The Intriguing Case of Metacognition: Theory Development from Origins to Future Research Trends

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Abstract

Metacognition has become an increasingly important field of study in recent years, as researchers seek to better understand the complex processes involved in thinking, learning, and problem-solving. While much progress has taken place in developing theories of metacognition, there are still many unanswered questions and areas in need of further exploration. This paper examines the dynamic course of Metacognition from its origins to Theory - at the intersection of 5 fields (literature, philosophy, psychology, neurosciences, and education); to some of the current trends in Metacognition Theory development and explores potential future directions for research in this area. Consequently, this study regards the trajectory of metacognition, from its historical origins to a conceptual construct, to its future research trends.

Keywords

Education, Literature, Metacognition, Neuroscience, Philosophy, Psychology, Research Trends, Theory Development.

INTRODUCTION

Metacognition, the process of reflecting on one's cognition, has a long and varied history. The concept was first introduced in the 1970s by researchers in the field of cognitive psychology [1]. Now, it's commonly summarized as the broader concept of "thinking about thinking. However, the origins of the idea of thinking about thinking can be found back to ancient Greek philosophy, indicating that its roots extend far into the past. Over the years, the preoccupation with the metacognition course of study has found itself at the intersection of fields such as philosophy, literature, psychology, neuroscience, and education, offering a fascinating insight into the human mind and its capacity for self-reflection and self-awareness. At the same time, each of these disciplines has contributed to our understanding of the complex phenomenon of metacognition, emphasizing different aspects of human experience and development.

The history of metacognition can be traced back to ancient Greece, where philosophers like Socrates and Plato emphasized the importance of self-knowledge and introspection [2]. During the Middle Ages, the concept of "conscience" was developed, which referred to a person's ability to reflect on their moral behavior [3]. Therefore, philosophy has long been concerned with the nature of knowledge and the relationship between the knower and the known. Literature, on the other hand, has explored the influence of metacognition in the construction of meaning and how humans engage with life. Metacognition has also been studied extensively in psychology, where it is viewed as a critical aspect of self-regulated learning [4]. Neuroscience studies have unequivocally identified brain regions involved in metacognitive processes [5]. But in addition, these investigations have contradicted the postulates of philosophy by showing that metacognition is not an exclusively human trait and that some animals also exhibit metacognitive abilities [6].

Finally, professors realized the implication of metacognition in the educational process and have started incorporating it into their pedagogies, making it a significant instrument for continuous learning abilities and thus articulating even more the path of metacognition from an abstract concept up to an applied model [7].

In essence, metacognition has a rich and diverse history that spans multiple disciplines such as philosophy, literature, psychology, neuroscience, and education. From ancient Greek philosophy to modern neuroscience, the concept of thinking about one's thinking has been widely studied and has provided valuable insights into the human mind and its capacity for self-awareness, self-reflection, and ultimately self-improvement. Furthermore, if education is the arena for all these domains, then incorporating metacognitive strategies into education has the potential to improve learning outcomes and equip individuals with valuable lifelong learning skills.

The ensuing discourse entails an explorative inquiry of the topic, in which we scrutinize its various aspects and approach it from a comprehensive standpoint, to acquire a deeper understanding of how this concept realized its evolution.

ORIGINS OF METACOGNITION AS A CONSTRUCT

Metacognition was first introduced as a term by James Flavell in 1979 and refers to the ability to observe, monitor and control one's cognition [1]. Since then, Metacognition has

