount of information or accuracy of knowledge that we convey from memory is dependent not only on memory processes but also on the functioning of metacognitive monitoring and control systems that govern memory reporting. However,the Feeling Of Knowing is not related to actual knowing but turns out to be accurate while recognizing the actual target. There has been a rapid increase in the studies concerning metacognition in the academic field, and attempts are being made to understand the nitty-gritty of metacognition and how metacognitive abilities can be enhanced in students. Factors known to affect memory, such as mood, context, and motivation, also affect metacognitive judgment. Research is required to have a deeper understanding of these factors and their influence on metacognitive judgment.

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