become a construct for several fields, including philosophy, literature, psychology, neuroscience, and education. The development of the theory of metacognition has undergone numerous phases in each of these domains. *In philosophy*, metacognition is discussed in the context of epistemology, the study of knowledge. Metacognition is seen as an important aspect of knowing, as it allows individuals to reflect on and evaluate their cognitive processes. *In literature*, metacognition is often explored through the use of metafiction or fiction that is self-aware. Metafiction often involves characters who are aware that they are in a fictional world, and who can reflect on their thoughts and actions. For example, the character of Tristram Shandy in Laurence Sterne's novel of the same name is constantly interrupting his own story to reflect on the process of storytelling itself [8]. *In psychology*, metacognition theory has evolved from early observations of children's ability to reflect on their thoughts and experiences, and it was the field where, due to extensive empirical investigations, theory development benefited from the accumulation of a considerable body of research hence contributing to a refined understanding of the concept of metacognition. *In neurology*, research has focused on the neural processes involved in metacognition, with investigations analyzing the brain regions and networks that underlie metacognitive abilities. *In education*, the concept of metacognition has been applied to promote self-directed learning, with research exploring ways to improve students' metacognitive skills through training and instruction. The process that materialized metacognition in the direction of becoming a theory, involved phases and resources from each of these domains. Starting with - the definition of the concept and developing a theoretical framework, identifying different types of metacognitive processes and components, exploring the neural basis of metacognition, and finally examining the practical applications of metacognition along with measuring and assessing this complex concept.

While each of these fields has a unique approach to the study of metacognition, the concept remains a critical area of inquiry with far-reaching implications for understanding human cognition, learning, and cognitive improvement.

FROM CONCEPT TO THEORY

The process of declaring a concept as a theory is an iterative and complex one that requires multiple stages of observation, formulation, testing, and refinement [9]. This process is crucial in establishing a reliable body of knowledge that can explain and predict phenomena in a particular field of study. *The first stage* of this process involves the observation and identification of patterns and regularities in data from various sources, such as empirical observations, experimental results, and theoretical models [10]. In the case of metacognition, Flavell's initial observations of children's ability to reflect on their thoughts and experiences led to the development of the concept of metacognition in 1979. *The next stage* involves the formulation of hypotheses to explain the observed patterns, which are tentative explanations that

are subject to testing through empirical research [11]. In the case of metacognition, the formulation of hypotheses involved the development of a theoretical framework that could explain how individuals observe, monitor, and control their own cognitive processes [12]. *Once hypotheses have been formulated*, they are tested through empirical research, which involves designing experiments that can provide evidence to support or refute the hypotheses [13]. In the case of metacognition, extensive empirical investigations were conducted in psychology to test different aspects of the theoretical framework, leading to the accumulation of a considerable body of research that contributed to a refined understanding of the concept of metacognition [14] *If the hypotheses are supported by evidence*, they can be considered as a theory, which is a set of concepts, principles, and laws that provide a framework for understanding a particular phenomenon [15]. In the case of metacognition, the accumulation of empirical evidence led to the development of a comprehensive theory that could explain the different types of metacognitive processes and components [1]. *The final stages* of the process involve refining and extending the theory, exploring its practical applications, and measuring and assessing the concept [16]. In the case of metacognition, research in neuroscience has explored the neural processes involved in metacognition, while research in education has applied the concept to promote self-directed learning [17].

In conclusion, declaring a concept as a theory involves multiple stages of observation, formulation, testing, and refinement. It requires the accumulation of empirical evidence and the development of a comprehensive theoretical framework that can explain the phenomenon under investigation. The development of the Theory of Metacognition serves as an example of how this process can be applied in practice to establish a knowledge corpus that can be reliably used to explain and predict phenomena in a particular field of study.

THE ORIGINS OF PHILOSOPHY

Philosophers have long been interested in the phenomenon of self-awareness, with metacognition playing a central role in philosophical theories of the self, even if the term metacognition was of course not yet articulated. Philosophers such as Rene Descartes [18] [19], Immanuel Kant [20] [21], and Jean-Paul Sartre [22] have all explored the emergent nature of self-consciousness and its relationship to human existential experience. The ancient Greeks were some of the first to explore the concept of what would come to be called metacognition. Socrates, for example, was known for his emphasis on self-reflection and self-awareness. He believed that true knowledge came from an understanding of oneself and one's limitations [23]. Plato, the student of Socrates, developed the concept of the "examined life," arguing that individuals should reflect on their thoughts and beliefs to gain a deeper understanding of themselves and the world around them [24]. Aristotle developed the concept that over time would be called "metacognition" through his exploration of

epistemology, the study of knowledge. He believed that self-awareness and reflection were essential to gaining knowledge and understanding. In his work "Metaphysics," [25] Aristotle argued that knowledge of oneself was the fundamental component of human knowledge. During the Enlightenment period in Europe, philosophers continued to explore the concept of metacognition. René Descartes, the French philosopher, famously declared "Cogito, ergo sum" ("I think, therefore I am"), emphasizing the importance of self-awareness and reflection [26]. Immanuel Kant, likewise, developed the concept of the "transcendental self", arguing that self-awareness and reflection were essential to understanding our place in the world [27]. In more contemporary philosophy, Daniel Dennett and John Searle have offered unique insights into the nature of metacognition and its role in shaping our understanding of the world [28] [29].

Today, developing metacognitive skills is recognized as a crucial component of personal success, as individuals who can reflect on their thinking are better equipped to navigate the complexities of the world and achieve their goals, both as individuals and especially as social beings. The legacy of metacognition in philosophy and its practical applications in personal and educational contexts continue to make it a topic of great interest and importance.

THE ORIGINS IN LITERATURE

The concept of self-awareness and reflection in literature has been explored for centuries, with metacognition often portrayed as a means for characters to gain insight into their thoughts and emotions, leading to self-discovery and personal growth [30]. Shakespeare's Hamlet [31] and Virginia Woolf's Mrs. Dalloway [32] are works that explore the intricacies of self-awareness and how it shapes our understanding of ourselves and the world around us). In Woolf's novel, the protagonist engages in metacognitive processes throughout the story, reflecting on her past, her relationships, and her sense of self, leading to a deeper understanding of her motivations. Similarly, T.S. Eliot's poem "The Love Song of J. Alfred Prufrock" [33] portrays the speaker engaging in self-questioning and self-monitoring, becoming aware of his insecurities and limitations through the process. In Shakespeare's Hamlet, the protagonist engages in metacognitive processes by reflecting on his thoughts and feelings, leading to an awareness of his inner turmoil and motivations [31]. J.D. Salinger's "The Catcher in the Rye" also explores self-evaluation, with the protagonist reflecting on his sense of self, relationships with others, and place in the world [34]. Finally, to cite a last illustrative example from the vast corpus of literature that could serve as a scholarly reference, Charlotte Perkins Gilman's short story "The Yellow Wallpaper" [35] depicts the protagonist engaging in self-questioning and self-monitoring, becoming aware of her mental health struggles and the impact of patriarchal norms on women's lives.

Perhaps without intention for its functional significance or nomenclature, metacognition is a powerful theme in literature, allowing authors to explore the human psyche and the complexities of our thoughts and emotions through characters' internal monologues, self-questioning, self-monitoring, and self-evaluation, thereby providing readers with a deeper engagement with the text and with themselves [36].

THE ORIGINS OF PSYCHOLOGY

Starting with the 1900s, new fields, such as psychology, were interested in studying our thinking mechanisms. The evolution of modern metacognition research finds its origins in the realms of cognitive psychology, cognitive developmental psychology, and social developmental psychology [37]. Researchers such as John Flavell [1] and Lev Vygotsky [38] developed theoretical frameworks that emphasized the importance of self-awareness, monitoring, and critical self-reflection.

At the beginning of this era, the concept of metacognition emerged as an autonomous field of study. And so, due to its pivotal role in establishing and developing the concept theory, this field will be afforded significant attention.

The emergence of the concept of metacognition in cognitive psychology can be traced back to 1979 when Flavell published his work "Metacognition and Cognitive Monitoring." This set the stage for subsequent developments in the field, such as the theoretical framework proposed by Nelson and Narens in their article "Metamemory: A Theoretical Framework and New Findings".

Later, researchers turned their attention towards developing measurement tools to better understand metacognitive processes. This led to the development of techniques such as confidence ratings [39] [40] and judgments of learning [41] [42] [43]. In recent years, there has been a growing interest in understanding the neural basis of metacognition. In 2012, Fleming and Dolan [5] identified specific brain regions involved in metacognitive processes. Duell and Schommer-Aikins [44] highlighted the influence of individual beliefs about learning on metacognitive processes . Recently, in 2018, Jordano and Touron, found that individuals who are more accurate at monitoring their learning tend to perform better on memory tasks [45]. While this overview provides only a glimpse into the extensive body of research on metacognition, it highlights the significant contributions that have been made to Theory Development for this concept. Researchers have thoroughly investigated metacognition concerning learning and cognitive development. Metacognition proved itself to be closely linked to other cognitive processes, including memory and attention, highlighting its importance for overall cognitive functioning [46]. In the 1950s and 1960s, early theories of cognitive psychology placed great importance on metacognition when it came to learning and memory. Figures such as Jean Piaget [47] and Lev Vygotsky [38] formulated theories of cognitive development that highlighted the

importance of self-awareness, monitoring, and evaluation in learning and problem-solving. As the 1970s and 1980s wore on, new theories of metacognition began to emerge. John Flavell [1] and David B. Resnick [48] were among the researchers who focused on the thinking process itself. Flavell defined metacognition as "knowledge and beliefs about cognitive phenomena," while Resnick emphasized the importance of metacognitive strategies such as planning, monitoring, and evaluating in achieving success. During the 1990s, there was a growing interest among psychologists in exploring the connection that exists between metacognition and academic achievement, which led to the emergence of a new field of study for metacognition: education. Researchers, including Brown et al. [49] and Dunlosky & Metcalfe [50], discovered that students who were instructed on metacognitive strategies, such as self-monitoring and self-evaluation, had a better ability to learn and retain information. However, psychology's effective main exploration of metacognition was in the area of the Theory of Mind. The relationship between Metacognition and Theory of Mind was discovered to be two interdependent cognitive concepts that involve the ability to understand and regulate one's own and others' mental processes [51].

The intricate and multidimensional association between the cognitive processes of metacognition and the theory of mind (ToM) earned major attention in the field of psychology. ToM, being a higher-order cognitive function, plays a crucial role in fostering the development of metacognition by facilitating the understanding of the cognitive or emotional state of other individuals. As an example, individuals who can acknowledge their friend's distraction due to a problem are more likely to regulate their attention and avoid distractions [1] [48]. Furthermore, studies have indicated a positive correlation between ToM and metacognition [52]. Evidence can be attributed to the fact that both these cognitive processes share aspects such as self-reflection, perspective-taking, and mental state attribution [53] [54].

Metacognition continues to be a subject of interest to psychologists, with studies exploring its relationship with learning, memory, and problem-solving, and devising strategies to improve metacognitive skills across all ages [50].

In recent years, in addition to the confluence between cognitive psychology and education, the link between metacognition and mental health has become a new focal point of research. Studies have demonstrated that individuals suffering from depression and anxiety often face challenges in metacognition, including negative thoughts and beliefs regarding their cognitive processes [55] [56].

THE ORIGINS OF NEUROSCIENCES

Neuroscience has not made metacognition itself visible, but it has provided a way to observe and study the neural activity that underlies this abstract process, advancing our understanding of how we think our think. Moreover, some neuroscientists argue that metacognition is a key component of conscious awareness, as it involves the ability to reflect on and monitor one's mental processes [5]. By studying the neural correlates of metacognitive processes, researchers can gain a better understanding of the neural mechanisms underlying conscious awareness and self-awareness.

But it was not only the evidence confirming metacognitive concepts and mechanisms that helped neuroscience develop the construct theory of metacognition. Neuroscience has challenged the notion that metacognition is a uniquely human ability. Studies have demonstrated that animals, including pigeons, monkeys, and rats, possess metacognitive abilities, such as monitoring their memory and adjusting their behavior based on this information. For instance, research has shown that monkeys can monitor their performance on memory tasks and adjust their behavior accordingly. Similarly, Dolphins showed varying behaviors that indicated their awareness or uncertainty about their own cognitive states [6] [57]. Rats can also recognize when they do not know the answer to a question and quit the task rather than guessing randomly [58]. However, Pigeons do not exhibited metacognitive skills by monitoring their uncertainty when presented with a memory task [59] [60]. These findings contradict the traditional philosophical view that humans are the only "thinking reed", implying that humans are unique in their ability to think about their thinking. Therefore, neuroscience research suggests that metacognition is not exclusive to humans, but rather a cognitive process shared by other animals, suggesting that other species have similar cognitive abilities.

THE ORIGINS OF EDUCATION

Metacognition was first introduced to the field of education in the 1980s, where it quickly became a crucial concept in the study of learning. Initially, it was viewed as a learning strategy and was incorporated into teaching practices. But as research progressed, teachers recognized metacognition as an essential component of the effective learning process and not just a simple strategy [4]. In the 1990s and 2000s, there was a growing interest in metacognition as a means of promoting higher-order thought processes as well as problem-solving skills. Researchers have explored the relationship between metacognition and other cognitive processes, such as critical thinking and decision-making, and how metacognition can be developed and subsequently integrated into different educational domains and contexts [61] [62].

Today, metacognition is widely recognized as a key aspect of learning and teaching in both formal and non/informal educational settings. It has become a fundamental component of learning strategies and attempts are being made to integrate it into various curricula and teaching practices at various levels of education [63]. In addition, to further highlight the intersection between the areas discussed, advances in neuroscience have provided insights into the neural mechanisms underlying metacognition, leading to further research on how this knowledge can be applied in education to improve learning outcomes [50].

In conclusion, metacognition has come a long way since its introduction into the field of education. It has gone from being seen as a mere learning strategy to being recognized as an essential component of effective learning. This recognition has led to its integration into various fields and educational contexts, and further research is being conducted on its application to improve learning outcomes.

CURRENT STATUS OF METACOGNITION THEORY

We have thus far traced how the interdisciplinary nature of metacognition theory has been shaped by contributions from several fields, focusing in the present study on 5 fields: philosophy, literature, psychology, neuroscience, and education. We saw that the philosophical perspective provided a conceptual framework for understanding the nature of metacognition, its relationship to cognition, and its role in human development. Literature has provided insights into the workings of the human mind and the importance of self-awareness and self-reflection [30] [64]. Psychology has been instrumental in identifying types of metacognitive processes and has also facilitated the concretization of a concept theory [14]. Neuroscience has contributed to the visible translation of metacognition but also by demolishing some entrenched beliefs [5]. Eventually, education recognized the importance of metacognition in learning and began to incorporate it into teaching practices, leading to the development of practical applications of metacognition theory [65] [66].

Through the contributions of these fields, metacognition theory has been refined and expanded, and its practical applications have been identified and implemented in a variety of contexts.

FUTURE TRENDS AND PROSPECTS

There have already been several theories that explain in depth the concept of metacognition. The most widely accepted theory is the Three-Component Model of Metacognition [1]. According to this theory, metacognition is composed of three components: knowledge, monitoring, and control. Accordingly, knowledge refers to what an individual knows about themselves, the needed strategies, and the task they are trying to complete. Monitoring involves the ability to assess one's performance, and control refers to the ability to evaluate and regulate one's thinking and behavior.

While the Three-Component Model of Metacognition is widely accepted, there are still gaps in our understanding of the concept. For example, there is a need for further research to explore the relationship between metacognition and motivation [67]. Additionally, there is a need for a more comprehensive understanding of the development of metacognition, including how it develops across different age groups and cultural contexts [68]. Also, by now metacognition research has made significant progress in identifying the components of metacognition, such as metacognitive knowledge, metacognitive regulation, and metacognitive experiences. However, the integration of these components into a comprehensive theory of metacognition remains a challenge. Additionally, the measurement of metacognition remains a critical issue, with the need for more precise and standardized measures. Therefore, let us finally turn our attention to considering the prospects of this concept.

Actual Trends in Metacognition Research:

- Exploring the impact of metacognitive interventions on educational outcomes: A current trend in metacognition research analyzes the effects of interventions aimed at improving individuals' metacognitive skills on educational outcomes. Researchers prove that incorporating metacognitive strategies into teaching can have a positive impact on student's academic success [69] [70]. Additionally, studies have suggested that for students with learning disabilities, such as those with ADHD or dyslexia, metacognitive interventions can help [71] [72] [73]. The exploration of the impact of metacognitive interventions on educational outcomes is important because it helps educators and researchers to better understand the effectiveness of different metacognitive strategies and interventions in improving learning outcomes. This knowledge can then be used to develop more targeted and effective teaching approaches that incorporate metacognitive strategies to support students' learning and academic success. Ultimately, improving educational outcomes through metacognitive interventions can have a positive impact on individuals' personal and professional lives, as well as on broader societal outcomes such as economic growth and social development.

- Exploring the metacognitive processes in online learning contexts: With the rise of online and hybrid learning, it is important to analyze if metacognitive mechanisms may differ in these environments compared to traditional face-to-face learning. For example, a recent study found that students who engaged in self-regulated learning behaviors such as planning and monitoring had better outcomes in online courses [74] [75]. This highlights the importance of metacognitive mechanics in the online learning context and the need for further exploration in this area.

- Exploring metacognition in the context of interdisciplinary learning: A third obvious direction for improving metacognition theory turns out to be metacognition in the context of interdisciplinary learning. Many current educational programs are designed to be interdisciplinary, emphasizing the simultaneous processing of information from different fields. Because metacognition empowers the skills needed to "learn to learn," it can play a crucial role in facilitating interdisciplinary learning by helping learners make connections between different concepts and fields of study [76].

- Exploring the metacognition of non-traditional students: Another potential area for theory development is the mechanisms of metacognition to non-traditional

learners, such as adult learners and learners with special needs. Adult learners may have different metacognitive needs and experiences compared to traditional school or college students, and understanding these differences can inform new educational practices [77]. Developing theory in these areas can lead to more diverse and effective educational practices.

- Exploring the integration of technology in the thinking and learning processes: This presents numerous possibilities for advancing the Theory of Metacognition. Because adaptive learning technologies, for example, can provide learners with personalized feedback and assistance to improve their metacognitive processes [78]. In addition, virtual and augmented reality technologies offer learners learning opportunities that cannot be easily achieved by traditional teachers. They are interactive and encourage metacognitive engagement [79]. Investigating the use of technology in metacognition research can accordingly provide new insights into how to appropriately create tools that address metacognition in truly effective ways.

MISSING LINKS FOR THE DEVELOPMENT OF THE THEORY OF METACOGNITION

- An area that does not benefit from the necessary exploration is the role of culture in metacognitive processes. Because current research on metacognition is based on data from applied studies on Western cultures, little is known about the impact of cultural differences on metacognitive processes. There is a need to investigate how cultural factors such as values, norms, and beliefs influence metacognition and how these processes differ across cultures. A quick example would be that in collectivistic cultures, individuals may be more likely to rely on external sources of feedback and prioritize social comparison over self-evaluation [80]. Future research should aim to investigate these cultural differences and their implications for metacognition.

- The missing links also exist in the research areas exploring the role of motivation in metacognition. Although numerous studies have demonstrated that metacognition plays a crucial role in self-regulated learning, very limited research has been conducted on the impact of motivation on metacognitive processes. More specifically, metacognitive strategies become effective as individuals are more motivated to engage in metacognitive monitoring and control when they are intrinsically interested in the task at hand [81]. To improve learning experiences, future studies should explore the dynamic interplay between metacognition and motivation and how this relationship can be optimized.

- A third missing link in metacognition research is the development of more sophisticated measurement tools. While there are several self/report measures of metacognition, for example, these measures have limitations, such as social desirability bias and reliance on introspection [67]. Advances in technology and neuroscience have the potential to provide more objective and accurate measures of metacognition. For example, eye-tracking technology can be used to measure how individuals allocate attention during a task, providing insights into metacognitive monitoring processes [82]. Neuroimaging techniques, such as functional magnetic resonance imaging (fMRI), can be used to examine the neural correlates of metacognitive processes [5]. Future research should aim to develop and validate new measurement tools that are more accurate and reliable.

- A fourth deficient aspect in the theory of metacognition lies in its interrelationship with other domains, including emotion regulation and decision-making mechanisms in humans. Although some research has explored the intersection between metacognition and these fields, it remains inadequate, and further investigation is needed. Research in this area has demonstrated that metacognition can influence emotion regulation, and individuals who possess better skills in regulating their emotions can effectively monitor their thoughts [83]. Likewise, metacognitive mechanisms are involved in conscious decision-making, and individuals who possess a heightened awareness of their cognitive processes may make more informed decisions [84]. To address this gap, future research endeavors should focus on integrating metacognition with these domains and examining their interplay.

CONCLUSION

In conclusion, even if in recent times, metacognition as a concept, is placed mostly in the educational field, it has been a component across various fields such as philosophy, literature, psychology, and neuroscience. A comprehensive overview of the various stages of the development of metacognition, from its origins to the current state of research is presented in Table 1 (ANNEX). Additionally, Table 1 explores potential future research trends for metacognition.

The idea of thinking about one's thinking has been traced back to ancient Greek philosophy and has evolved into a critical aspect of self-regulated learning, self-awareness, and ultimately self-improvement. But the concept of metacognition first emerged in psychology, with Flavell's initial observations of children's ability to reflect on their thoughts and experiences in 1979. Philosophical theories and literary analysis were not directly involved in this initial stage. However, these fields can contribute to the formulation of hypotheses and the development of a theoretical framework. Empirical investigations were conducted in psychology to test different aspects of the theoretical framework of metacognition. Neuroscience research can also provide evidence to support or refute hypotheses, while educational research can provide evidence to support or contradict hypotheses and contribute to the development of a

theory. The accumulation of empirical evidence led to the development of a comprehensive theory that could explain the different types of metacognitive processes and components. As the theory of metacognition continued to develop, further empirical investigations, refinement, and extension of the theory were carried out in psychology, neuroscience, and education. Practical applications of metacognition were also explored, such as using metacognition to improve learning and problem-solving, decision-making, and promote self-directed learning. Looking to the future, philosophical theories can influence future research trends, while literary analysis and criticism can also provide insights and feedback on future research trends. In psychology, future research trends may include investigating the relationship between metacognition and other cognitive processes. Future research trends in neuroscience may include exploring the neural mechanisms underlying metacognitive processes. Educational research may continue to explore practical applications of metacognition, such as how metacognition can be practically measured, and how metacognitive interventions can improve academic performance and student outcomes.

In conclusion, Table 1 presents a comprehensive overview of the evolution of metacognition from its inception as an idea to its current status as a well-established theory and potential future research trends. As research continues to progress in this field, it will be interesting to see how metacognition continues to be studied and applied in a variety of settings.

While much progress has been made in developing Theories of Metacognition, there are still many unanswered questions and areas in need of further exploration. The dynamic course from the origins of metacognition to its current state has been a fascinating journey, and future research should aim to integrate and explore the interaction between different domains, such as emotion regulation, decision-making, and precisely: education. The incorporation of metacognitive strategies into education has the potential to improve learning outcomes and equip individuals with valuable lifelong learning skills. Therefore, it is essential to continue to investigate and develop the concept of metacognition to enhance our understanding of its potential applications and impact on human cognition and behavior.

Overall, this study has provided a necessary inquiry into the topic of metacognition, offering a comprehensive understanding of its history in theory development, as necessary future directions in need for research. Metacognition is a complex phenomenon, and its investigation continues to require a multidisciplinary approach to fully understand its nature and implications.

As such, further research is needed to continue building upon the interdisciplinary foundations and to expand the knowledge of this critical aspect of cognition.

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ANNEX

Table 1. The Trajectory of Metacognition: Origins, Development, and Emerging Research Trends

The Development of Theory	Philosophy	Literature	Psychology	Neurosciences	Education
1. Origins of the Construct	No direct involvement in this stage.	No direct involvement in this stage.	Flavell's initial observations of children's ability to reflect on their thoughts and experiences led to the development of the concept of metacognition in 1976.	No direct involvement in this stage.	No direct involvement in this stage.
2. Formulating Hypotheses	Philosophical theories contributed to the formulation of hypotheses.	Literary analysis and criticism contributed to the formulation of hypotheses.	The formulation of hypotheses involved the development of a theoretical framework that could explain how individuals observe, monitor, and control their own cognitive processes.	Neuroscience research contributed to the formulation of hypotheses.	Educational research contributed to the formulation of hypotheses.
3. Empirical Testing	Philosophy (can) critique and evaluate empirical testing methods and results.	Literary analysis and criticism can provide insights and feedback on empirical testing methods and results.	Empirical investigations in psychology were conducted to test different aspects of the theoretical framework of metacognition.	Neuroscience research provided evidence to support or refute hypotheses.	Educational research (can) provide evidence to support or refute hypotheses.
4. Developing a Theory	Philosophical theories can contribute to the development of the theory.	Literary analysis and criticism can contribute to the development of the theory.	The accumulation of empirical evidence led to the development of a comprehensive theory that could explain the different types of metacognitive processes and components.	Neuroscience research can contribute to the development of the theory.	Educational research can contribute to the development of the theory.
5. Refining and extending the theory	Philosophical theories can contribute to the refinement and extension of a theory.	Literary analysis and criticism can provide insights and feedback on the refinement and extension of a theory.	Further empirical investigations can refine and extend the theory of metacognition.	Neuroscience research can contribute to the refinement and extension of a theory.	Educational research can contribute to the refinement and extension of a theory.
6. Exploring practical applications	Philosophical theories can explore practical applications.	Literary analysis and criticism can provide insights and feedback on practical applications.	Psychology research can explore practical applications, such as using metacognition to improve learning and problem-solving.	Neuroscience research can explore practical applications, such as using metacognition to improve decision-making.	Educational research can explore practical applications, such as using metacognition to promote self-directed learning.
7. Measuring and assessing the concept	Philosophical theories can critique and evaluate measures and assessments of the concept.	Literary analysis and criticism can provide insights and feedback on measures and assessments of the concept.	Psychology research can develop and evaluate measures and assessments of metacognition.	Neuroscience research can develop and evaluate measures and assessments of metacognition.	Educational research can develop and evaluate measures and assessments of metacognition.

The Development of Theory	Philosophy	Literature	Psychology	Neurosciences	Education
8. Future Research Trends	Philosophical theories can influence future research trends.	Literary analysis and criticism can provide insights and feedback on future research trends.	Future research trends in psychology may include investigating the relationship between metacognition and other cognitive processes.	Future research trends in neuroscience may include studying the neural mechanisms underlying metacognitive processes and developing brain-computer interfaces that can enhance metacognitive abilities.	Future research trends in education may include exploring the use of technology and gamification to promote metacognitive skills and investigating the effectiveness of metacognitive interventions in improving academic performance.